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shot (as imagined by the late Prof. Marreco and Mr. D. P. Morrison), or by a fall of roof, a train of mine waggons that has just passed, or any other accidental circumstance, and subsequently carried past the moath of the shot-hole at the instant the flame issues from it."

Immediately after the passage quoted above the Commissioners proceed to say :—

"The following facts relating to the part played by dust in coal-mine explosions may, however, now be regarded as conclusively established :—

"1. The occurrence of a blown-out shot in working-places *where very highly inflammable coal-dust exists in great abundance*, may, even in the total absence of fire-damp, possibly give rise to violent explosions, or may at any rate be followed by the propagation of flame through very considerable areas, and even by the communication of flame to distant parts of the workings where explosive gas-mixtures, or dust-deposits in association with non-explosive gas-mixtures, exist."

"2. The occurrence of a blown-out shot in localities *where only small proportions of fire-damp* exist in the air *in the presence of even comparatively slightly inflammable or actually non-inflammable, but very fine, dry, and porous dusts* may give rise to explosions the flame from which may reach to distant localities, where either gas accumulations or deposits of inflammable coal-dust may be inflamed, and may extend the disastrous results to other regions."

This has the appearance of conceding all that is asked, but when read in the light of the first quotation it leaves the matter in considerable doubt. Indeed, it was stated at the inquest on Altofts explosion that the proprietors of that colliery had not gathered from the Commissioners' Report that they were running any risk of an explosion, such as the one that happened ; and at the inquest on Elemore explosion, which has been adjourned until the 18th inst., Mr. Lishman, the manager, gave utterance to similar sentiments. Be this as it may, it is obvious that legislative measures ought to be adopted without further delay, with the object of rendering the recurrence of coal-dust explosions impossible for the future. In providing against them it must also be recollected that a local explosion of fire-damp, such as the one which originated Mardy explosion, produces exactly the same result as a blown-out shot fired under the most favourable conditions imaginable.

Cardiff, January 5 W. GALLOWAY

The Cambridge Cholera Fungus

IN your issue of December 23 (p. 171) appears a letter from Dr. E. Klein, in which that gentleman attempts to show that the micro-organisms found by Dr. Graham Brown, Mr. Sherrington, and myself in the substance of the mucous membrane of the small intestine in cases of *Cholera asiatica* are nothing more than "common mould (probably aspergillus)," which has grown on and into the tissue during the process of hardening. We were and are, however, perfectly well acquainted with the fact that imperfectly preserved animal tissues are liable to be invaded by various forms of fungi, and took, therefore, precautions which we believe to be ample to prevent such contamination of our material. Moreover, the presence of the micro-organisms in certain parts of the tissues only, their absence in others or on the surface of the specimens, the fact that their presence in the part is accompanied by anatomical changes which could not have taken place during the process of hardening, and, most of all, the characters of the micro-organisms themselves, render such an hypothesis as that brought forward by Dr. Klein absolutely unacceptable.

It is unnecessary for me to answer all the arguments advanced by Dr. Klein in support of his views on this subject. They prove nothing more than that fungi grow on and in animal tissues which are not adequately preserved—a fact which no one will doubt. That, on the other hand, the micro-organisms found by us are of this nature is a matter which neither Dr. Klein nor any other person who is unacquainted with the facts is in a position to decide. Since a short preliminary account only of the work done by Dr. Graham Brown, Mr. Sherrington, and myself, on the pathology of cholera has as yet been published, Dr. Klein has not before him the facts on which alone a decision of any value is possible. CHARLES ROY

Pathological Laboratory, New Museums, Cambridge
December 30, 1886

An Error in Maxwell's "Electricity and Magnetism"

THE criticism of Mr. McConnel upon Maxwell's derivation of the inductive action of currents from the principle of energy is perfectly correct. It is inconsistent with the experimental facts appealed to by Mr. McConnel and Mr. Maxwell's own treatment of the fi energy.

In the excellen d Joubert, a similar misleading proof, and I have little doubt th it. I should be inclined to thin y of the field was not distinctly

Maxwell, as is pplication of Lagrange's equatio case of two currents, this electro e equation—

$$T = \tfrac{1}{2}(L_1 i_1^2 + M i_1 i_2 + L_2 i_2^2),$$

where $M = \int\int \frac{\cos\epsilon}{r} ds ds'$ taken round both circuits, and L_1 and L_2 are similar expressions for the separate circuits.

I believe, though I dare not trespass upon your space to give the reasoning *in extenso*, that this result may be obtained somewhat more simply and without the use of the Lagrangean equations, a treatment which has the disadvantage of assuming the electric co-ordinates y_1 and y_2, the currents being $\dot{y}_1$ and $\dot{y}_2$. Then the equation of energy becomes

$$A_1 i_1 + A_2 i_2 = \frac{dT}{dt} + \frac{dT_m}{dt} + R_1 i_1^2 + R_2 i_2^2,$$

where T_m is material kinetic energy, and $\frac{dT_m}{dt} = i_1 i_2 \frac{dM}{dt}$

supposing the circuits rigid. Therefore

$$A_1 i_1 + A_2 i_2 = i_1 \left\{ \frac{d}{dt}(L_1 i_1 + M i_2) + R_1 i_1 \right\} + i_2 \left\{ \frac{d}{dt}(L_2 i_2 + M i_1) + R_2 i_2 \right\},$$

reducing to Mr. McConnel's equation, when the currents are constant.

In the case of two circuits thus moving in connection with their batteries we may infer that A_1 and A_2 must be such functions of i_1 and i_2, and the coefficients of configuration, that, when the suffixes are interchanged in the expression for A_1, that for A_2 must result, and *vice versâ*. If this be so, then the aforesaid equation necessitates the separate equations—

$$A_1 = \frac{d}{dt}(L_1 i_1 + M i_2) + R_1 i_1 ;$$

$$A_2 = \frac{d}{dt}(L_2 i_2 + M i_1) + R_2 i_2.$$

Or Maxwell's equations are obtained without the use of Lagrange. HENRY W. WATSON

Berkeswell Rectory, near Coventry

The Manipulation of Glass containing Lead

IN a note on this subject in NATURE (Dec. 16, p. 150), Mr. H. G. Madan has made a suggestion which is likely to be very valuable to those who require to manipulate "combustion-tubing" before the blow-pipe. But, in proposing the employment of oxygen in place of air to produce flames for heating glass containing lead, Mr. Madan introduces a refinement which is unnecessary ; for lead-glass may be quite as easily manipulated in flames produced by plain air and gas as soda-glass itself. The pointed flame should be employed for small objects, and the oxidising brush-flame in the case of larger objects. By the oxidising brush-flame, however, I do not mean the brush-flame as ordinarily employed, but one to which the air is supplied liberally through an air-tube without any contraction at its end, and at a steady pressure from a good blower ; care being taken, on the other hand, not to introduce such an excess of air as to reduce the temperature of the flame.

In his note, Mr. Madan quotes me as saying, in the "Methods of Glass-blowing," that the reduction of lead-glass may be prevented or remedied by holding the glass a little in front of the visible flame, with the comment that there is hardly enough heat in that region to do all that is required in the manipulation

of the glass. I hope he will excuse me if I point out that in this he hardly does me justice; for, although words in the above sense are to be found on p. 18, they occur only towards the end of the preliminary treatment of the subject, attention is at once called to the objections to the method, and they are followed by a full account (with references to diagrams) of the method of adjusting the supplies of air and gas so as to produce flames *within which* lead-glass may be sufficiently heated without reduction.

I have ventured to trespass on your space to this extent, because, for various reasons, I have come to the conclusion that lead-glass is distinctly the best glass for beginners to work with, and therefore I am anxious to correct the widespread and mistaken idea that its manipulation is very difficult, and requires special appliances. W. A. SHENSTONE

Clifton, December 28

Pyrometers and Fusion-Points

I READ with much interest the letter from Naples of Dr. H. J. Johnston-Lavis, and beg to offer a few suggestions in answer to his inquiries. I have done much work with pyrometers, and for my purposes have used Siemens's water pyrometer with satisfaction.

It occurs to me, however, that the pyrometer most suitable for the volcanic lava investigations proposed by Dr. Johnston-Lavis would be either Siemens's electrical pyrometer, or the one recently introduced by Messrs. Murries and Co., 45, West Nile Street, Glasgow. It would seem that, with the latter, observations can be readily taken at a considerable distance from the pyrometer, so that the pyrometer stem might possibly be lowered into the crater, and readings of the internal temperatures taken at various depths, and possibly of the contained lava also.

With regard to the fusing points of various substances, reference may be made to the recent careful researches on this subject of Dr. Thomas Carnelley and Prof. W. C. Williams.

THOS. ANDREWS

Wortley Iron Works, near Sheffield, January 4, 1887.

Electricity and Clocks

THE exact combination about which Mr. Wilson inquires is already in existence: it can be seen at 2, Garfield Buildings, Gray's Inn Road, in the Jensen electric bell factory. The arrangement used by Mr. Jensen—and it seems to me preferable to that suggested by Mr. Gardner—is to cause the hammer of the small clock to make electric contact in the circuit of the distant large bell as it rises in preparation for striking the blow upon its own small bell. With a rubbing contact the action is perfectly certain. SILVANUS P. THOMPSON

City and Guilds Technical College, Finsbury

Barnard's Comet

ON December 25, about 6h., with a binocular field-glass, power about 4, I noticed a third tail to this comet between the other two. It was extremely faint, but 6° long, reaching to 11 Aquilæ. The principal tail was reduced to 10° in length, and was far more conspicuous than this shorter, though much broader, tail. The shortest tail, though actually much brighter than this latter, was very indistinct with these field-glasses, being best seen with the telescope, power 20, whereas the middle tail was not distinctly visible therewith, although it showed an evident dark space immediately preceding the principal tail. With the naked eye I could see the long tail only. The head was about as bright as δ Aquilæ. T. W. BACKHOUSE

Sunderland, December 29, 1886

Meteor

I HAVE just seen a very beautiful meteor about the size of Sirius. The local time was within a minute or two of half-past 10. It started out between Pollux and the star-cluster in Cancer, and fell rather slowly in the direction of Regulus, going out before it reached that star. It had a trail, which vanished with it. The sky had just cleared after a thunderstorm.

Sidmouth, December 28 J. M. H.

Red Sunsets and New Zealand Eruptions

NEW ZEALAND eruptions have not the projectile force to cause red sunsets. Singularly, the very same current of ideas expressed by Prof. Newcomb in NATURE, vol. xxxiv. p. 340, occurred to the writer, when in Australian waters the June previous, on the deck of the P. and O. steamer *Ballaarat*, off the Great Bight, on noticing a peculiarly red northerly sunset. The newspapers at King George's Sound were full of accounts of the magnitude of the eruption of Tarawera, and it must be the fine dust from New Zealand that has passed overhead.

The atmosphere of Australia, it may be mentioned, is one of the clearest, "exceptionally free," as Prof. Newcomb puts it, "from vapours or other attenuated matter," and in which volcanic dust would tell immediately.

This suggestion disappeared at once on getting to the actual site of the New Zealand eruption, only six weeks after it had occurred, and on seeing the limited area covered with mud—a mere nothing compared with the vast stretch of country in the North Island passed through. As there was not a trace of its effects till within eight miles of the foot of Tarawera, it was simply ridiculous to suppose that any of the dust had invaded the higher atmosphere.

Besides this, the boundary of the cloud of atmospheric disturbance was distinctly seen, and the altitude placed by none of the spectators to be above 12,000 feet.

The explosion at Tarawera appears to have been merely one of superheated steam. It was different in the case of Krakatão, where the initial force had much more of the character of an explosion of nitroglycerine than of high-pressure steam, as the matter was stated to have been projected at least 40,000 feet into the air.

The magnitude of the New Zealand eruption could only be felt after getting well within the diameter of sixteen miles on which the mud fell, plastering hill and dale, evenly, of a dull gray, eighteen inches thick. Exterior to this it possessed none, and the distant results evidently were infinitesimal.

The writer also saw the "green sun" from the south of India, where it lasted for days, and has no doubt that this phenomenon was due to the dust from Krakatão, such an appearance having never been even faintly approached, before or since, from ordinary natural causes, and more impressive, because unaccounted for, than a total eclipse of the sun.

India, November 26, 1886 A. T. FRASER

THEODOR VON OPPOLZER

THEODOR VON OPPOLZER, one of the most eminent of modern astronomers, died at Vienna on December 26, 1886. He was the only son of Johannes von Oppolzer, the famous pathologist of Vienna, and was born on October 26, 1841. In accordance with the wish of his father, he studied medicine, and took his doctor's degree in 1863. From early youth he had shown great interest in astronomy, and, soon after taking his degree, he caused an observatory to be built at his own expense, and resolved to devote himself wholly to his favourite science. In 1866 he began to lecture at the University of Vienna, on theoretical astronomy, and he was soon promoted to the position of full Professor in his department. In 1870 he was asked by his Government to take charge of the operations for determining the length of a degree in Austria, and to this task he applied himself with so much energy that all the necessary observations were by and by completed, although his results have not yet been published.

Oppolzer distinguished himself in all departments of astronomical science. One of the most important of his writings was his "Lehrbuch zur Bahnbestimmung der Kometen und Planeten," a work which has already become classical. He had hoped to place the theory of the moon on a new basis, but his labours in connection with this subject were not finished at the time of his death. On his death-bed he corrected the last proof-sheets of his "Canon der Finsternisse," in which he calculates all the eclipses of the sun and moon which have taken place, or which have yet to take place, between the years B.C. 1500 and A.D. 2000.

His services to science were recognised by all the great learned Societies, and he was a Foreign Member of the Royal Astronomical Society of London. He was a man of a singularly noble personal character, and his death is deeply regretted by a wide circle of friends.

THE COLONIAL AND INDIAN EXHIBITION

CANADA.—This section of the Exhibition will be remembered chiefly for its agricultural machinery in motion, its fur, and agricultural trophies, and its large collection of furniture. The collection of fruits in the agricultural trophy has probably never before been equalled either in number, variety, or perfection of preservation, the colours of the several fruits being extremely well preserved in various solutions, such as dilute sulphurous acid for the lighter coloured fruits or salicylic acid for the darker ones. Besides these, however, there were numerous exhibits which, though less imposing to the general visitor, were of considerable interest, such, for instance, as the collection of timbers, and manufactures therefrom, photographs of American timber-trees, &c. The enormous sizes of many of the American Coniferæ were well illustrated by magnificent planks of such woods as the Douglas fir (*Pseudotsuga Douglasii*), some sixteen feet high and about ten feet in diameter, large slabs of hemlock spruce (*Tsuga canadensis*), also enormous logs of black walnut (*Juglans nigra*), and many others. Perhaps the most compact and interesting collection of timbers, however, was that from New Brunswick, where the woods were arranged so as to form a kind of design, the lower or basal portion being formed of trunks of trees, with their barks remaining, about three feet high, over this were arranged sections of the wood in frames composed of the young branches with the bark on; and above these, again, panels of the same wood as shown below, cut longitudinally and with a cross section at the base, both polished to show the grain or figure, and on the panel of each wood was painted a very good representation of a spray or branch of the plant itself. Each specimen was properly named, so that the whole thing was very complete. The series of photographs before alluded to are correct representations of the tree flora, each photograph being framed with the wood of the tree illustrated. The general use of the bark and wood of the cedar of British Columbia (*Thuja gigantea*), for useful and ornamental articles, was well shown in the exhibits of mats, native head-dresses, masks cut from the solid wood and grotesquely painted, spoons, whistles.

Fiji.—Though the space occupied by these islands was but small, the exhibits were of an interesting character, including a fine set of native timbers, for the most part scientifically named, and including some large blocks of Fijian sandalwood (*Santalum yasi*), roots of the kava (*Piper methysticum*), which is generally used in the Society and South Sea Islands in the preparation of an intoxicating beverage by chewing the root, ejecting the saliva into large bowls, and then fermenting it; or by pounding the root between two stones, then putting it into a bowl, pouring water upon it, kneading it, and afterwards straining it. The taste is said to be like that of soap-suds, but a liking for it is easily acquired, and it is said to quench the thirst better than any other beverage. A spirit prepared from it in Germany was sold in the Exhibition under the name of yagona or kava schnaps. This spirit, which is something of the nature of a liqueur, is described as having medicinal properties, and is recommended for its remarkable soothing and stimulant effects, restoring faded energies and exhausted nerve-power. Cocoa-nut fibre and oil of course form large staples of produce in Fiji, and were fully represented in the Exhibition, as well as dilo nuts and oil (*Calophyllum inophyllum*). Some excellent samples of sugar, grown and manufactured in the islands, and tea, also grown and prepared in Fiji, as well as many other products, were shown in quantity. Great credit is due to the Executive Commissioner, the Hon. J. E. Mason, for making the resources of his colony known by the distribution of small samples, during the period the Exhibition was open, to any one having a real interest in their development.

Victoria.—Besides the splendid collection of water-colour drawings of Australian plants exhibited on the north side of the Court, the fine series of Victorian woods, the golden arch, and the native encampments, all of which attracted a considerable amount of attention, the products of the genus *Eucalyptus* in the shape of oils and resins, exhibited by Mr. Joseph Bosisto, M.P., and President of the Commission, were among the most interesting and important. Samples of the oil of *Eucalyptus amygdalina*, rectified and non-rectified, were shown. This is the best quality of eucalyptus oil, and the oil for the preparation of which Mr. Bosisto's firm has become noted. A sample of the essential oil of eucalyptus of commerce was also shown, and described as being obtained from the allied varieties of *E. amygdalina*, but not from the true species. So many varieties of this species are known that it is difficult for bushmen who collect the leaves to distinguish those of the true species from its congeners, forming, as they often do, a compact jungle or bush growing in close proximity to each other. The oil is rubefacient, antiseptic, disinfectant, and a deodorant of great power. The essential oil of *Eucalyptus globulus*, the blue gum-tree of Victoria, having tonic, stimulant, and antiseptic properties, as well as those of *E. oleosa*, *E. dumosa*, *E. citriodora*, *E. goniocalyx*, *E. obliqua*, &c., were also shown. A sample of eucalyptol from *E. amygdalina* and *E. globulus* is described in the Catalogue as "a homologue of camphor, and appears to be two steps higher in the series. Its vapour, mixed with air, is agreeable when inhaled, and is employed as a therapeutic agent in bronchial and diphtheritic affections." Amongst resins were those of the red gum of Victoria (*E. rostrata*), described as a thoroughly soluble and delicate mucilaginous astringent, and *E. resinifera*, Australian kino. Fine samples of the resin of the Australian grass-tree (*Xanthorrhœa hastilis*) were also shown. This is obtainable in large quantities; it is of a deep amber colour, soluble in spirit, and is used for staining wood to imitate cedar and oak, and is also used in this country in French polish to deepen the colour of light mahogany and other woods.

New South Wales.—Minerals, wools, timber, and furniture made of the timber, were the principal objects exhibited. None of the woods called for any special remark except, perhaps, a small collection either known or considered to be adapted for wood-engraving, and these specimens were of little or no value in themselves, being badly selected, and in many cases much split or cracked. The collection was more valuable as giving a clue to the source of the woods considered suitable for engraving purposes than for any qualities of their own. Among the woods so exhibited were *Backhousia myrtifolia*, *Hymenosporum flavum*, *Xanthoxylum brachyanthum*, *Acacia Cunninghami*, *Duboisia myoporoides*, *Dysoxylon Fraserianum*, *Gmelina Leichhardtii*, *Hemicyclia australasica*, *Weinmannia rubifolia*, *Eugenia myrtifolia*, *Pentaceras australis*, and others. Amongst fibres and fibrous barks was the bark of the small-leaved nettle-tree (*Laportea photiniphylla*), also a fishing-net, cordage, and a dilly bag made from the fibre by the aborigines of the northern coast districts. The collection from New Guinea exhibited in this Court was of considerable interest. The utilisation of the bony seed shells of *Pangium edule* for decorating the skin drums is one not seen by us before. The seeds produce a rattling sound when shaken similar to those of *Thevetia nereifolia*, which are used for like purposes in British Guiana.

South Australia.—The centre of attraction here was undoubtedly the scene on the Murray River wherein the habits of the aborigines were depicted. Wool figured largely, and the applications of emus' eggs for a great variety of purposes were fully illustrated. A good collection of small specimens of the woods of the colony was shown, as well as a collection of fruits and seeds.

Western Australia.—A fine collection of the timbers of the colony was exhibited in this Court, and outside near the basin adjoining. The principal woods shown were jarrah (*Eucalyptus marginata*), and karri (*E. diversicolor*). Of the former, one of the principal attractions in the Court was a log, some seven feet long, over four feet in diameter, and weighing nearly five tons, carefully polished on one end to show the cross section, and in the middle to show the longitudinal structure. The wood has a very fine deep red colour, and "for the durability of its timber," Baron Mueller says, "is unsurpassed by any kind of tree in any portion of the globe." When carefully selected and dried, it is proof against the attack of teredo, termites, or any other wood-borers. It is consequently in great demand for jetties, piles, railway-sleepers, fence posts, and all kinds of underground work, as well as for planking and frames of ships. This fine block of wood, and a fine slab or counter-top of figured jarrah and other West Australian woods, have been presented to the Museum of the Royal Gardens, Kew. Amongst the plants exhibited as being used for tea by the natives were the following:—The leaves and flowers of *Verticordia pennigera*, known, it is stated, to the settlers in the earlier days of the colony, and used medicinally. The taste is said to be similar to Chinese tea. Another kind of native tea proved upon examination to be furnished by *Kunzea Muelleri*.

Queensland.—Of vegetable products exhibited from this colony the collection of woods was the most noteworthy, not only for the number of species, but for the care shown in their selection and preparation. The two enormous trunks of cedar (*Cedrela Toona*), each some fifteen feet high, and one with a girth of twenty feet five inches, will as long be remembered for their majestic size by those interested in tree growth as the number and brilliancy of the opals will be remembered by those interested in gems.

New Zealand.—Next to the collection of birds and minerals, the timbers of New Zealand held a prominent place, and the furniture made from the most important and beautiful woods, such as mottled kauri (*Dammara australis*), and totara (*Podocarpus totara*) was well illustrated. The beauty of these woods is so great that it is remarkable they should still remain comparatively unknown amongst cabinet-makers in this country.

Cape of Good Hope.—The centre of attraction in this Court was undoubtedly the diamonds and diamond-polishing. Of the vegetable products a collection of native medicinal plants was shown, and their uses were well described in the catalogue of Cape exhibits, and for the most part are to be found also in Pappe's *Florae Capensis Medicae Prodromus*. There was also a very fine collection of well-seasoned and polished wood slabs, amongst them being Outeniqua yellow-wood (*Podocarpus elongatus*), an extremely valuable, fine-grained wood of a light yellow colour, useful for furniture, planks, flooring-boards, beams, &c. One slab of this fine wood—which was almost entirely hidden during the Exhibition by a counter being built over it, and measures about twenty feet long by five feet in diameter—has been presented to the Kew Museum, together with a fine set of other Cape woods, many of which might become useful in this country were they better known, notably the stinkwood or laurel wood (*Oreodaphne bullata*), a dark-coloured wood much resembling walnut in appearance, but heavier and considerably stronger, so that it has been recommended quite recently for gun-stocks. In the colony it is very highly prized for nearly every kind of work connected with building and cabinet-making, being little inferior if not equal to teak in strength and durability.

Natal.—Raw vegetable products largely predominated in this Court. Sugar, maize, tea, and tobacco were the principal staples. The cultivation and manufacture of tea is a new industry for Natal, and the result is that an article of very good quality has been produced, Natal tea having been on sale during the period of the Exhibition and well spoken of, so that there seems every probability of a future trade in this article with Natal. Amongst tanning materials we noticed the root, both entire and broken, of the Elands Bontjis (*Elephantorhiza Burchellii*), which has attracted some attention of late as a valuable tanning material. Preserved native fruits, such as granadilla (*Passiflora maliformis*), papaw (*Carica Papaya*), amatungulu (*Carissa grandiflora*), and others, were exhibited, as well as a variety of hard woods, many of which were without scientific names.

West African Settlements.—Under this head was included the Gold Coast, Lagos, Gambia, and Sierra Leone. The exhibits consisted largely of raw products of both the vegetable and animal kingdoms, together with some native manufactures, such as textiles from indigenous palm fibre or grasses, carvings in wood, &c. Oil seeds were shown in variety as well as in bulk, and notable amongst them were the kernels of *Elais guineensis*, malukeh seeds (*Polygala rarifolia*), which only occasionally finds its way to this country, physic nuts (*Jatropha Curcas*), benni-seed (*Sesamum indicum*), and others as well known. Some very large balls of rubber were exhibited from Sierra Leone, and some fine masses of a kind of gum copal from the Gold Coast.

Ceylon.—Vegetable products abounded in this Court. On the walls were exhibited no less than 362 specimens of native vegetable drugs, got together by the Director of the Royal Botanic Gardens, Peradeniya. A very fine series of planks of the principal useful or ornamental timbers were exhibited, amongst them being tamarind, satinwood, ebony, calamander, and nedun (*Pericopsis mooniana*). The most attractive of the Ceylon woods is certainly calamander, but this is said to be now extremely scarce, and as it is of slow growth, the supply is very limited. Satinwood trees are common "in the northern, eastern, and north-western forests, but the proportion of these which yield 'flowered satinwood' is very small, and this description of wood is therefore comparatively high in price." Notwithstanding this scarcity of "flowered satinwood," several of the show-cases which contained the exhibits of tea, cardamoms, &c., and some of the barrels containing coffee, were of flowered satinwood. The Ceylon collection on the whole was one of particular interest.

India.—The extent of space occupied by our Indian Empire, and the varied and interesting character of the exhibits, will long be remembered. The contents of the art courts do not come within our notice, but there was sufficient material in the Economic Court for an extended notice. Space, however, will not allow us to say more than a few words on the unrivalled collection of the raw products of India—such a collection, indeed, as in all probability was never brought together at one time before. In such a collection it would be impossible to individualise any of the exhibits—those most striking, such as the bamboo bridge, will remain fresh in the memory—but it is in such details as the individual contents of the several shops that the interest of the economic botanist lies. To obtain any idea of the contents and value of the Indian Economic Court, we must refer our readers to the recently-issued "Special Catalogue of Exhibits," a large portion of which has been compiled by Dr. Watt, who had charge of the Economic Court during the Exhibition. This catalogue is a valuable and interesting record of one of the most important sections of the whole Exhibition.

We cannot close these notes without saying a word in commendation of the excellence of most of the catalogues, especially those of Ceylon and the Cape of Good Hope.

JOHN R. JACKSON

Museum, Royal Gardens, Kew

IPECACUANHA CULTIVATION IN INDIA

THE following note is from a letter which I have received from Mr. Gammie, who has charge of the cinchona plantations of the Bengal Government at Darjeeling. The facts are of considerable biological interest, as showing that amongst closely connected forms, which can scarcely be distinguished by palpable morphological differences, there may yet be unobvious constitutional distinctions which in the struggle for existence may determine the survival and ultimate dominance of some one form in particular.

The facts are also perhaps interesting in another way. To any one who will be at the pains to turn up vol. vii. of NATURE, p. 6, it will be amusing to see the sequel which the chance of circumstance has brought to one branch of a long-burnt-out controversy.

W. T. THISELTON DYER

Royal Gardens, Kew, December 13

"I don't think I ever told you the final results from our ipecacuanha-growing experiments, but do so now.

"Our original stock of plants came from Kew and Edinburgh—the great majority from Edinburgh. The few plants from Kew differed a good deal in appearance from the Edinburgh lot, which, again, differed greatly from each other. All the Kew plants were of one sort, which we named, from the start, the Kew variety. It was rougher in the leaf than the Edinburgh sorts, and not so strong-growing while under glass.

"After we had satisfied ourselves that we could make nothing of ipecacuanha, from a commercial point of view, we put all the plants out in the open, under shade, and let them take their chance. By this time we had all the sorts mixed up together; and as we had originally at least ten Edinburgh plants for each one of the Kew sort, and the Edinburgh lot had, besides, been much the stronger growers under glass, the Kew plants formed less than 5 per cent. of the whole. But very soon the Edinburgh sorts began to disappear, until, in the course of a year or two, there was not a single plant of one of the Edinburgh varieties alive, whilst almost every plant of the Kew variety lived. Of it, at the present moment, we have a good stock, and in one place, at 1400 feet elevation, under the shade of living trees, we have plants, which were put out many years ago, in the most perfect health, but unfortunately their growth has been so slow as to render the prospect of any profitable return from them almost hopeless. Still it strikes me that, in places geographically better situated for ipecacuanha-growing than Sikkim, this particular variety may succeed, although other sorts may have failed. Probably our ipecacuanha experiments may prove another instance of the folly of giving up the cultivation of new crops as hopeless until the most exhaustive experiments have been carried out. It may be that there are even hardier varieties of ipecacuanha than the 'Kew variety' to be found."

SUNSPOT OBSERVATIONS IN HUNGARY[1]

THE Observatory, of which the first volume of Publications is now before us, was founded by Cardinal Haynald in 1878 in connection with the archiepiscopal gymnasium at Kalocsa in Hungary. Preliminary geodetic operations, of special importance as supplying an independently determined point of reference for the Hungarian survey, with the examination and adaptation of instruments, cost much time and labour; so that only a fragmentary part of the energy of the establishment has hitherto been available for purely astronomical work. The Director, however, Dr. C. Braun, has wisely embraced the rule of concentration which governs most successful campaigns, and is hence enabled to present, in lieu of a multitude of scattered and perhaps useless observations, the connected results of four years' solar study, unpretending in aim, but thoroughly well executed, and developed with much clearness and not a little originality. The time, it is true, has somewhat gone by for visual solar work of the kind here described; and Dr. Braun, like all other astronomers, is getting ready his camera. Still, it is well worth while to consider what has been learned—even at a somewhat disproportionate cost of labour—by graphical delineation pursued through fifty consecutive solar rotations.

The instrument employed was the smaller of two excellent Merz refractors possessed by the Kalocsa Observatory. It is of four Paris inches aperture, is equatorially mounted, and appears to possess uncommonly fine definition. To its eye-end was fitted an apparatus invented and constructed by Dr. Braun himself, by means of which an image of the sun 22 centimetres in diameter was projected, after total reflection from a right-angled prism, upon a sheet of drawing-paper. In this way nearly 5000 drawings of spots were executed during the years 1880 to 1884. For their reduction two expeditious methods—one graphical, the other computative—were devised; and the resulting heliographical latitudes are rendered strictly comparable with those derived by English observers, through the application of a small correction due to a difference in the adopted elements of the solar rotation. Now that sunspot observations have become cosmopolitan, it seems indeed a pity that there should not be unanimity on this point among astronomers. Dr. Braun conforms, however, to the solar prime-meridian chosen at Greenwich, so that the longitudes given in his maps practically coincide with Greenwich longitudes.

The highest grade of accuracy was not aimed at in these observations. Their object was the collection of materials for studying the processes of spot-formation and the relation of spots to prominences, with side-glances towards a possible, but every year less and less probable, transit of "Vulcan." The determination of the solar rotational elements, or of the minute changes of latitude of spots, was left to observers provided with the means of executing refined micrometrical measurements. Nor was the estimation of maculated area attempted. Yet with all these limitations, much of interest remains to be gathered from the paper before us.

The results are portrayed in fifty maps, each representing the aspect of the sun's surface between the parallels of 40° north and south, during one synodical rotation. The indication of the solar meridians which on successive days were central at mean mid-day (Kalocsa time) renders it easy to trace the fluctuating appearance of the actual visible disk throughout each period. The maps further contain two long sinusoid curves—one denoting the heliographical latitude of that point on each meridian of which the position-angle on the east limb was 90°, the other showing the latitude of the points similarly situated on the west limb. Hence the position-angle of any given spot as it traversed either edge of the sun can at once be deduced—a datum obviously much facilitating inquiries into the connection of spots with prominences.

To each map corresponds a table, in which, besides the heliographical position of each spot, something of its history and peculiarities is set forth—the number of times it was observed, the epochs of its appearance and disappearance, with a general description of its size and shape. Especial interest attaches to a table in which Dr. Braun

[1] "Berichte von dem Erzbischöflich-Haynaldschen Observatorium zu Kalocsa in Ungarn." Von Carl Braun, S. J. (Münster i. W.: Aschendorff, 1886.)

has separately collected particulars of sixty-one spots, held, with more or less of probability, to have presented themselves afresh after making the circuit of the sun, and hence to be available as guides to the period and law of its rotation. From these data he constructed a curve (Plate XVI. Fig. 2) showing the variations in the rate of spot-displacement with varying latitude, the perfect symmetry of which on either side of the sun's equator testifies to the absence of any systematic difference in this respect between the hemispheres. From the curve were derived three distinct formulæ of the solar rotation, all fitting perfectly with the observations within the parallels of 30°, but diverging widely in their results for high latitudes. For example, No. I. gives for the region close to either pole a period of just 33 days; No. III. of a little over 40; No. II. of 55·8 days. From Carrington's formula, Dr. Braun deduces a polar period of 30·86 days; Faye's implies one of 32; Spörer's actually reverses the direction of change beyond the spot-zones, indicating a recovery of velocity towards the far north and south, and a period, in latitude 90°, of no more than 25·1 days—about the same which prevails in parallels of 10°. It may be worth remarking, as at least a coincidence, that almost precisely this rate of motion was inferred by Father Secchi (very doubtfully, it is true) from observations of relatively stable prominences near the pole. Nevertheless, a survey of the discrepancies tabulated by our author can hardly fail to inspire a profound distrust of empirical formulæ, and still more of the risky process termed "extrapolation."

The swiftest-moving spot noted by the Kalocsa observers was situated 1° 20′ north of the equator; its estimated daily displacement of 868′ bringing about the completion of its circuit in 24·88 days. The most sluggish was in south latitude 29° 38′, and gave a period of 26·5 days. As might have been expected, considerable irregularities are apparent; yet not more than might reasonably be set down to uncertainties of observation. A much higher degree of accuracy must, however, be reached before the mean rate of motion proper to each parallel can be at all satisfactorily ascertained. This mean rate is itself, in Spörer's view, subject to cyclical change; and his observations during the years 1861-1871, as compared with Carrington's during seven preceding years, disclosed persistent differences not easily accounted for. Dr. Braun's results, on the other hand, agree quite as well as could be expected with those of the English observer. A further complication is introduced by what may be called the individual caprices of spots. Each spot has probably a velocity of transport peculiar to itself, depending upon the circumstances of its origin; this velocity is certainly subject to accelerations connected with the processes of its development. These accelerations (for the change of motion is always in a *forward* direction) are shown, in Prof. Spörer's recent communication to the Physical Society of Berlin, to be very considerable; they are beyond question highly significant; yet they emphasise our disadvantage in being compelled to rely upon such unstable phenomena for all our knowledge regarding that most important datum—the rate of the sun's revolution on its axis.

The Kalocsa solar observations were made at a critical period. They cover the whole of the prolonged maximum which culminated near the close of 1883, and disclose or confirm very satisfactorily some of its characteristics. Dr. Braun has depicted in a remarkable curve the progressive changes in the mean latitude of the spot-zones during the years 1880-84. Their continuous approach to the equator at once strikes the eye; but superposed upon the line of uniform descent is a series of minor oscillations with a period of about a year, and an amplitude of fully 2°, which seem too regular and strongly-marked to be the mere effect of accident. This feature is quite novel and deserves attention.

The general rule that the long series of spots comprised within each cycle break out first in high latitudes, and become extinct close to the equator, was first observed by Carrington, and may now be regarded as fully established. Ordinarily, the maximum occurs when the mean latitude of the zones is 16° or 18°, the energy of the disturbance diminishing as they close further in. But the retarded character of the recent crisis was significantly attested by the fact that it did not reach its height until the closing in had proceeded much further than usual. In 1882, when the maximum was due, the average latitude of spots was (from Dr. Braun's curve) about 16°; whereas, at the close of 1883, when the maximum actually occurred, it was no more than 11°. It would seem as if the punctual and duly prepared completion of the outburst had been frustrated, and its stored-up energy spent upon an abnormal protraction of the maximum.

It might even be said that the perturbation thus indicated affected chiefly, or solely, the southern hemisphere of the sun. Although the respective sum-totals of spots observed at Kalocsa north and south of the equator eventually almost exactly balanced each other, large temporary discrepancies were manifest. The northern hemisphere displayed in 1880 an excess of activity, still more conspicuous in the ensuing year. Southern spots, on the contrary, outnumbered northern in 1882 to the extent of 8 per cent., and in 1883 in the proportion of nine to five. Dr. Braun adds the remark that each hemisphere would almost seem to have completed its cycle of change independently of the other, the northern maximum having occurred late in 1881, while the southern was postponed for two further years. The cause of perturbation should, in this view, be localised in the southern hemisphere.

A. M. CLERKE.

NOTES

ON November 10 last, an important meeting of intercolonial delegates was held at the rooms of the Royal Society, Sydney, for the purpose of forming an Australasian Association for the Advancement of Science. There were delegates from all the principal scientific Societies of Australia, and they seem to have had no difficulty in arriving at a decision on the questions they had met to discuss. On the motion of the chairman, Mr. Russell, it was agreed that an association of the scientific Societies of Australasia should be formed under the name of "The Australasian Association for the Advancement of Science." It was also resolved that the rules of the British Association should be adopted, and that the first meeting of the Australasian Association should be held in Sydney in the first week of September 1888. This date was fixed because it will be the hundredth anniversary of the foundation of the colony of New South Wales.

Mr. H. N. RIDLEY, of the British Museum, intends to make an expedition to the island of Fernando Noronha for the purpose of investigating its natural history. The funds for the expedition have been supplied by the Royal Society, and Mr. Ridley hopes to be able to start at the end of February. The marine flora and fauna were collected by the *Challenger* Expedition, but owing to the fact that the island is a Brazilian penal settlement, no naturalists have hitherto been permitted to make collections therein. The Trustees of the British Museum have obtained from the Emperor of Brazil the necessary permission for Mr. Ridley's exploration of the island, which, from what little is known of it, and from its geographical position, promises to be of exceptional interest from a natural history point of view.

THE death is announced, at Victoria, British Columbia, of Dr. W. F. Tolmie. Dr. Tolmie's name has been favourably known to ethnologists for many years in connection with his researches respecting the Indian tribes of British Columbia and

neighbouring parts of the Pacific coast, where he has been almost continuously resident since 1833. Dr. Tolmie was a native of Inverness, but in 1832 accepted an appointment as medical officer to the Hudson's Bay Company at Fort Vancouver on the Columbia River, and subsequently became a chief factor in the Company's service. Information supplied by him to Mr. George Gibbs and other ethnologists has appeared in various publications. In 1884 he published, in conjunction with Dr. G. M. Dawson, a nearly complete series of short vocabularies of the principal languages spoken in British Columbia. He has had for many years a larger work in contemplation on the traditions and folk-lore of the same tribes, but the materials for it were not complete at the time of his death.

CHARLES SHALER SMITH, the distinguished engineer, died at his home in St. Louis, Mo., on December 19, 1886. He had been suffering from the effects of a fall, which resulted in serious injuries. From the first his case was considered very grave, but his great vital powers enabled him to keep up for two years.

MR. CLEMENT WRAGGE, late of Ben Nevis Observatory, and now of Adelaide, is to be appointed Meteorologist to the Government of Queensland.

YESTERDAY Prof. A. W. Reinold, F.R.S., delivered at John Street, Adelphi (the Society of Arts), the first of the usual short course of lectures adapted for a juvenile audience. The subject was "Soap Bubbles." The second lecture will be given on January 12.

THE lectures founded by Sir Thomas Gresham will be read to the public gratuitously on the following days, at Gresham College, Basinghall Street, in the subjoined order, beginning each evening at 6 o'clock:—Rhetoric (Mr. J. E. Nixon), January 18, 19, 20, and 21; law (Dr. Abdy), January 25, 26, 27, and 28; geometry (Dean Cowie), February 1, 2, 3, and 4; physic (Dr. Symes-Thompson), February 8, 9, 10, and 11; divinity (Dean Burgon), February 15, 16, 17, and 18; astronomy (the Rev. E. Ledger), February 21, 22, 24, and 25; and music (Dr. H. Wylde), March 1, 2, 3, and 4.

THE complaint is frequently heard that natural science does not get adequately encouraged in Oxford. Six weeks ago a notice was issued by Queen's College that an examination would be held on March 1, 1887, for the purpose of filling up various Scholarships and Exhibitions, including one Scholarship for mathematics and another for natural science. This notice was inserted in various newspapers, of which copies were sent to upwards of a hundred schools in England. The result is that *one* candidate has signified his intention of offering himself for examination in natural science. No doubt there will be at least ten candidates for the vacancy in mathematics, and twenty for each vacancy in classics. This certainly does not show a demand for natural science scholarships in excess of the supply.

ON December 9 the Council of the College of Surgeons adopted, and ordered to be entered on the minutes, a report from the Committee, recommending that the Committee's powers should be enlarged, with a view to the extension of the museum and the library, and the addition of work-rooms. It was also recommended that the Committee should receive power to take other improvements into consideration, and to inquire to what extent an increase of the staff would be rendered necessary by the proposed changes. The improvements, it is believed, would be paid for out of the Erasmus Wilson legacy. The scheme is likely to meet with some opposition, and before finally deciding on a matter of so much importance the Council would do well, as the *British Medical Journal* suggests, to submit its plans to the Fellows.

WE regret to notice that objection is being made in Hong Kong to the expense of publishing in the official gazette the Monthly Weather Reports of the Observatory there. These tables, which have frequently been noticed in these columns, contain the usual statistics of evaporation, radiation, the relative humidity and tension of aqueous vapour, the classification of clouds, and other meteorological details. The local critics say that these are of no practical value; but they surely forget that similar tables are published by every Observatory in the world. The Tokio and Siccawei establishments, to select two which are nearest to Hong Kong, publish periodically the same meteorological statistics, and it is therefore sincerely to be hoped that Dr. Doberck will be permitted to pursue his arduous and useful labours. The colony handsomely voted a sufficient sum for an Observatory a few years ago without question, and the work which it has since done is appreciated in Europe. Only a few weeks since we printed a paper by Dr. Doberck on the typhoons of the China seas, which was essentially and directly practical, for it told the mariner of the various classes of these storms, their direction, and course, and the time at which they are most prevalent. It further explained how vessels caught in these typhoons may best minimise or escape altogether from their evil effects. All this information, the value of which for the protection of life and property, can be appreciated nowhere better than in Hong Kong, with its enormous shipping trade, is obtained only by the careful and sedulous collection and collation of statistics. The physical position of Hong Kong renders its Observatory one of considerable importance in meteorological science, and it is the duty of the colonial Government to see that the institution is not allowed to decline from the high standard which it has already attained.

THE ideas of some Americans as to the education of women seem to be very far ahead of those which still prevail in this country. At Northampton, near Amherst, an observatory is being built by the Trustees of Smith College for young women. Mr. David P. Todd, Director of the Amherst College Observatory, has lately devoted much time to the plans for the construction and equipment of this building, taking care that it shall be thoroughly fitted for the purposes of collegiate instruction, and that it shall contain ample facilities for research.

A SOCIETY for the promotion of the higher education of women has been founded in Japan, under the presidentship of the Prime Minister, and with the support of various influential foreign and Japanese gentlemen. Besides regular courses of instruction which will be provided, special courses of afternoon lectures will be delivered by the professors of the University. The whole institution will be under the control of a foreign lady principal, assisted by two or more foreign lady teachers. Although female education in Japan has already reached an advanced stage, this appears to be the first attempt to provide for the higher education of women, as understood in European countries.

THE late Mr. Greenleaf, the Boston hermit, left the whole of his fortune—probably amounting to five hundred thousand dollars—to Harvard College. The conditions imposed by him are said to be not unreasonable, but it would have been better, as *Science* urges, if he had imposed no conditions whatever. Wealthy men who think of bequeathing money to learned institutions apparently find it hard to realise that the authorities of those institutions are likely to be the most competent judges of the way in which the money should be spent. The needs of Harvard College were certainly not so well known to Mr. Greenleaf as to its President and Faculty.

THE other day *Science* commented on the fact that advertisements calling for applications for vacant Chairs in leading educa-

tional institutions are often inserted in educational and literary journals in England. This is never done in the United States. There were no fewer than forty applications for a recent vacancy in a prominent American college, and if the appointment had been advertised, the number would no doubt have been very much larger. *Science* is of opinion that American colleges lose nothing by declining to follow the English example in this matter, since in the case of every important college "the president and trustees keep their eyes continually open, and when a vacancy occurs they are pretty sure to know who is the best man for the place, or, in any event, they have made up unconsciously a short list from which the selection is to be made." A distinct advantage of the American plan is that governing bodies are not troubled with the importunities of persons who wish to be appointed to positions for which they are wholly unsuited.

THE Wagner Free Institute of Science, Philadelphia, has issued a valuable report, by Mr. Angelo Heilprin, on his explorations on the west coast of Florida and in the Okeechobee Wilderness. Mr. Heilprin is of opinion that the whole State of Florida belongs exclusively to the Tertiary and post-Tertiary periods of geological time, and consequently, as a defined geographical area, represents the youngest portion of the United States. There is not, he thinks, a particle of evidence supporting the coral theory of the growth of the peninsula. Sedimentation and deposition along this portion of the American coast appear to have been practically unbroken or continuous, as is indicated by the gradational union of the different formations, and the absence of broad or distinct lines of faunal separation. The elevation of the peninsula, especially in its more southern parts, seems to have been effected very gradually, judging from the perfect preservation of most of the later fossils, and the normal positions—*i.e.*, the positions they occupied when living—which many of the species still maintain. There is evidence that before its final elevation a large part of the peninsula was for a considerable period in the condition of a submerged flat or plain, the shallows covering which were most favourably situated for the development of a profuse animal life, and permitted of the accumulation of reef-structures and of vast oyster and scallop banks. The present submerged plain or plateau to the west of the peninsula may be taken to represent this condition. Fresh-water streams, and consequently dry land, existed in the more southern part of the peninsula during the Pliocene period, as is proved by the inter-association of marine and fluviatile mollusks in the deposits of the Caloosahatchie. Mr. Heilprin holds that the doctrine of evolution receives positive and most striking confirmation in Florida, because the modern fauna of the coast is indisputably a derivative, through successive evolutionary changes, of the pre-existing faunas of the Pliocene and Miocene periods of the same region; and the immediate ancestors of many of the living forms, but slightly differing in specific characters, can be determined among the Pliocene fossils of the Caloosahatchie. He is also convinced that man's great antiquity on the peninsula is established beyond a doubt, and he suggests that the fossilised remains found on Sarasota Bay, now wholly converted into limonite, may represent the most ancient belongings of man that have ever been discovered.

AN interesting paper on the sub-genus Cylinder (Montfort) of Conus, contributed by Mr. J. Cosmo Melvill, M.A., F.L.S., to the tenth volume of the third series of Memoirs of the Manchester Literary and Philosophical Society, has been reprinted. Mr. Melvill has much to say about the *Conus gloria maris*. This exquisite shell is "prominent among all its kindred for beauty of shape and excellence of pattern;" and "the reticulations are so fine as to defy the skill of the lithographer." The land of its nativity is Jacna, island of Bohol, Philippines, where the late Mr. Hugh Cuming found two examples, one very juvenile, scarcely more than an inch in length. Mr. Cuming tried hard to find other specimens, employing all the available natives in dredging expeditions; but his efforts were unsuccessful. It is said that the original very circumscribed locality has been annihilated by an earthquake, and Mr. Melvill thinks that this is not improbable. Only twelve specimens are known to exist. Five are in this country, and one of them is in Mr. Melvill's collection at Prestwich. Another—perhaps the finest specimen known—is in the collection which belonged to the late Mrs. De Burgh, and three are in the British Museum collection at South Kensington. A good example was bought by Mr. Lovell Reeve in 1865 for the Melbourne Museum.

WE have received a "List of the Macro-Lepidoptera of East Sussex," compiled by Mr. J. H. A. Jenner, F.E.S., Lewes. It is reprinted from the Proceedings of the Eastbourne Natural History Society. East Sussex, according to Mr. Jenner, is probably one of the richest, in number of species, in the country. This he attributes to the southern latitude of the district and its varied characteristics—its downs, marshes, extensive woods and forests, and its sea-coast. Some parts of East Sussex have been well worked by entomologists, especially near the larger towns, but little is known of some of the outlying districts.

AMONG the numerous forms of fungus which live upon higher plants (many of which are so detrimental to their hosts) are some, it is now believed, which live with these on terms of mutual assistance. Frank found that the young root points of some of our forest trees, as the beech and the oak, are covered with a coating of fungus (probably belonging to the truffle or allied family), which seems to help in the nutrition of those trees. Another interesting case is that of fungi which live with orchids, and whose mode of propagation has lately been established by Herr Wahrlich (*Botanische Zeitung*). The fungus appears in the outer cells of the root tissue in the form of yellow bladder-like balls (of the nature of *haustoria* or suckers) surrounded by numerous filaments. It works no perceptible harm to the plant, but on the contrary it is thought that, especially in the case of orchids which live on the humus of woods, the fungus probably transforms the humus matters into such as are more easily utilised by the orchid, thus doing it a physiological service. The fungi observed by Herr Wahrlich belong to the family of *Pyrenomycetes*, and the genus *Nectria*.

THE amount of free carbonic acid in the ground has been lately shown by Prof. Wollny (we learn from *Naturforscher*) to depend, on the one hand, on the factors of decomposition of organic substances (heat, moisture, porosity), as affected by the physical nature of the ground and its covering; on the other hand, on the resistance which the ground presents, according to its mechanical state, to the escape of the gas. Ground-air seems to have most carbonic acid when the ground is at a slope of about 20°. Slopes facing south have most carbonic acid; those facing north, least, though the difference is not great, as the two principal factors, heat and moisture, largely counteract each other. In drought, ground facing north has more carbonic acid. With equal quantities of organic matter there is more carbonic acid, the more finely granular the ground; and such ground hinders movement of the gas downwards as well as into the atmosphere. The air in ground shaded by living plants has considerably less carbonic acid than that in bare ground, and in the latter it has less (in dry years, not in wet) than in ground covered by dead parts of plants.

IN lecturing upon the "Denizens of the Aqueous Kingdom" on Friday last at the Royal Aquarium, Mr. August Carter referred to deformities that exist among fish. In 1885 and 1886 he had examined many thousands of trout and salmon fry at South Kensington on their emerging from the ova, and found

one case of deformity in every thousand, and one case of monstrosity, such as twin and dual-headed fish, in every four thousand. From observations he had made at the South Kensington Aquarium and elsewhere, the lecturer concluded that certain fish, such as the carp and perch, have the power of communicating with one another.

WHILST collecting fish ova from the River Colne for the hatchery at the Delaford Fish Culture Establishment, the water-bailiffs found an "egg-bound" trout, that is, one that had died through being unable to extrude its eggs. It was brought to Mr. W. Oldham Chambers, who on examination found the ova to be thoroughly healthy, although the fish, judging from its decomposed state, must have been dead about three weeks. He at once obtained a milter, and succeeded in impregnating the ova, which appear to be quite healthy and capable of incubation. The spawning season has been greatly retarded by the extreme severity of the weather.

WE have received the first number of the *Cycling Budget*, the editors of which undertake to keep cyclists "thoroughly well posted in every imaginable topic which may be of service to them." There are to be careful analytical descriptions of every new or modified type of machine as it comes into the market. The *Budget* advocates the building of a club-house for cyclists in London. In America, it appears, there are magnificent club-houses for "the votaries of the pastime."

DURING the year ended October 31, 1886, the total quantity of steel and ingot iron made from phosphoric pig was 1,313,631 tons, of which 927,284 tons were ingot iron containing under '17 per cent. of carbon. As compared with the make of the previous twelve months, there was an increase of about 368,314 tons. The total quantity produced represents about 394,000 tons of slag, containing from 30 to 35 per cent. of phosphate of lime. Most of the basic slag made in Germany is finely ground, and used in place of superphosphates.

M. ALFRED MARCHE, who has already been despatched on more than one scientific mission to distant regions on behalf of the French Ministry of Public Instruction, left Marseilles on the 19th ult., on a similar errand, for the Marianne Islands.

M. THOUAR'S expedition to solve the question of the navigability of the Pilcomayo, and its suitability as a trade route between Bolivia and the eastern parts of South America, has had to be postponed so far as the upper waters are concerned, owing to the refusal of the Bolivian Government at present to supply its share of the funds for the undertaking. Writing, however, from Suere on Octo'er 22, M. Thouar reports that the Bolivians have confided to him a mission of exploration in the same regions. He is to cross the Bolivian Chaco and survey it, with a view to discovering a land route for trade, and also to make a scientific investigation of the territory on the right bank of the Paraguay, directing especial attention to its capacity for cultivation and to the methods by which immigration should be encouraged. M. Thouar was to start on this mission about November 18.

THE *Annuaire pour l'An* 1887, issued by the Bureau des Longitudes, Paris, contains much astronomical and other scientific information, arranged in a convenient form. The work is carefully edited, and has been considerably enlarged, by M. Loewy, one of the members of the Bureau.

THE current number of the *Memorie della Società degli Spettroscopisti Italiani* contains a good portrait of the late Alessandro Dorno, with a brief sketch of his career. Dorno was born at Asli on February 13, 1825. He had scarcely taken his degree at the University of Turin in 1848 when he was appointed Professor of Mechanics at the Military Academy there. In 1865 he was made Professor of Astronomy at the University of Turin and Director of the Observatory. Many papers by him appeared in the Transactions of the Turin Academy of Sciences, and he was a frequent contributor to the various scientific journals. In 1874 he took part in the scientific expedition to India for the observation of the transit of Venus. He died at the Villa di Borgo, San Pietro, near Turin, on August 19, 1886.

WE have received Parts 16-20 of the "Länderkunde des Erdteils Europa," which is being issued at Leipzig and Prague. This admirable work is edited by Dr. A. Kirchhoff, who has secured the co-operation of many eminent geographers. There are numerous illustrations, all of which are carefully executed.

WE print to-day an abstract of an excellent paper on "The Use and Equipment of Engineering Laboratories," by Prof. A. B. W. Kennedy, M.Inst.C.E., read at the ordinary meeting of the Institution of Civil Engineers on Tuesday, December 21, 1886.

WITH regard to the postscript to his letter on "Electricity and Clocks," in our last number (December 30, 1886, p. 198), Mr. Henry Dent Gardner writes to us that it is the weak spring, not the hammer, which should be kept away from a banking.

THE additions to the Zoological Society's Gardens during the past week include two Green Lizards (*Lacerta viridis*), a Slow-worm (*Anguis fragilis*), European, presented by Mr. R. M. J. Teil; a Yellow-footed Rock-Kangaroo (*Petrogale xanthopus*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

THE ANDROMEDES, NOVEMBER 27, 1886.—P. F. Denza, writing in *Cosmos* under date December 2, gives the results of the watch maintained on the night of November 27 last at seven observatories distributed over the Italian peninsula. All the reports alike agree in showing that there was no repetition of the shower of 1885, the number of meteors observed being no greater than on an ordinary night, and of these the majority radiated from Perseus and Taurus, only very few from the radiant of the Andromedes. It follows, therefore, from these observations and those of 1873 and 1885, that the meteoric cloud giving rise to the shower is of comparatively small extent, but very dense. This fact tends to confirm the theory of the recent formation of the stream and of its origination in the disintegration of Biela's comet. The interval, thirteen years, between 1872 and 1885, corresponds to two revolutions of the comet; but the earth was in quite a different part of its orbit at the date of the intermediate return, and therefore no shower was witnessed.

THE REDUCTION OF THE POSITIONS OF CLOSE POLAR STARS FROM ONE EPOCH TO ANOTHER.—A paper containing a catalogue of 130 Polar stars for the epoch 1875·0, resulting from all the available observations made between 1860 and 1885, and reduced to the system of the Catalogue of Publication xiv. of the Astronomische Gesellschaft, has been communicated to the American Academy of Arts and Sciences by Prof. W. A. Rogers and Miss Anna Winlock. The first section of this work, giving an investigation of the methods of reducing the positions of close Polar stars from one epoch to another, has been published in the Memoirs of the Academy, vol. xi. part 4, No. 5. And Prof. Rogers chivalrously appends a note to the effect that his connection with the work is limited to the methods of discussion adopted, and to an examination of the numerical results obtained; and that beyond this all the work in the preparation of the paper has been done by Miss Winlock, who is entitled to all the credit therefor. By the laborious process of actual computation, taking the instance of Groombridge 1119—a star situated within 1° of the Pole, it is shown that it is impossible to obtain an exact agreement between the values of the precessional motion computed by Taylor's theorem and the corresponding values computed from the rigorous trigonometrical formulæ, in the case of such a star, when the time exceeds forty years. But it is also shown that the time at which the values derived from the development by Taylor's theorem begin to deviate from those derived from the rigorous formulæ may be extended many years by means of a secondary series, which represents the residuals

between the exact co-ordinates and those obtained with any assumed limit to the terms of the series. The application of this principle to the case of Groombridge 1119 is explained, and the formulæ formed for reducing the stellar co-ordinates to any date between 1875 and 1955, and also between 1875 and 1755. The results obtained by Miss Winlock will doubtless be very useful to astronomers discussing the positions of close Polar stars.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1887 JANUARY 9–15

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on January 9

Sun rises, 8h. 6m.; souths, 12h. 7m. 20·2s.; sets, 16h. 9m.; decl. on meridian, 22° 6′ S.: Sidereal Time at Sunset, 23h. 24m.

Moon (Full) rises, 4h. 11m.; souths, 0h. 9m.*; sets, 8h. 3m.*; decl. on meridian, 18° 44′ N.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury ...	7 4 ...	10 55 ...	14 46 ...	23 45 S.
Venus	8 42 ...	12 46 ...	16 50 ...	21 45 S.
Mars	9 19 ...	13 47 ...	18 15 ...	18 4 S.
Jupiter... ...	1 47 ...	6 52 ...	11 57 ...	11 28 S.
Saturn... ...	16 5* ...	0 10 ...	8 15 ...	21 55 N.

* Indicates that the rising is that of the preceding evening and the southing and setting each that of the following morning.

Occultations of Stars by the Moon (visible at Greenwich)

Jan.	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image ° °
9 ...	B.A.C. 2432 ...	6½ ...	19 6 ...	19 40 ...	106 175
10 ...	*f* Geminorum ...	6 ...	3 5 ...	4 9 ...	111 303
11 ...	54 Cancri	6½ ...	8 6	near approach	205 —
12 ...	18 Leonis... ...	6 ...	6 21 ...	6 55 ...	54 346
12 ...	45 Leonis... ...	6 ...	21 11 ...	21 50 ...	83 171
12 ...	*p* Leonis	4 ...	23 29 ...	0 30† ...	61 199
13 ...	49 Leonis... ...	6 ...	1 29	near approach	320 —

† Occurs on the following morning.

Jan.	h.	
9 ...	5 ...	Venus at greatest distance from the Sun.
9 ...	14 ...	Saturn in opposition to the Sun.

Variable Stars

Star	R.A. h. m.	Decl. ° ′		h. m.	
U Cephei	0 52·3	81 16 N.	Jan.	11, 23 22	*m*
Algol	3 0·8	40 31 N.	,,	13, 5 52	*m*
R Persei	3 22·8	35 17 N.	,,	13,	*M*
λ Tauri	3 54·4	12 10 N.	,,	9, 1 4	*m*
			,,	12, 23 56	*m*
U Monocerotis ...	7 25·4	9 33 S.	,,	13,	*m*
V Cancri	8 15·3	17 39 N.	,,	9,	*M*
W Virginis	13 20·2	2 48 S.	,,	11, 5 0	*m*
Z Virginis	14 4·3	12 46 S.	,,	14,	*M*
δ Libræ	14 54·9	8 4 S.	,,	10, 19 15	*m*
U Coronæ	15 13·6	32 4 N.	,,	13, 23 56	*m*
R Draconis	16 32·4	67 0 N.	,,	10,	*m*
U Ophiuchi... ...	17 10·8	1 20 N.	,,	9, 5 4	*m*
		and at intervals of		20 8	
β Lyræ...	18 45·9	33 14 N.	Jan.	9, 23 0	m_2
			,,	13, 4 0	*M*
R Lyræ	18 51·9	43 48 N.	,,	13,	*M*
S Delphini	20 37·9	16 41 N.	,,	14,	*m*
R Vulpeculæ ...	20 59·4	23 22 N.	,,	12,	*m*
δ Cephei	22 25·0	57 50 N.	,,	11, 23 0	*m*

M signifies maximum; *m* minimum; m_2 secondary minimum.

GEOGRAPHICAL NOTES

THE latest news from Dr. Oscar Lenz is of much interest. Three letters have been received from him, the latest dated June last from Kasonge, a large Arab town, three days south-east from Nyangwe, on the Upper Congo. Dr. Lenz, it will be remembered, went out for the purpose of reaching Dr. Junker and Emin Bey. The latest rumours state that he has been compelled to abandon this object, and may therefore be soon heard of at Zanzibar. Dr. Lenz, in canoes furnished by the famous Tippoo Tip, journeyed up the Congo from Stanley Falls, taking fifty days by the way. This, however, included frequent stoppages. He found great changes had taken place since Mr. Stanley made his memorable voyage down the river ten years ago. Then there were few Arabs to be seen beyond Nyangwe, and the river over a great part of its length was peopled by natives, between whose villages the expedition had to run the gauntlet. Now Dr. Lenz finds the whole country practically in the hands of Arab and Zanzibari slavers and traders. The natives in many places have retired into the recesses of the forest, and large Arab settlements have taken their place at several points along the river. There is a constant traffic up and down the river between Nyangwe, or rather Kasonge, and Stanley Falls. Immense rice-fields occupy the swampy and unhealthy areas round these Arab settlements, and all round Nyangwe and Kasonge the country is covered with rice, and plantations of bananas and other fruits. Nyangwe is no longer the important centre it was in the days of Livingstone. It is an irregular collection of Arab settlements, covering a considerable area. Kasonge, three days' journey off further up the river, is, on the other hand, a large town, with broad streets and many well-built houses. This is the head-quarters of Tippoo Tip and other Arab traders, who have their agents for their ivory in Muscat and India. It is evident that we have here a great and increasing intrusion of a foreign element among the native population. In some cases the natives are on friendly terms with the Arabs, and in other cases hostile. At any rate the result will in the end be a very serious modification of the population over a great area of Central Africa, and a marked change in the face of the country by the introduction of rice and other exotic cultures.

MM. BONVALOT AND CAPUS, the French travellers in Central Asia, lately turned back by the Emir of Afghanistan, write to the French Geographical Society, giving some account of their recent journeys. They refer especially to the country between Teheran and Meshed, which they traversed in April last, and which, as they say, is so much frequented that no one thinks it worth while to observe its special features. They found it much cut up by broad rivers with pebbly beds, and irrigation canals which nourish the rare oases along the base of the Elburz Range. The travellers found themselves almost always in the steppe region, on the edge of an immense basin, the bottom of which is the "Khevir" or great salt desert. It is incrusted on the surface with a great quantity of saline crystals, especially soda and magnesia, which often spoil the water and render cultivation impossible. The flora, the fauna, and the geology are those of the steppe, and MM. Bonvalot and Capus make out that the region forms a geographical unit with Central Asia. Not a tree, not a bush even, unless a few garden fruit-trees, with willows and poplars along the canals, relieve the monotony of the country. From the bridge of Saugil to the Thian-Shan, going from west to east, such a thing as a forest is unknown.

HERR QUEDENFELDT, in a paper in the last number of the *Verhandlungen* of the Berlin Geographical Society, on a recent journey in Morocco, mentions a fact of some geographical interest. For more than two years a commission of three or four Spanish staff officers, with a colonel as chief, has been stationed at Tetuan, and have quite publicly been carrying out a topographical survey. They have in this way already surveyed a considerable part of the Garb region, as far as Tangier, Arsila, Laraish, Alkasar, and even Fez.

IN the December *Petermann*, Count Pfeil describes his journeys of exploration last year in the Ulanga and Ussagora regions, with a map. But the article which will attract most interest now—a melancholy interest in some respects—is the preliminary report of the late Dr. Fischer, on the expedition for discovering Dr. Junker; this, too, is accompanied by a map. Dr. Emil Jung continues his essay on the effect of the last Indian famine on the movements of the population, basing the discussion on the official census. A special part of the *Mittheilungen* has been issued, containing an elaborate and systematic index of the contents of the periodical for the ten years 1875-84, including ten annual volumes and eight supplementary volumes. By an ingenious system of colouring, a glance at the maps of the various continents shows

that special maps have been published with the magazine during that period, what the scale of each is, at what part of the publication it is to be found, and whether the map is topographical, physical, geological, or statistical. These maps, with their variously-coloured lines, show, too, in a moment, what are the regions of the earth which have most engaged attention during the last ten years. In Europe the Balkan peninsula is covered with lines, in Asia the khanates, the Pamir, Tibet, and South-Western China, while the number of lines in Central Africa north and south of the equator form a veritable labyrinth. A rough idea of the work of every traveller in the last ten years could be formed from this outline map alone, as the name and occasionally the date are added in each case. The index and the maps give a bird's-eye view of the work of this famous geographical publication better than anything else can do, and we are glad to know that it begins a new decade full of youthful life and vigour, and with the prospect of a career of as much usefulness in the future as in the past.

HERR NIEDERLEIN, of Buenos Ayres, has been appointed Naturalist and Geographer to the Argentine-Brazilian Boundary Commission, on behalf of the Argentine Government, and he left in October last for the *rendezvous* of the Commission at Misiones. He has been engaged for sixteen months in the Ministry of Foreign Affairs of the Republic, working out the results of a previous journey, especially his surveys on the Uruguay and Parana Rivers and their main tributaries; these, however, did not rest on any astronomical observations, a defect which he hopes to remedy in the present journey. A careful geodetic survey of the frontier districts will be made, and a map of these and of the province of Corrientes will be published next year.

TASMANIAN FISHERIES

THE Report for 1885 of Mr. Saville Kent, Superintendent and Inspector of Fisheries to the Tasmanian Government, contains a good deal that is of scientific as well as economic interest, as will be seen from the following extracts:—

(1) *The Oyster Fisheries.*—It affords me much gratification to inform you that considerable success has attended the experiments made in the direction of breeding oysters on the Government reserves and in private fisheries, upon the system advocated and explained in my last year's Report. This system consisted chiefly of laying "collectors," constructed of thin planks or split palings coated with cement, over the breeding oysters placed upon the beds. At the Government reserve at Little Oyster Cove, on a private bed at Great Oyster Cove, and on one at the Prosser's River on the East Coast, a considerable quantity of brood or spat has adhered to the collectors laid down, giving the greatest encouragement for a yet more substantial and commercially remunerative return resulting from the following out of the system upon a sufficiently extensive scale. The operations so far conducted have been furthermore productive of much valuable information concerning the breeding habits of the oysters of this colony that may be hereafter utilised in their artificial culture. Thus, last summer none of the collectors were placed on the beds until November, which is generally accepted, as is May in England, as representing the earliest month in which the spat or brood is liberated. From the size of the brood deposited on the collectors, as also by an examination from time to time of the parent oysters, it was, however, made evident that the greater portion of the spat had been already emitted before the collectors were placed over them. This circumstance indicates the desirability, in future years, of having at least a considerable portion of the collectors in position by the commencement of September. It is of interest to observe that the larger portion of the spat deposited, at both the Government reserve at Little Oyster Cove and on the private bed in the adjacent bay, was derived from the New Zealand oysters, thus demonstrating that that variety is suitable for acclimatisation in Tasmanian waters. Another important circumstance to be recorded of the Oyster Cove reserve is the fact that the spat thus obtained was attached exclusively to the cemented collectors, and in no case to the shells of the parent oysters or to the rocks, cultch, or other natural objects to which they customarily adhere; this fact of itself affords practical evidence of the efficacy of these collectors for the purpose for which they have been devised.

At the Government reserve at Spring Bay the collectors ordered were not supplied sufficiently early to intercept the fall of spat. At the same time the fall which took place, both in the reserve and also upon the public and private oyster-beds throughout the Spring Bay district, has been a very abundant one, the young brood adhering plentifully to the parent shells, mussels, cultch, stakes, and any other objects that afforded them a suitable fulcrum for attachment. With a continuance of this past season's rate of increase, and provided a sufficient amount of breeding stock is maintained on the reserves and private beds, it should not take many years for this locality to regain its original prominent position with relation to the oyster trade. At the present time the recovery of this district has advanced to such an extent that there has been no difficulty experienced in obtaining from it during the present season a stock of about 50,000 breeding oysters for laying down upon various private beds and the Government reserves. From the third Government reserve, established at the West Arm on the Tamar estuary, no substantial results have as yet been obtained, it having been found impossible to complete it and stock it with oysters in time to obtain last summer's fall of spat. A fourth oyster reserve is in process of formation at Little Swanport; and it is proposed, with the funds available for the purpose during the current year, to establish similar Government reserves in the following neighbourhoods, *i.e.* the Carlton River, Taranna, and Southport in the southern district; and at George's Bay, Port Sorell, and other favourable localities to be yet selected, on the north-eastern and northern coast-lines.

I am gratified to be able to report to you that there are already substantial prospects of accomplishing one of the most important objects of the establishment of the Government oyster reserves. At the time of their inauguration it was anticipated and intended that these reserves, in addition to fulfilling the part of nurseries for the propagation of oysters and the replenishment of the surrounding waters, should likewise constitute central stations for the assistance and encouragement of private enterprise in a similar direction, and by whose aid, if developed upon an extensive scale, the restoration of the oyster fisheries of this colony on a thoroughly substantial commercial basis would be greatly accelerated. One private bed with breeding oysters is already established in the vicinity of the Government reserve at Little Oyster Cove, one at Spring Bay, and another at the Prosser's River. Encouraged by the success of these undertakings, applications have been or are about to be made for the leasing of three more suitable areas for the same purpose at Spring Bay, for the same number at Great and Little Oyster Cove, and for others in the neighbourhood of Little Swanport, and at Port Sorell on the north coast.

The important operations connected with oyster-culture in course of progress at the newly inaugurated Fisheries Establishment at Battery Point are recorded under the following heading.

(2) *Fisheries Establishment, Battery Point.*—Since the date of my last Report, and in accordance with the recommendations therein made, suitable premises, including a residence, have been selected and are now rented by the Government at Battery Point for the development and maintenance of a Fishery Establishment. To this site the marine hatchery originally erected at Gore Street has been transported, and re-erected with various additions. The premises occupied include a sea frontage of about three hundred feet, allowing the location of the hatchery so close to the water's edge that the salt water necessary for the maintenance of a constant circulation through the tanks is pumped direct from the sea. The mechanical arrangements are at the same time so disposed that in the event of a storm or flood rendering the outside water temporarily unfit for circulation, the intake pipe can be disconnected, and the water circulated independently from a small reservoir beneath the building. The great advantages derived from the transport of the marine hatchery to its present site, next to the means now afforded for obtaining an unlimited supply of pure sea-water, are the facilities it has provided for constructing in connection therewith tidal ponds for the culture of oysters and marine fish generally upon the adjacent shore. For this purpose an area of about one acre has been inclosed with stakes wired together after the manner adopted for the fencing off of the Government oyster reserves, and within this inclosure two such ponds have been already constructed. In consequence of the circumstance that at ordinary ebb tide the water recedes from a large portion, and at spring tides from almost the entire extent of this inclosed area, the plan has been adopted of excavating these ponds for a foot or two below lowest tide-level, so that under any circumstances they contain an abundant supply of water. The nature of the ground upon the

foreshore inclosed has proved to be well adapted for the construction of these ponds, as immediately beneath a thin superficial covering of sand it is composed of pebbles and tenacious clay so firmly amalgamated as to almost resemble concrete; any excavations made in this bed are consequently thoroughly water-tight. In the preparation of this site for the required purpose, it was found desirable to divert the course of that portion of the Sandy Bay Rivulet which formerly at low tide flowed over the area now occupied by the ponds. This has been accomplished by further excavating the main channel of the stream straight out to sea, and away from the area inclosed, and by interposing between the two a barrier or groin of rocks and tree-trunks, which has had the desired effect of accumulating along its course a natural sand-bank which effectually shuts off the water of the creek. One of the ponds constructed in the inclosure, measuring sixty feet long by thirty wide, is situated immediately beneath the hatchery, and serves as a reservoir for the constant supply of the tanks. This pond, being fenced round with wire netting, is further utilised for the storage and culture of a variety of edible fish in addition to oysters. With each ebb and flow of the tide the water in this pond is more or less completely renewed, and the fish under these conditions are found to thrive remarkably. A list of the edible species of fish that have been cultivated in the pond and tanks since the establishment of the fishery at Battery Point—that is, between the months of February and July 1886—is herewith annexed.

1. Native Salmon (*Arripis salar*).
2. Sea Carp (*Chilodactylus allporti*).
3. Black and Silver Perch (*Chilodactylus macropterus*).
4. Magpie Perch (*Chilodactylus gibbosus*).
5. Real Trumpeter (*Latris hecateia*).
6. Silver Bastard Trumpeter (*Latris forsteri*).
7. Rock Gurnet (*Sebastes percoides*).
8. Flathead (*Platycephalus bassensis*).
9. Tasmanian Whiting (*Sillago ciliata*).
10. Snotgall Trevally (*Neptonemus brama*).
11. Sea Mullet (*Agonostoma forsteri*).
12. Rock Cod (*Pseudophycis barbatus*).
13. Tasmanian Ling (*Genypterus blacodes*).
14. Flounder (*Rhombosolea monopus*).

In both the ponds and tanks of the Fisheries Establishment the chief attention is at present being given to the culture of oysters. There is already upon the premises a stock of some eight or ten thousand oysters of different varieties, and in all stages of growth, which stock it is proposed to yet further increase in anticipation of the approaching spatting-season. The varieties include the irregular-shaped Rock Oyster (*Ostrea angulata*) from New South Wales; the smooth variety of *O. edulis* from New Zealand, and many modifications of the indigenous type of the same species. The majority of these oysters have now been acclimatised in the tanks and ponds for the last three or four months, in which space of time it is gratifying to have to record that all of them have thriven and considerably increased the size of their shells. This is particularly noticeable of the New South Wales species, which it is anticipated from this experience it will be found possible to establish and propagate in these waters. The experiment now in course of trial, as to whether they will be able to withstand the severity of the Tasmanian winter months, will be an important factor in this question. The series under cultivation includes, in addition to the stock of adult oysters for breeding purposes, samples of brood raised last summer at Little Oyster Cove and other Government reserves. Among the useful functions accomplished by the Oyster-Culture Department of the Fisheries Establishment at Battery Point may be mentioned the *rôle* it fulfils of an accessible model for the advantage of those who, in increasing numbers, are taking up oyster-culture as a private enterprise, and who can there obtain information and instructions as to the best methods upon which to conduct their operations. It is also of much value as a central station, at which practical experiments can be made with the view of solving the many vexed problems that present themselves to the pioneers of this industry, and of discovering newer and more profitable methods of cultivating and breeding this mollusk. Already among eminent American and European oyster-culturists it is maintained that the secret of obtaining a far larger percentage of the brood produced by the parent oyster than has hitherto been accomplished is to be solved through the medium of tidal ponds and tanks, wherein the oysters will be supplied with all the requirements necessary for their healthy growth and development, and wherein at the same time suitable provision is made for the retention of the produced spat. Tentative experiments having this object in view are now in course of progress under scientific direction in all of the more important oyster-growing communities, and it is hopefully anticipated that some material assistance towards the solution of this important question may be forthcoming from this newly-established practical branch of the Fisheries Department of this colony.

Among the more important points to which my attention has been recently directed and advice solicited is the widely recognised desirability of discovering some method for cultivating oysters in localities in all respects suitable for their growth, with the exception that the labour involved in keeping them constantly clear from sedimentary deposits, or from sinking beneath a too yielding bottom, is too costly for their profitable culture. Experiments made with the view of surmounting this difficulty have resulted in the invention of a species of frame or cradle composed of wood and strong galvanised wire netting, measuring 6 feet long and 3 feet wide, upon which the oysters are placed, and raised to a height of from 9 to 10 inches off the ground. This description of frame so completely answers the purpose for which it was devised that they are being supplied to all of the Government reserves, and are recommended for the use of private growers. Each frame of the dimensions above quoted, which are found to be most portable, conveniently carries as many as 500 adult oysters, so that for a well-stocked bed of, say, 10,000 oysters, a score of them will be sufficient. Having the stock placed on frames of this description, a vast amount of labour usually bestowed in keeping the beds clean and the oysters free from sediment can be dispensed with. In place of the tedious process of dredging the bed through and raising the oysters a few at a time, to be cleaned and re-deposited on the cleared ground, each frame, with its contents, can be raised to the surface, a few shakes suffice to get rid of the sediment that may have accumulated upon them, and they may again be lowered to their place. This object may indeed be accomplished in many instances without raising the frames to the surface, it being sufficient merely to tilt the frame to and fro a few times, as it lies on the bottom, with the aid of a boat-hook, such agitations effectually getting rid of all the sedimentary matter. Wire handles for raising the frames to the surface of the water, with the aid of a boat-hook, should be attached.[1] Further advantages are attached to this frame-system of oyster-culture, since not only can the frames and their contents be raised to the surface at all times to be cleaned and manipulated, but it affords facilities, hitherto unprovided, of keeping an accurate estimate of the amount of stock placed upon the beds, and of watching, from time to time, the progress it is making in development. The form of spat collector that can be most advantageously utilised in conjunction with these oyster-frames is the one figured and described in my last Report under the title of the "single pale" collector, consisting, as its name implies, of a single split paling 4 feet long by 8 or 9 inches wide, having its under surface coated with cement and a brick attached at either end to retain it in the desired position. The experience gained by the past season has demonstrated this to be the most economic and productive form of collector, no alteration in its construction being suggested, with the exception that, by placing a single wire loop or handle in the centre instead of one at each end, as hitherto, their portability, both in and out of the water, is greatly increased. The adaptability of these paling collectors for use in conjunction with the newly-invented frames is very obvious, and their size is such as to allow of their being placed over the oysters in either a single or in two or more transverse rows. It is anticipated that the oysters placed upon the frames will of themselves constitute very efficient spat-collectors, their under surfaces, exposed through the meshes of the wire netting, being kept free from slime and sediment, and raised to a height above the ground favourable for the adherence of the spat. Empty shells or cultch similarly placed on frames in the vicinity of the breeding stock are also likely to prove favourable fulcra for the brood to adhere to. A remaining direction in which the oyster culture department of the Fisheries Establishment at Battery Point is found to be of great assistance in the operations now in course of progress relates to its value as a central depot for the reception and temporary storing of the stock brought from a distance for distribution among other reserves.

[1] The frames are raised to the surface of the water by blocks and cord attached to a tripod; where the boat is sufficiently large to carry a mast, the same apparatus may be more conveniently worked from a small derrick affixed to the mast.

THE FORMS OF SEEDLINGS: THE CAUSES TO WHICH THEY ARE DUE [1]

SIR JOHN LUBBOCK commenced the lecture with some general remarks on the innumerable types of foliage among mature plants and the causes to which we might refer their various forms, the breadth of some and narrowness of others, the differences of position, the differences of length in conifers, &c. He said that these considerations had led him to study the cotyledons or first leaves of seedlings. Cotyledons do not present such extreme differences as leaves; nevertheless, they afford a very wide range. Some are broad, some narrow, some are long, some short, some are stalked, some sessile, some lobed, some even bifid or trifid. At first sight these differences seem interminable, and it might appear hopeless to attempt to explain them. Sir John Lubbock, however, pointed out, as regards many species, taking especially the commonest plants, such as the familiar mustard and cress, the beech, sycamore, pink, chickweed, &c., the conditions of their formation and growth, and it is beautiful to see the various reasons to which the differences are due, gradually unfolding themselves; the same result being sometimes brought about by very different circumstances—emargination of the cotyledons, for instance, being due to at least six different causes. He mentioned one curious peculiarity in the seedling of a species allied to our common mistletoe. It is a parasitic species, and its fruit, like that of the mistletoe, is somewhat viscid, so that it adheres to any plant on which it falls. But, even if it reaches the plant on which it grows, it may light on an unsuitable position—say, for instance, a leaf. What then happens? The radicle elongates for about an inch, and then develops on its tip a flattened disk, which applies itself to the plant. If the situation be suitable, there it grows; if not, the radicle straightens itself, tears the berry from the spot where it is lying, curves itself, and then brings the berry down on to a new spot. The radicle then detaches itself, curves in its turn, and thus finds a new point of attachment. We are assured that this has been seen to happen several times in succession, and that the young plant thus seems enabled to select a suitable situation.

The form of the cotyledons, or seed-leaves, depends greatly on that of the seeds, long narrow seeds naturally, in most instances, producing embryos with narrow cotyledons. The cases, however, which can be so simply accounted for are comparatively few. Many plants with narrow cotyledons have flattened and orbicular seeds. In such species, however, the cotyledons lie transversely to the seed. An interesting case is afforded by the pink family, where the pink itself has broad cotyledons, while the chickweed has narrow ones. In both cases the seeds are flattened and orbicular, but in the pink the seed is dorsally compressed, and the cotyledons lie in the broad axis of the seed; while in the chickweed the seed is laterally flattened, and the cotyledons lie transversely to the seed.

Another very interesting case which he gave is that of the genus Galium, to which the common "cleavers" of our hedges belongs. Here also we find some species with narrow, some with broad, cotyledons; but the contrast seems to be due to a very different cause. *Galium aparine* has broad, *Galium saccharatum* narrow, cotyledons. So far as the form of the seed is concerned, there is no reason why the cotyledons should not be much broader than they are. The explanation may perhaps be found in the structure of the pericarp, which is thick, tough, and corky. It is very impervious to water, and may be advantageous to the embryo by resisting the attacks of drought and of insects, and perhaps even, if the seed be swallowed by a bird, by protecting it from being digested. It does not split open, and is too tough to be torn by the embryo. The cotyledons, therefore, if they had widened as they might otherwise have done, would have found it impossible to emerge from the seed. They evade the difficulty, however, by remaining narrow. On the other hand, in *Galium aparine* the pericarp is much thinner, and the embryo is able to tear it open. In this case, therefore, the cotyledons can safely widen without endangering their exit from the seed. The thick corky covering of *Galium saccharatum* is, doubtless, much more impervious to water than the comparatively thin test of *Galium aparine*. The latter species is a native of our own isles, while *Galium saccharatum* inhabits Algiers, the hotter parts of France, &c. May not then, perhaps, he suggested, the thick corky envelope be adapted to enable it to withstand the heat and drought. In this genus, as in many other plants, the embryo occupies only a part of the seed, being surrounded by a store of food or "perisperm." In many cases the embryo occupies the whole seed, and the cotyledons must, therefore, in large seeds, either be thrown into various folds, as in the beech, or be thick and fleshy, as in the bean or oak. The reasons for their numerous differences open up an inexhaustible variety of interesting questions. Sir John gave a great number of examples, which were rendered clearer by means of numerous diagrams of seeds and seedlings.

In conclusion, he said it might be asked whether the embryo conformed to the seed, or the seed to the embryo, and showed that, at least as regards certain species, the former was the case; while the shape of the seed, again, might be shown to be influenced by considerations connected with the construction of the fruit. In reply to this he compared the seedlings of the sycamore and of the oak. In the sycamore, the seed is more or less an oblate spheroid, and the cotyledons, which are long and ribbon-like, being rolled up into a ball, fit it closely, the inner cotyledon being generally somewhat shorter than the others. On the other hand, the nuts of the beech are triangular. An arrangement like that of the sycamore would therefore be utterly unsuitable, as it would necessarily leave great gaps. The cotyledons, however, are folded up somewhat like a fan, but with more complication, and in such a manner that they fit beautifully into the triangular nut. Can we, however, he said, carry the argument one stage further? Why should the seed of the sycamore be globular, and that of the beech triangular? Is it clear that the cotyledons are constituted so as to suit the seed? May it not be that it is the seed which is adapted to the cotyledons? In answer to this, we must examine the fruit, and we shall find that in both cases the cavity of the fruit is approximately spherical. That of the sycamore, however, is comparatively small, and contains one seed, which more or less exactly conforms to the cavity in which it lies. In the beech, on the contrary, the fruit is at least twice the diameter, and contains from two to four nuts, which consequently, in order to occupy the space, are compelled (to give a familiar illustration, like the pips of an orange) to take a more or less triangular form. Thus then, he said in conclusion, in these cases, starting with the form of the fruit, we see that it governs that of the seed, and that the seed again determines that of the cotyledons. But, though the cotyledons often follow the form of the seed, this is not invariably the case. Other circumstances, as I have attempted to show, must also be taken into consideration, and we can throw much light on the varied forms which seedlings assume.

I fear you may consider that I have occupied your time by a multiplicity of details, and I wish I could hope to have made those little plants half as interesting to you as they have made themselves to me; but, at any rate, I may plead that without minute, careful, and loving study, we cannot hope in science to arrive at a safe and satisfactory generalisation.

The lecture was accompanied not only by numerous diagrams, but by specimens, kindly lent by the authorities of Kew, and by some practical illustrations.

[1] Lecture at the Royal Institution, May 21, 1886, by Sir John Lubbock, Bart., M.P., D.C.L., LL.D., F.R.S., M.R.I.

ON THE USE AND EQUIPMENT OF ENGINEERING LABORATORIES

AT the ordinary meeting of the Institution of Civil Engineers, on Tuesday, December 21, 1886, Mr. Edward Woods, President, in the chair, the paper read was on "The Use and Equipment of Engineering Laboratories," by Prof. Alex. B. W. Kennedy, M.Inst.C.E. The author believed that it was essential for a young engineer to obtain his practical training, in the ordinary sense of the expression, in a workshop. But the practical training of a workshop was incomplete even on its own ground, and there appeared to be plenty of room for practical teaching such as might fairly fall within the scope of a scientific institution, and which should at the same time supplement and complete workshop experience without overlapping it. In an ordinary pupilage a young engineer did not have much opportunity of studying such things as the physical properties of the iron and steel with which he had to deal, nor the strength of those materials, nor the efficiency of the machines he used, nor the relative economy of the different types of engines, nor the evaporative power of boilers. He required such experience as might help him to determine for himself, or at least to see for himself how other people had

determined, all the principal engineering constants, from the tenacity of wrought-iron to the calorific value of coal, or the efficiency of a steam-engine, or the accuracy of an indicator-spring, or the discharge-coefficient of an orifice. He thought that this kind of practical experience could be gained best in an Engineering Laboratory, in connection with some institution where technical instruction was given. He claimed that, in the matter of engineering laboratories, as a branch of technical education, England had really taken the lead, instead of being, as was too often the case in such matters, in the rear.

After distinguishing between laboratories whose chief function was original investigation or research, and those whose main object was the practical education of young engineers, and after giving an outline of the method of work which he had adopted, he went on to enumerate the principal subjects upon which experiments in an engineering laboratory might be carried out, summarising them thus:—(1) Elasticity and the strength of materials; (2) the economy, efficiency, and general working of prime movers, and especially of the steam-engine and boiler; (3) friction; (4) the accuracy of the apparatus commonly used for experimentation, such as springs, indicators, dynamometers, gauges of various kinds, &c.; (5) the discharge over weirs and through orifices, and hydraulic experiments in general; (6) the theory of structures; (7) the form and efficiency of cutting-tools; (8) the efficiency of machines, especially of machine-tools and of transmission-gearing; (9) the action and efficiency of pumps and valves; (10) the resistance of vessels and of propellers, and experiments in general connected with both. The paper dealt mainly with the three first subjects, the others receiving brief mention only.

In discussing the best form of testing-machine for laboratory purposes the author described specially the Werder machine, used by Bauschinger and largely elsewhere in engineering laboratories on the Continent, the vertical machine of Mr. J. H. Wicksteed, and the horizontal machine of Messrs. Greenwood and Batley, on Mr. Kirkaldy's principle, used by himself. Incidentally he described a number of other testing machines, including the Emery machine at the United States Arsenal at Watertown, Fairbanks' machine, and others. The three machines first named were compared in some detail in respect to their accuracy, mode of applying load, methods of making observations, adaptability for varied experiments, simplicity, and accessibility, and the comparative advantages and disadvantages of each were discussed, the author preferring, on the whole, the Greenwood type. The method of testing employed by the author, with pump, accumulator, and Davy motor, was then described and illustrated,

Different apparatus for the measurement of minute extensions, compressions, &c., occurring below the limit of elasticity, were next discussed, the instruments specially mentioned being those of Prof. Unwin, Prof. Bauschinger, Mr. Stromeyer, and the author, as representing micrometric, optical, and mechanical exaggeration of strains. Automatic test-recording apparatus was next dealt with, Prof. Unwin's, Mr. Wicksteed's, Mr. Ashcroft's, and the author's diagramming machines being mentioned and illustrated. Automatic diagramming apparatus for elastic strains was next discussed. The paper contained *facsimiles* of various diagrams, both ordinary and elastic. In concluding this section of the paper, brief references were made to machines for transverse tests, torsional tests, shearing tests, cement and wire tests, secular experiments, experiments on repeated loads, &c.

In discussing the design of an experimental engine for laboratory purposes, the author first enumerated the principal conditions under which such an engine should be capable of working, summarising them thus:—(1) Condensing or non-condensing; (2) simple or compound; (3) compound, with cranks at various angles; (4) with the greatest possible variation of steam-pressure; (5) with the greatest possible variation of cut-off and other points in the steam distribution; (6) with the greatest possible variation of brake-power; (7) with considerable variation in speed; (8) with or without throttling; (9) with or without jackets, and with varying conditions as to their use; (10) with variation of clearance-spaces; (11) with variation of receiver-volume; (12) with or without arrangements for intermediate heating; (13) with variation in the reciprocating masses. He then enumerated the principal quantities which had to be measured during an engine-test, making remarks upon each important point in passing. A list was given of the principal experimental engines in existence, including those in London, Birmingham, Leeds, Munich, and Liége. This section was concluded by a description of the arrangement of an experimental boiler.

Under the head of friction-experiments, the principal points were summarised upon which experiments were required, in order that anything like a complete theory of friction in machines might be worked out. These included the variations of velocity, intensity of pressure, extent of contact, temperature, lubricant, method of lubrication, and nature of rubbing material. Friction-measuring machines, used or proposed by Prof. Thurston, Prof. R. H. Smith, Mr. Tower, and himself, were briefly described. The paper concluded with a few remarks on laboratory experiments connected with hydraulic work, the theory of structures, the form and efficiency of cutting-tools, the efficiency of machines and of transmissions, the action and efficiency of pumps and valves, and the resistance of vessels and propellers.

In an appendix there were added:—(*a*) Forms used by the author for conducting engine-trials. (*b*) Notes on the principal engineering laboratories in Europe and in America, with brief accounts of the chief apparatus used in each.

BIRDS' NESTS AND EGGS[1]

THE philosophy of birds' nests and eggs involves questions far too profound to be settled in an hour's lecture. The extreme partisans of one school regard birds as *organic automata*. They take a Calvinistic view of bird-life: they assume that the hedge-sparrow lays a blue egg because, under the stern law of protective selection, every hedge-sparrow's egg that was not blue was tried in the high court of Evolution, under the clause relative to the survival of the fittest, and condemned, a hungry magpie or crow being the executioner. The extreme partisans of the other school take an entirely opposite view. They regard the little hedge-sparrow, not only as a free agent, but as a highly intelligent one, who lays blue eggs because the inherited experience of many generations has convinced her that, everything considered, blue is the most suitable colour for eggs.

Perhaps the first generalisation that the egg-collector is likely to make is the fact that birds that breed in holes lay white eggs. The sand-martin and the kingfisher, which lay their eggs at the end of a long burrow in a bank, as well as the owl and the woodpecker, which breed in holes in trees, all lay white eggs. The fact of the eggs being white, and consequently very conspicuous, may have been the cause, the effect being that only those kingfishers which bred in holes survived in the struggle for existence against the marauding magpie. But the converse argument is equally intelligible. The fact that kingfishers breed in holes may have been the cause, and the whiteness of the eggs the effect; for why should Nature, who is generally so economical, waste her colouring-matter on an egg which, being incubated in the dark, can never be seen? The fact that many petrels and most puffins, which breed in holes, have traces of spots on their eggs, whilst their relations the auks and the gulls, who lay their eggs in open nests, nearly all lay highly-coloured eggs, suggests the theory that the former birds have comparatively recently adopted the habit of breeding in holes, and that consequently the colour being no longer of use is gradually fading away. Hence, we assume that the colour of the egg is probably the effect of the nature of the locality in which it is laid.

The second generalisation which the egg-collector is likely to make is the fact that so many of these birds which breed in holes are gorgeously coloured, such as kingfishers, parrots, bee-eaters, &c. The question naturally arises, Why is it so? The advocates of protective selection reply, Because their gay plumage made them so conspicuous as they sat upon their nests, that those that did not breed in holes became the victims of the devouring hawk, exactly as the conspicuous white eggs were eaten by the marauding magpie. But the advocates of sexual selection say that all birds are equally vain, and wear as fine clothes as Nature will let them, and that the kingfisher is able to dress as gorgeously as he does because he is prudent enough to breed in a hole safe from the prying eyes of the devouring hawk. The fact that many birds, such as the sand-martin and

[1] Abstract of a lecture delivered by Mr. H. Seebohm at the London Institution on December 20, 1886.

the dipper, which breed in holes, are not gorgeously coloured, while others, such as the pheasants and the humming-birds, are gorgeously coloured, but do not breed in holes, is evidence, as far as it goes, that the gorgeous colour of the bird is not the effect of its breeding in a hole, though the white colour of the egg probably is. It must be admitted, however, that the latter cases are not parallel. Whilst the hen kingfishers and bee-eaters are as gorgeous as their mates, the hen pheasants and the hen humming-birds are plainly, not to say shabbily, dressed. If birds be as vain as the advocates of sexual selection deem them, it must be a source of deep mortification to a hen humming-bird to have to pass through life as a foil to her rainbow-hued mate. Whilst the kingfisher relies for the safety of its eggs upon the concealed situation of its nest, the humming-bird depends upon the unobtrusiveness of the plumage of the sitting hen.

A very large number of birds, such as the grouse, the merlin, most gulls and terns, and all sandpipers and plovers rely for the safety of their eggs upon the similarity of their colour to the ground on which they are placed. It may be an open question whether these birds select a site for their breeding-ground to match the colour of the eggs, or whether they have gradually changed the colour of their eggs to match the ground on which they breed; but, in the absence of any evidence to the contrary, it is perhaps fair to assume, as in the previously mentioned cases, that the position of the nest is the cause, and the colour of the egg the effect.

Many birds make their nests in lofty trees, or on the ledges of precipitous cliffs. Of these, the eagles, vultures, and crows are conspicuous examples. They are, for the most part, too powerful to be afraid of the marauding magpie, and only fear the attacks of beasts of prey, amongst which they doubtless classify the human race. They rely for the safety of their eggs on the inaccessible positions of the nest. Many of them also belong to a still larger group of birds who rely for the safety of their eggs upon their own ability, either singly, in pairs, or in colonies, to defend them against all aggressors. Few colonies of birds are more interesting than those of herons, cormorants, and their respective allies. These birds lay white or nearly white eggs. Nature, with her customary thrift, has lavished no colour upon them because, apparently, it would have been wasted effort to do so; but the eggs of the guillemot are a remarkable exception to this rule. Few eggs are more gorgeously coloured, and no eggs exhibit such a variety of colour. It is impossible to suppose that protective selection can have produced colours so conspicuous on the white ledges of the chalk cliffs; and sexual selection must have been equally powerless. It would be too ludicrous a suggestion to suppose that a cock guillemot fell in love with a plain-coloured hen because he remembered that last season she laid a gay-coloured egg. It cannot be accident that causes the guillemot's eggs to be so handsome and so varied. In the case of birds breeding in holes secure from the prying eyes of the marauding magpie, no colour is wasted where it is not wanted.

The more deeply Nature is studied, the more certain seems to be the conclusion that all her endless variety is the result of evolution. It seems also to be more and more certain that natural selection is not the cause of evolution, but only its guide. Variation is the cause of evolution, but the cause of variation is *unknown*. It seems to be a mistake to call variation spontaneous, fortuitous, or accidental, than which expressions no adjectives less accurate or more misleading could be found. The Athenian philosophers displayed a less unscientific attitude of mind towards the Unknown when they built an altar in its honour.

SCIENTIFIC SERIALS

American Journal of Science, December 1886.—On the crystallisation of native copper, by Edward S. Dana. This elaborate memoir, which is illustrated with four plates figuring fifty-four varieties of native copper crystalline forms, is based chiefly on the fine collection of over sixty specimens from Lake Superior, belonging to Mr. Clarence S. Bement, of Philadelphia, supplemented by reference to the cabinets of Yale College Museum and Prof. G. J. Brush. The planes here determined are disposed in the three groups of tetrahexahedrons, trisoctahedrons, and hexoctahedrons, and include several new to the species. The paper also comprises an historical summary from the studies of Hauy and Mohs (1822) to the recent contributions of W. G. Brown.—On the trap and sandstone in the gorge of the Farmington River at Tariffville, Connecticut, by W. North Rice. The trap and sandstone of this locality are here specially studied with a view to the general elucidation of the history of these formations in the Connecticut Valley. The author's researches confirm the conclusion already arrived at by Prof. W. M. Davis, that some of the sheets of trap intercalated among the sandstones and associated rocks are contemporaneous, and others intrusive.—Comparative studies upon the glaciation of North America, Great Britain, and Ireland, by Prof. H. Carvill Lewis. This is an abstract of a paper by the author, read at the Birmingham meeting of the British Association last September. Its object is to show that the glacial deposits of the British Isles, like those of America, may be best interpreted by considering them with reference to a series of great *terminal moraines*, which both define confluent lobes of ice, and often mark the line separating the glaciated from the non-glaciated areas.—On certain fossiliferous limestones of Columbia County, New York, and their relation to the Hudson River shales and the Taconic system, by J. P. Bishop. The author describes some new fossils recently discovered in a metamorphic limestone occurring in the Chatham and Ghent districts on the western border of the Taconic slates of Columbia county, and tending to throw further light on the age of the Taconic formation. His investigations are still in progress, but from the facts so far determined, he considers that the fossils are of Trenton age, suggesting a synclinal having the Trenton limestone outcropping on both sides, and with the eastern edge pushed over westward.—Crystallised vanadinite from Arizona and New Mexico, by S. L. Penfield. The specimens here described and figured belong partly to the collection of the late Prof. B. Silliman, partly to that of Prof. Geo. J. Brush. Those from Pinal County, Arizona, are specially interesting, being of a deep red colour, and usually showing the very simple combinations already described by L. H. Blake.—The viscosity of steel and its relations to temper, by C. Barus and V. Strouhal. Having during the course of their former researches expressed the belief that the qualities of retaining magnetism exhibited by steel would probably stand in relation to the viscous properties of the metals, the authors here make a first search for such a relation. For several reasons their investigations are limited to torsional viscosity, and a new and very sensitive differential method is partially developed for the study of this property, with incidental reference to the viscosity of iron and glass. The results of the method as applied to steel are further compared with the known behaviour of permanent linear magnets tempered under like conditions.—Some remarks upon the journey of André Michaux to the high mountains of Carolina in December 1788, in a letter addressed to Prof. Asa Gray, by C. S. Sargent. Michaux's chief object was to secure living specimens of *Magnolia cordata*, and the locality explored by him appears to have been the highland region of North and South Carolina about the head waters of the Savannah River. The author has recently visited the same district for the purpose of re-discovering the same plant where Michaux was thought to have found it, but he searched for it in vain, and he concludes that Michaux's *Magnolia cordata*, as known in gardens, must be regarded as a rare and local variety of *M. acuminata*.—Note on the age of the Swedish Paradoxides beds, by S. W. Ford. It is argued on several grounds that these beds, or at any rate those above the division characterised by *Paradoxides kjerulfi*, are of the age of the Menevian group. Even this species should probably be referred to the same group, so that the strata containing it may be regarded as constituting a legitimate portion of the Swedish Paradoxides measures.

Rivista Scientifico-Industriale, November 1886.—On the development of atmospheric electricity which accompanies the condensation of aqueous vapour to rain or snow caused by a lowering of the temperature, by Prof. Luigi Palmieri. Those physicists who still doubt the reality of this phenomenon are recommended to conduct their researches with the Bohnenberger electroscope, as perfected by the author.—On the electric conductibility of vapours and gases, by Prof. Constantino Rovelli. Some experiments are described, fully confirming the important conclusions recently announced by Prof. Luvini regarding the non-conducting property of aqueous vapour.—On the pairing-season of frogs and toads in the Venetian district, by Dr. Alessandro P. Ninni. This period is shown to be determined by the atmospheric conditions, being advanced or retarded according to the mildness or severity of the weather in spring.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, November 18.—"On the Specific Heats of Minerals." By J. Joly, B.E., Trinity College, Dublin. Communicated by Prof. Fitzgerald, F.R.S.

A number of experiments—carried out by the method of condensation—are tabulated in this paper, on minerals whose specific heats have not previously been determined as well as on some mineral substances previously dealt with by Kopp, Regnault, &c.

The observation of specific heat is suggested as of value in determinative mineralogy. It is, with some exceptions, nearly constant for the same chemical composition, and calculable from an assumed chemical constitution, not alone in the case of simple compounds, but in the case, often, of the more complicated silicates, &c. No difficulty is introduced into its determination by conditions of aggregation such as looseness, &c. The method by weighing in air and steam admits of its value being very simply determined, and, if great accuracy be not required, very rapidly.

The experiments made by the writer show that there is a small variation in the specific heats of minerals of the same species, accompanying slight differences in translucency, lustre, perfection of crystalline form, the tendency being for the specific heat to be a minimum in the most perfect crystals. There is, further, in some cases, a variation of quite different order accompanying pronounced differences in physical appearance, as from the transparent aquamarine to the clouded beryl, sapphire to corundum, &c.; so that a distinct and definite value exists for each variety, unaccounted for by any probable variation in chemical composition.

It appears, also, that this kind of variation obtains in the case of the isometric sulphides, pyrite, galenite, sphalerite, and in such degrees as admit of the several values being stated in numerical proportion from one substance to another. Thus, using the initial letters for the observed values, it is found that—

$$p_1 : p_2 :: s_1 : s_2;$$

and, if the orthorhombic disulphide of iron, marcasite, be included, the proportion

$$s_1 : s_2 :: p_1 : m :: g_1 : g_3$$

obtains very closely. The observations of other observers are included in these ratios, the existence of which, if further borne out, suggest as an explanation the existence of variations of structure of definite character affecting, in a definite way, the freedom of the atom. From this point of view, the case of marcasite would be that in which such variation proved adequate to determine a special symmetry for the aggregate.

December 9.—"Note to a Paper on the Geometrical Construction of the Cell of the Honey-Bee" (*Proc. R.S.*, No. 240, p. 253, 1886). By Prof. H. Hennessy.

The author found in the foregoing paper that a side of one of the lozenges terminating the cell was three times the difference between two parallel edges of the hexagonal prism, and from this result he constructed one of the lozenges by erecting a perpendicular at one-third of its length from one end, and from this end, with radius equal to the side, he inflected a second side of the lozenge, which gave the whole figure and also the six trapeziums forming the prism. With a compass and ruler the whole figure can be thus easily constructed.

The author further proves that the triangular pyramid which terminates the bee's cell may be inscribed in a sphere whose diameter is three times one of the edges of the pyramid. Moreover, this sphere contains within it as much of the hexagonal prism as may be measured by twice the side of a lozenge on the prism's shorter edge. These results, together with the extremely simple mode given by the author for constructing the figure, divest the problem of the complex character which it was sometimes supposed to have, and they may also assist in explaining the action of the bees in moulding the cells of the honeycomb to their observed shapes.

"The Intra-ovarian Egg of some Osseous Fishes." By Robert Scharff, Ph.D., B.Sc. Communicated by Prof. McIntosh, F.R.S.

December 16.—"On the Changes in the Proteids in the Seed which accompany Germination." By J. R. Green.

The author described experiments proving the existence in germinating seeds of a ferment resembling the proteolytic ferment of the pancreas. This exists in the resting seeds in the condition of a mesostate or zymogen, and is, on the starting of the germinative process, transformed into the active ferment. He traced the changes which it brings about in the reserve proteids of the seed, and showed that, while they passed through the stage of peptone, the nitrogen was carried to the growing points in the condition of a crystalline amide, such as leucin, asparagin, &c.

Zoological Society, December 21, 1886.—Prof. W. H. Flower, LL.D., F.R.S., President, in the chair.—Mr. Howard Saunders, F.Z.S., exhibited and made remarks on a specimen of a hybrid between the Tufted Duck and the Pochard, bred in Lancashire in 1886.—Mr. J. Bland Sutton, F.Z.S., read a paper on atavism, being a critical and analytical study on this subject.—Dr. von Lendenfeld read a paper on the classification and systematic position of the Sponges. This was based on the recent researches on the Hexactinellida, Tetractinellida, and Monaxonida of the *Challenger* Expedition, and on his own investigations on the rich Australian Sponge-fauna, particularly of the groups Calcarea, Chalinidæ, and Horny Sponges. A complete system of Sponges was proposed, and worked out down to the families and sub-families, and all the principal genera were mentioned. An approximately complete list of the literature of Sponges (comprising the titles of 1446 papers), a "key" to the determination of the 46 families, and a discussion of the systematic position of the Sponges were also contained in the paper.—Prof. Ray Lankester communicated a paper by Dr. A. Gibbs Bourne, of the Presidency College, Madras, on Indian earthworms, containing an account of the earthworms collected and observed by the author during excursions to the Nilgiris and Shevaroy Hills. Upwards of twenty new species were described.

Geological Society, December 15, 1886.—Prof. J. W. Judd, F.R.S., President, in the chair.—John Usher and Joseph Tertius Wood were elected Fellows of the Society.—The following communications were read:—Notes on *Nummulites elegans*, Sow., and other English Nummulites, by Prof. T. Rupert Jones, F.R.S. The author finds, in the "Sowerby Collection," now in the British Museum, the original specimens on which Sowerby founded his *Nummularia elegans* (1826, "Min. Conch." vol. vi. p. 76). These are partly specimens from that part of the bed "No. 29" of Prof. Prestwich's section of Alum Bay (Quart. Journ. Geol. Soc., vol. ii. (1846), p. 257, pl. ix. fig. 1), which is known to be the lowest of the Barton series; and partly some in a stone said to be from Emsworth, in Hampshire. The former are the same as those named *Nummulites planulata*, var. *Prestwichiana*, by Rupert Jones in 1852; and the latter are *N. planulata*, Lamarck (1804), and probably foreign. Thus *N. elegans* has priority over *Prestwichiana*; and as this last was determined by De la Harpe to be a variety of *N. wemmelensis*, Van den Broeck and De la Harpe, this variety should be var. *elegans*. The author thinks that, on broad zoological principles, *N. planulata* might still be regarded as the species; but, in view of the careful differentiation worked out by De la Harpe, he accepts the "specific" standing of "*wemmelensis*" as useful among *Nummulites*; but "*Prestwichiana*" has to give way to "*elegans*" for the peculiar "Barton" variety. A bibliographical history of the long-misunderstood *N. elegans*, Sowerby, descriptions of this form and of *N. variolaria* (Lam.), notes on *N. levigata* (Brug.), and an account of their range in England, complete the paper.—On the dentition and affinities of the Selachian genus *Ptychodus*, Agassiz, by A. Smith Woodward, F.G.S. The genus *Ptychodus*, owing to the detached condition in which the teeth are usually found, has hitherto been imperfectly understood. Agassiz referred it to the Cestraciontidæ, on account of a supposed resemblance in the arrangement of the teeth, and Owen's researches on their microscopic structure served to confirm this view. On the other hand, several writers have pointed out characters tending to show affinity between *Ptychodus* and *Rhynchobatus*. More recently, however, Prof. Cope and the author had shown that the supposed affinities between *Ptychodus* and the Cestraciontidæ were only apparent, and in the present paper additional evidence was brought forward. The author proceeded to describe several specimens of *P. decurrens* in the British Museum, and in the collection of Mr. H. Willett, of Brighton, one of the latter, especially, containing, what had been previously entirely unknown, the dentition in part of both jaws. These specimens showed that each jaw contained six or seven longitudinal rows of teeth on each side of the median row, and that the genus [illegible]

be referred to the true Rays, and not to the Cestracionf sharks, though the precise family to which *Ptychodus* belongs was more difficult to determine. On the whole the writer was disposed to assign it a place either amongst the Myliobatidæ or in their neighbourhood. The microscopic structure of the teeth was shown to be insufficient, by itself, to show their affinities.—On a molar of a Pliocene type of *Equus*, from Nubia, by R. Lydekker, B.A., F.G.S. A small collection of Mammalian remains from near Wadi Halfa had recently been placed in the author's hands; some of the bones were mineralised similarly to those of the Upper Pliocene of the Val d'Arno, or the Lower Pleistocene of the Narbadda valley. Amongst others, the most interesting is a right upper cheek-tooth of *Equus* but little worn. It evidently does not belong to any of the late Pleistocene or recent species of the genus, but to the more generalised group comprising *E. sivalensis*, &c.; though, bearing in mind the impossibility of distinguishing many of the existing species of the [illegible]s by their teeth alone, its absolute specific identity is not asserted. We may infer, then, that the ossiferous beds of Wadi Halfa are not improbably of Pliocene age, since this group of horses, both in Europe, Algeria, and India, had totally disappeared after the period of the forest-bed. Moreover, it is of interest, in view of previously expressed opinion, to find in the Tertiary of Nubia a species of this primitive group of *Equus*, which is apparently more nearly allied to the Siwalik than to the European species.

Royal Microscopical Society, December 8, 1886.—Rev. Dr. Dallinger, F.R.S., President, in the chair.—Mr. J. Mayall, Jun., called attention to a microscope, exhibited and made by Mr. Hilger after the designs of Sir A. Campbell, for measuring with great accuracy the divisions ruled upon a diffraction-plate. A special feature was the application of electricity, so that, by means of a weak battery and a galvanometer, it could be arranged that a contact should be made when passing every line, such contact being shown instantly by a deflection of the galvanometer-needle. In this way, end-measurements could be made with great accuracy.—Mr. Mayall also exhibited and described a new form of heliostat (made by Mr. Hilger) for use in solar photomicrography. The pencil of sunlight reflected from the first mirror could, by means of the second, be directed in any desired direction, affording to the worker the very great advantage of being able to place his microscope and camera in any position he pleased.—Mr. F. R. Cheshire exhibited and described an improved form of inoculating needle for use in connection with Bacterium culture-tubes. It was mounted in a wooden handle having a square ferrule which prevented it from rolling when placed upon an unlevel surface; in this was inserted a piece of silver tube, at the end of which was the platinum wire. A circular disk of silver was fixed on the tube, which, when placed in the flame of a lamp, rapidly became hot, and communicated the heat to the needle, while the small size of the tube enabled it to be introduced into the culture-tube more easily than the glass rod usually employed.—Prof. Bell called attention to some specimens exhibited of *Tænia nana*, the smallest of the human tape-worms, originally found by Bilharz in Egypt in 1850. Though extremely rare, it had the great advantage, to the physiologist at least (though not perhaps to the patient), of being found in considerable numbers. In the present instance the worms had been found in quantities in the duodenum of a girl aged seven years, at Bellegarde. The largest specimen met with was only 15 millimetres long.—Mr. J. D. Hardy called attention to a paper, by Dr. O. Zacharias, in which it was stated that Rotifers could never be revived after desiccation. He thought a protest should be entered against this, as it was within his knowledge that revivification had taken place over and over again. He had frequently tried the experiment, and had found that, when the dried mud was moistened, the Rotifers constantly revived. Prof. Stewart pointed out that a good deal must turn on what was meant by "desiccation." It was exceedingly difficult, under ordinary circumstances, to produce a condition of complete desiccation, and it was therefore very probable that in all cases of revivification there was sufficient moisture retained to preserve life. Prof. Bell said this explanation had usually been accepted as the real one when this subject perennially came to the front. The most curious part of Dr. Zacharias's paper, however, was that he did not in any way attempt to criticise the observations of his predecessors on the facts, but simply declared them to be fables, not inquiring at all into the conditions under which the revivals took place, so as to ascertain whether or not they were desiccated in the same sense in which his objects were when dried up in a granite basin. A discussion ensued, in which the President, Mr. Crisp, Mr. Michael, and Mr. Lewis joined.—Colonel O'Hara's note on the dissimilarity of appearances of crystals of blood as examined by him, and the illustrations in text-books, was read.—Mr. P. H. Gosse's paper, on twenty-four new species of Rotifera, was read, and two plates, drawn by Mr. Gosse in illustration, were handed round for inspection.

Anthropological Institute, December 14.—Francis Galton, F.R.S., President, in the chair.—The election of Mr. J. A. Otonba Payne, of Lagos, as an Ordinary Member, and of Dr. W. J. Hoffmann as a Corresponding Member, was announced.—Dr. E. B. Tylor read a paper by the Rev. G. Brown on Papuans and Polynesians, in which Mr. Brown contended that, notwithstanding physical differences, the similarity of their languages and customs prove the Papuans and the inhabitants of all the Pacific Islands have a common origin.—The following papers were also read:—Notes on songs and song-makers of some Australian tribes, by A. W. Howitt, F.G.S.—Music of the Australian aborigines, by G. W. Torrance, Mus.D.—On the aborigines of Western Australia, by R. H. Bland.

PARIS

Academy of Sciences, December 27, 1886.—M. Jurien de la Gravière, President, in the chair.—The proceedings were opened with an eloquent allocution by the President on the progress and triumphs of science during the past year, with a touching allusion to the loss sustained by the Academy in the death of its distinguished members, MM. Tulasne, de Saint-Venant, Laguerre, and Paul Bert.—The allocution was followed by the announcement of the prizes awarded during the year to the successful competitors in the various branches of the physical and natural sciences:—Prix du Budget (Mathematics), Edouard Goursat; Prix Francœur (Geometry), Emile Barbier; Extraordinary Prize of 6000 francs (Navigation), Capt. G. Fleuriais 4000 francs, Capt. de Bernardières 2000 francs; Prix Montyon, 2500 francs (Mechanics), M. Rozé; Prix Plumey (Naval Engineering), M. de Bussy; Prix Poncelet (Mathematics), Emile Picard; Prix Lalande (Astronomy), M. O. Backlund; Prix Damoiseau (Astronomy), M. Souillart, and to M. Obrecht 1000 francs; Prix Valz (Astronomy), M. Bigourdan; Prix Bordin (Optics), M. R. Radau; Prix Montyon (Vital and Social Statistics), M. Victor Turquan, with honourable mention of Dr. Mireur, Cazin, and Socquet; Prix Jecker (Chemistry), divided equally between MM. Colson and Oechsner de Coninck; Prix Vaillant (Geology), the members of the French Mission to Andalusia, MM. Michel Lévy, Bertrand, Barrois, Offret, Kilian, and Bergeron, and 1000 francs to M. de Montesson; Prix Barbier (Botany), M. Eugène Collin; Prix Desmazières (Botany), MM. H. van Heurck and A. Grunow; Prix de la Fons Mélicocq (Botany), divided equally between MM. Gaston Bonnier, G. de Layens, and E. G. Camus; Prix Montagne (Botany), Dr. Quélet; Prix Thore (Entomology), M. Peragallo; Prix Montyon (Medicine), Drs. Léon Colin, Dejerine and Landouzy, and Oré, 2500 francs each, besides honourable mention with 1500 francs to MM. Cadéac and Malet, Masse, and Ollivier; Prix Bréant (Medicine), Dr. Duflocq 2000 francs, M. Ad. Guérard 1500 francs, and M. Thoinot 1500 francs; Prix Godard (Surgery), M. Bazy; Prix Lallemand (Surgery), M. W. Vignal; Prix Montyon (Experimental Physiology), M. Gréhant, with honourable mention of M. Assaky; Prix Gay (Physical Geography), M. Ph. Hatt; Prix Montyon (Unhealthy Industries), MM. Appert Brothers, and M. Kolb 2500 francs; Prix Trémont (Magnetism), M. Moureaux; Prix Gegner, M. Valson; Prix Delalande-Guérineau (Terrestrial Physics), M. Hyades; Prix Jean Reynaud (Therapeutics), M. Pasteur; Prix Ponti (Aërial Navigation), MM. Renard and Krebs; Prix Marquise de Laplace, M. E. A. Brisse.—Prizes proposed for the year 1887:—Francœur, 1000 francs, discoveries or works useful to the progress of pure and applied mathematics; Extraordinary Prize of 6000 francs, works tending to increase the efficiency of the French naval forces; Poncelet, 2000 francs, for the most useful work for the advancement of the pure and applied mathematical sciences; Montyon, 700 francs, mechanics; Plumey, 2500 francs, improvement of steam-engines, or any other invention contributing most to the progress of steam navigation; Fourneyron, 500 francs, theoretical and practical study of the progress made in aërial navigation since 1880; Lalande, 540 francs, Valz, 460 francs, and Damoiseau and Janssen, gold medals, works contributing to the advancement of astronomy; Grand Prize of the

Mathematical Sciences, 3000 francs, researches on the elasticity of one or more crystallised bodies from the experimental and theoretical standpoints; L. Lacaze, 10,000 francs each, to the authors of the best work on physics, chemistry, and physiology; Montyon, 500 francs, vital statistics; Jecker, 10,000 francs, organic chemistry; Delesse, 1400 francs, to the author of a treatise on the geological or mineralogical sciences; Barbier, 2000 francs, for any valuable discovery in surgery, medicine, pharmaceutics, or botany, in connection with therapeutics; Desmazières, 1600 francs, for the most useful work on the whole or any section of cryptogamy; Thore, 200 francs, awarded alternately for works on the cellular cryptogams of Europe, and for researches on the habits and anatomy of any European entomological species; Montagne, 1000 and 500 francs, to the authors of important works on anatomy, physiology, the development or description of the lower cryptogams; Grand Prize of the Physical Sciences, 3000 francs, researches on the phenomena of phosphorescence in animals; Bordin, 3000 francs, for a comparative study of the African, South Asiatic, and Australasian freshwater fauna; Bordin, 3000 franc, for a comparative study of the auditory apparatus in the warm-blooded vertebrates, mammals, and birds; Savigny, 975 francs, for young zoological travellers; Montyon, 750 francs, medicine and surgery; Bréant, 100,000 francs, to the discoverer of an efficacious remedy against Asiatic cholera; Godard, 1000 francs, anatomy, physiology, and pathology of the genito-urinary organs; Serres, 7500 francs, general embryology, especially as applied to physiology and medicine; Chaussier, 2500 francs, for important works on forensic and practical medicine; Lallemand, 1800 francs, for works relating to the nervous system in the widest sense of the term; Montyon, 750 francs, experimental physiology; Gay, 2500 francs, distribution of heat on the surface of the globe; Montyon, unhealthy industries; Trémont, 1100 francs, for any naturalist, physicist, artist, or mechanician needing assistance in the accomplishment of any undertaking useful to France; Gegner, 4000 francs, in aid of any *savant* distinguished by serious pursuits undertaken for the purpose of advancing the positive sciences; Petit D'Ormoy, 10,000 francs, pure and applied mathematics, and the natural sciences; Laplace, a complete edition of the works of Laplace, for the first student leaving the Ecole Polytechnique. General conditions: the Academy retains all memoirs, the authors being at liberty to obtain copies from the Secretary. Competitors must send in their papers by June 1, accompanied by a brief summary of the part containing the discovery on which they desire the judgment of the Academy. No one can claim the title of Laureate of the Academy unless awarded a prize. Honourable mention or any other formal recognition of merit does not justify the assumption of this title.

STOCKHOLM

Society of Natural Science, September 18.—Prof. Wittrock gave an account of the gypsies, chiefly in relation to Hungary, which country he had recently visited with a view to studying its various nationalities.—Dr. Skåuberg exhibited abnormal specimens of various plants he had found in Sweden last summer, viz. *Phleum pratense*, *Listera ovata*, *Linaria cymbalaria*, *Typha angustifolia*, and *T. latifolia*.—Herr Berggren exhibited a specimen, in spirits, of *Nyctalis parasitica*, which had grown on another fungus, *Russula adusta*, whilst the latter was still quite fresh. The former fungus, he said, was also at times attacked by a smaller parasitic one, imparting to it a kind of coating.—Herr Meves exhibited a specimen of *Oriolus galbula*, shot last May, a bird very rarely found in Sweden.

Entomological Society, September 25.—Prof. Chr. Aurivillius gave an interesting account of his studies, last summer, of the habits of various species of Hymenoptera. He specially referred to one, *Odynerus muralis*, which he had found when boring holes in red-painted wooden walls, at the bottom of which it deposited its larvæ, protecting the latter against attack by making partitions of clay at intervals, and by putting a prop at the end, which it carefully covered with tiny bits of red paint, whereby these holes were almost impossible to detect.—Dr. Lampa described his observations of the remarkable keenness of the olfactory organs of the males of *Bombyx quercus*, L., whereby they were enabled to discern the females, even when far off. In one instance a female had been discovered by a male, although access to the former, which was in a cage, could only be gained through a balcony and room beyond.—Dr. Adlerz referred to an unusual case of hermaphroditism in an ant, whose left half was formed like a male, and the right like a female.

CHRISTIANIA

Society of Sciences, October 1.—The following papers were presented:—Der Ursprung der Etrusker durch zwei lemnische Inschriften erläutert, by Prof. Sophus Bugge.—Fresh contributions to our knowledge of the extension of the tube plants in Norway, by Prof. A. Blytt.—On variations in climate in the course of time (see NATURE, vol. xxxiv. pp. 220 and 239), by the same.—Ueber die Entwickelungsgeschichte der Pollenkörner des Angiospermen, by Dr. N. Wille.—Fresh contributions to our knowledge of the extension of lichen in Norway, by Herr B. Kaalaas.—Dr. G. Storm read a paper on voyages to countries north and north-west of Iceland, maintaining that the priests who, in 1285, discovered "Nya Land" (New Land) did not reach Newfoundland, but the south-eastern part of Greenland, and that the island discovered in 1194, "Svalbarde," was Jan Mayen. He further believed that the old Norsemen knew of other Arctic countries north of Russia and Norway.

BOOKS AND PAMPHLETS RECEIVED

Annual Report of the Geological and Natural History Survey of Canada, new series, vol. i.: A. R. C. Selwyn (Dawson Bros., Montreal).—Negretti and Zambra's Encyclopædic Catalogue.—Proceedings of the Royal Physical Society, Session 1885-86 (M'Farlane and Erskine, Edinburgh).—Den Norske Nordhavs-Expedition, 1876-78, XVI. Zoologi, Mollusca, II.: H. Friele (Grondahl, Christiania).—Transactions of the Sanitary Institute of Great Britain, vol. vii. 1885-86 (Stanford).—Zeitschrift für Wissenschaftliche Zoologie, xliv. Band, 4 Heft (Engelman, Leipzig).—Geological Survey of Alabama—On the Warrior Coal-Field: H. McCalley (Montgomery).—Year-book of Photography, 1887 (Piper and Carter).—Anuario de la Oficina Central Meteorolojica de Chile, 3er Cuaderno, Mayo i Junio.—Fourth Annual Report of the Metropolitan Public Gardens Association.

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THURSDAY, JANUARY 13, 1887

SCIENCE AND THE JUBILEE

II.

IN our article last week we referred to two directions in which the Jubilee memorial could in our opinion be made to fulfil functions of the highest importance which none of our existing institutions could take up, and we pointed out that one of them would be almost exclusively scientific.

The fact that so distinguished a man of science as Sir Frederick Abel has been appointed the organising secretary of the new institution amounts almost to an assurance that these possible high purposes will not be lost sight of. Sir Frederick Abel has proved himself to be not only a brilliant and patient investigator of new problems in science, but also one of those men whose indomitable energy and administrative power peculiarly fit him for a post in which sympathy with science in its highest aspects must be associated with a keen knowledge of and interest in affairs.

It is not merely a coincidence, but rather a sign of the times, that this week we refer in our columns to two other apparently distinct subjects, which in fact are most germane to the one we are discussing. The first is an article by Mr. Morris on the botanical federation of the West Indies, and the second is the recently issued Report of the Committee appointed by the Government to consider the question of the national science collections. Mr. Morris's article is connected with the proposed Jubilee memorial in this way: it shows that already, by the nature of things, the West India Islands are associating themselves with the mother country in things botanical, as, according to our view, all our colonies should in things scientific generally. The necessity, the thoroughness, and the economy which obviously must result from such an arrangement are well stated by Mr. Morris, than whom we know no higher authority. It should be a subject of pride to our men of science that, thanks to the broad views taken by three successive Directors of the Royal Gardens, Science is ahead of politics on a line where politics is bound to follow her; for the political federation of the West India Islands is a thing of the not very distant future. This reference to the West Indies induces us, almost compels us, to return for one moment to another matter touched on in our article last week. We then pointed out that topography, geology, and botany would not be the only arts of peace to which we need confine ourselves. Now, we are inclined to believe that any money which might be spent in federating the West Indies meteorologically by means of the telegraph, even if new cables had to be laid here and there, would be saved over and over again in twenty years by the protection afforded to shipping by forecasts during the hurricane season. Now, supposing such a system as this at work in one of the most interesting regions of the world from a meteorological point of view, and controlled, if need be, from the mother country, represented by the Meteorological Council, good would come all round; the Meteorological Council would gain a larger and closer view of the phenomena which it is its duty to study, and the federated colonies would obviously gain by the reduction in the yearly loss of life and capital.

We now pass to the Report on the National Science Collections. The connection between this Report and the proposal for the Institute can be gathered from the following statements.

We showed in our last article that the Committee appointed by the Prince of Wales were driven to South Kensington for a site by stress of money, even supposing that South Kensington was the worst possible site that could be selected. Our opinion is that South Kensington is the best site that could be selected for any institution which is to be anything more than an expanded Chamber of Commerce or Mart. But, however this may be, the fact remains that the Institute buildings, if erected at all, will be erected at South Kensington. Further the building must have a frontage.

It will be gathered from the Report of the Government Committee on the Science Collections that it is proposed to house them, including the historical and other objects recently transferred from the Patent Museum, in a building to run from Prince's Gate to Queen's Gate, at the back of the Museum of Natural History. Now, why should not the Royal Commissioners and the Government arrange matters so as to enable the Science Museum, which thus must be geographically associated with the Institute, to be commenced at the same time? In this way, it appears to us that the Royal Commissioners would have fully discharged their functions as regards the southern part of the land for which they are trustees, provided always that the Institute is really to promote the progress of science and art.

One word now as to the real place of this Science Museum among our national institutions for the promotion of knowledge. The student of literature in this country—the man who has to make new books, or whose desire it is to obtain any of the knowledge contained in old ones—finds in the British Museum library and reading-room the most magnificent organisation to supply him with what he wants. In this respect the British citizen to-day is as well off as, but perhaps no better off than, the citizen of Alexandria was in olden times; and now, as then, it is conceded that it is the duty and glory of a State which makes any pretence to civilisation to have such an institution as this among its resources. It is one of the arsenals of peace.

Turn to another line of intellectual activity: take the student of the biological sciences. The British Museum of Natural History is a library no longer containing books merely, but things which have to be studied to obtain new knowledge. Here, as among the books, the student is allowed to examine, to study, to collate, and to describe without stint, microscopes and other apparatus being provided for him; facilities are afforded to him in order that he may learn, and that the field of knowledge may be enlarged through his labours.

Yet another region of activity: take Art in all its branches. Our National Gallery and the art collections at the British Museum and South Kensington show that

in past times, at all events, the State has considered it its duty to bring together collections for the benefit of the student, and even for the delight of the eye of the uninformed.

These institutions are not merely depositories for loans, in which the State enables its citizens to be benefited provided only that the process costs nothing, or next to nothing; but fabulous sums have at times been given, and willingly given, by the nation in order that we shall not be behind others in the opportunities afforded of cultivating the arts of peace.

We now come to the newest developments of human activity. We leave the ground common to us and Greece and Rome, and we approach the modern world, the world which is as it is because physics and mechanics and chemistry have been developed since those earlier days to which we have referred. These developments form the glory of our modern civilisation, and are the pith and marrow of our national life.

What do we find in our national collections representing these in this our England, where till a few years ago physics, mechanics, and chemistry had been most, and most successfully, applied?

Nothing, or practically nothing. The State, which has absorbed greedily some two millions nett in patent fees which have come into its coffers in consequence of these developments, has given nothing, or practically nothing, back. It is true that the generosity of private individuals has enabled the nation to possess and exhibit some of the most interesting among the historical apparatus illustrating the applications of those branches of science to which we refer. It is true also that the Science and Art Department has done its best to make bricks without straw, and the state of things is better now than it was ten years ago. We say ten years ago, because it is about that period since the Duke of Devonshire's Commission pointed out in the clearest and most emphatic way this great and damaging gap in our national resources, and pointed out, too, the various evils which would arise from it. Since that time other Committees have reinforced the Commission's suggestions. Those who know best know how well for the country it would be if the modern developments of knowledge were illustrated as well as the older ones. It is true that after ten years the thing has gone so far that a Treasury Committee has been appointed to consider how such a national collection could be housed. But it is not impossible that another ten years may elapse before anything is done, unless some special and extraneous reason be urged for the doing of it.

Then why should not the men of science in this year of Jubilee urge upon the Government that it also should not be lacking in commemorating this year? If the citizens of Greater Britain contribute a quarter or half a million in commemorating the year, why should not the Government contribute some 25,000*l.* (as an instalment of 100,000*l.*, which is all such a Museum need cost) in starting an institution which all students of science or its applications know will be the most important of all in fifty years time, most important, that is, in everything that relates to the development of the resources of Greater Britain?

So much then for what the Government might well do in the year of Jubilee. It remains for us to consider what men of science as such can do. We believe that the keynote of what they can best do was struck by Prof. Huxley as President of the Royal Society. To this matter we shall probably take another opportunity of referring.

MARINE ENGINEERING

Die Schiffsmaschine; ihre Construction Wirkungsweise und Bedienung. Bearbeitet von Carl Busley. (Kiel: Verlag von Lipsius und Tischer, 1886.)

THE concluding volume of this important work on marine engineering equals in merit and style the portion previously published, of which a notice appeared in NATURE, vol. xxix. p. 426. It is a most laborious and well-digested compilation of all that is best worth preserving in relation to the resistance and propulsion of ships. The author with true German industry has sought far and wide for his materials, drawing from the writings of French, German, Dutch, American, and English authorities. But it may be stated with some satisfaction that the most recent and valuable investigations to which reference is made are those of our own countrymen. The labours of the late Mr. Scott Russell, Prof. Rankine, and Mr. W. E. Froude, have given an impulse and direction to the theoretical and experimental investigations of the problems of resistance and propulsion, of which the practical value cannot well be over-estimated. The action of the Admiralty in assisting the late Mr. Froude, and in now establishing, under the able direction of Mr. R. E. Froude, experimental works on an enlarged and permanent basis, has yielded substantial advantages to the Royal Navy, and benefited the science and practice of shipbuilding generally. One private firm on the Clyde has, for its own purposes, created a similar experimental establishment; another was established in Holland by the late Chief Constructor, Dr. Tideman; France has done something in the same direction; and Russia and the United States have given attention to the matter. Everywhere it is now recognised that the resistances of full-sized ships may be closely approximated to by means of experiments with models; and in this manner the problems of ever-increasing difficulty incidental to the attainment of higher and yet higher speeds are being dealt with confidently and successfully. Pure theory cannot master these problems, although it has suggested the best experimental procedure. The older theories of resistance summarised by Mr. Busley have given place to the "stream-line" theory, and upon it has been based the "law of comparison" between ships and models independently laid down by the great French teacher, M. Reech, and the late Mr. W. Froude.

Mr. Busley shows full appreciation of the value of these modern experimental methods, while he also describes the more or less "rule-of-thumb" methods which formerly prevailed and have still their uses. It is not possible for most shipbuilders and marine engineers to have model experiments for new ships, and they therefore depend largely upon the analysis of the results of speed trials made with other ships. Carefully conducted trials on what is

called the "progressive" principle—that is, at a number of different speeds from the maximum speed attainable down to four or five knots per hour—are of the greatest value to future designs of ships and machinery. For a long time they have been made occasionally in the Admiralty practice; but Mr. W. Denny deserves great credit for bringing the system into general use and establishing its practical value. Associating progressive trials with the "law of comparison" for the resistances of ships of different dimensions but similar forms, a designer can feel great confidence of success in most of his practice. If he has the *data* for small ships propelled at relatively high speeds, he has the means of approximating closely to the performances of larger ships up to much higher speeds, and this is of enormous value under present conditions.

Methods of *propulsion* and details of *propellers* occupy a large section of the volume under review. The paddle-wheel, the screw, and the water-jet propeller all receive full discussion in their theoretical and practical aspects. Probably no such summary of facts relating to modern practice has been made before by any writer. Under paddle-wheels, for example, there are descriptions constituting practical data for designing paddles at the *sides* of steamers (the ordinary plan), at the *stern*, as in light-draught river-steamers, and at the *centre*, between twin hulls, as is the fashion in some American river-steamers. Under the jet-propeller appears a great mass of information as to the fittings and performances of a number of vessels, including the English gunboat *Waterwitch* and Thornycroft's torpedo-boat of recent construction, the German *Hydromotor*, described in NATURE, vol. xxvi. pp. 18 and 247, and a Swedish experimental boat. Naturally the greatest attention is bestowed upon screw-propellers, which are most generally employed. To the theory of the screw-propeller laid down by Rankine, many valuable additions have been made by the Froudes, father and son, Mr. R. Froude being still engaged in the investigation of the subject experimentally. Up to the present, however, it cannot be said that any complete, acceptable theory has been put forward. Experience shows that by the choice of proper screws enormous economies of power or sensible increases in speed may be secured. The first trials of H.M.S. *Iris*, nearly ten years ago, were fortunately most disappointing, for they compelled a close study of the screw question in her case, with the result that the speed was increased from 16½ to 18½ knots per hour simply by a change of screws. Similarly striking results have been obtained in ships and boats of the torpedo flotilla, and in vessels of the mercantile marine. Much yet remains to be done before a satisfactory practice can be insured in choosing a suitable propeller for a ship of novel type or exceptional speed. Probably here also experiment with models of screws will come in to assist full-scale operations. Attempts in that direction have been made for many years past in the Admiralty Experimental Works, but the task is one of great delicacy and difficulty, and is far from having been completed.

Mr. Busley goes over this ground very carefully, and gives practical rules, based on experience for the most part, for fixing the sizes and pitch of screws. One of the best of these is that published by Mr. S. Barnaby and based on the extensive experiments of the Messrs. Thornycroft, whose success in the construction of exceptionally swift vessels results in part from the close attention given by them to screw-propellers. Mr. Busley has an interesting chapter on the geometry of screw-propellers; and his remarks on the most suitable materials for propellers are important.

The illustrations to this volume are numerous and well executed. The letterpress and general style of production leave nothing to be desired. It may be anticipated that the work now completed will speedily become a standard book of reference for German marine engineers.

W. H. W.

AN ARCTIC PROVINCE

An Arctic Province: Alaska and the Seal Islands. By Henry W. Elliott. Illustrated by many Drawings from Nature, and Maps. (London: Sampson Low and Co. 1886.)

MANY accounts of Alaska and of the wonderful seal-rookeries to be met with on some of the islands in its Arctic seas have been published, but none which have given in so interesting and succinct a manner the history of these far-off northern solitudes as the present volume. The author's personal knowledge of these regions, and his intimate acquaintance with the very numerous writings of others on the subject, have enabled him to write a volume that will long remain a standard one; while the illustrations from his own pencil are full of life and vigour, and add immensely to the value of the work.

The volume contains, of course, an account of the discovery, in 1741, of the Alaskan Province by Veit Bering, and of his shipwreck and sad death. The survivors spread the news of the wealth of fur and ivory that was to be found there, and soon came the rush of Russian traders. Fierce struggles took place between the individual traders and the natives, and much blood was shed, but at last a Russian American Company was established with supreme powers; and for a time, under the supervision of that very remarkable man, Governor Alexander Baranov, it flourished. Its decadence, however, proved to be as rapid as its rise; and after various vicissitudes, lasting during the first half of the present century, the district was, in 1867, acquired by the United States Government by negotiation from Russia. The name of Bering was given to the Straits connecting the Pacific with the Arctic Ocean by our Capt. Cook.

The features of the Sitkan region are treated of in a special chapter. Were it not for the damp and extensive rainfall, the climate would be endurable. A great deal of the scenery is most picturesque. The aboriginal life of the Sitkans is glanced at, but this portion of the work contains nothing very new or profound, as the author does not profess to know as much about the natural history of the human race as about that of the marine mammalia. In separate chapters, the alpine zone of Mount St. Elias, Cook's Inlet and its people, and the great Island of Kodiak, are treated of. The quest of the otter has a whole chapter devoted to it. Few ladies realise how many men are engaged in deeds of hazardous peril

to obtain for them the ebony sea-otter trimming to their dainty sealskin sacques. These otters would seem to be on the eve of extirpation, so ruthlessly are they hunted and destroyed. All the world's supply comes from the North Pacific and Bering Sea. The chase and capture of the otter furnish the only employment possible for several thousands of the semi-civilised natives of Alaska, so that the destruction of this trade would be very disastrous to the hunters.

The chapter on the great Aleutian Chain tells us of the volcanic island of Oonimak, the cone-shaped crater of Shishaldin, and Oonalashka Island, with its smoking volcano of Makooshin. The chief interest of the volume centres, however, in the chapters relating to the wonderful Seal Islands, and on the modes of capture of the seals, and on their habits. The Pribylov Islands of Bering Sea were discovered just a century ago by Pribylov, the commander of a Russian sloop. He called them Subov Islands, but the Russians seem unanimously to have elected to call them after their discoverer. Sketch-maps of St. Paul and St. George are given, and there are very full and minute details of each, and of the few neighbouring rocky islets, including Walrus Island, which would appear to teem during the summer season with bird life. The history of the progress made from the earliest to the present times by the various villages on these islands is also given, and the writer alludes to the fact that the natives may be expected in the end to adopt the English rather than the Russian tongue.

The longest chapter in the volume is that devoted to the history of the habits and manners of the fur seal, which in myriads frequents these islands, and this chapter will well deserve perusal. From the economic point of view the author seems satisfied that, should the laws and regulations made by the United States Government be acted on in the future as they are now, 100,000 male seals under the age of five years and above the age of one year may be safely taken each year without the slightest injury to the regular birth-rate, or the natural increase thereof. Calculating the pups at 1,000,000 a year, of this number half are males. Of these, say one-half are lost during their first year of infancy. Owing to the polygamous habits of the males and the great age to which the adult males live, not one-fifteenth of this number is ever needed on the rookeries, and on this showing it is better that they should be killed to supply the fur trade with their skins, than that they should be allowed to live to consume millions of cod and wolf-fish.

The sea-lion (*Eumetopias stelleri*) is also a characteristic pinniped of these islands, but, having no fur, is for its naked skin valuable only to the natives. Mr. Elliott gives a graphic account of the habits of these enormous beasts, the adult males of which will measure 10 to 11 feet in length, with a girth of 8 to 9 feet around the chest and shoulders.

In the chapter on "Innuit Life and Land" a good deal of information is given as to an immense northern area, where the dwelling-houses are approached by underground passages, and where moose and reindeer abound. Still more northern wilds are described in a chapter on "Lonely Northern Wastes," while one on "Walrus and Walrus-hunting" concludes the volume. These morse are perhaps of all animals the most difficult subjects that an artist can find to reproduce from life. There are no angles or elbows to seize hold of; the outlines of the body and limbs are all rounded, free, and flowing. Some life studies of the young made by artists no doubt are good; but, until the appearance of Mr. Elliott's drawings of the fully mature animal, we had nothing in the way of portraits much better than caricatures of these strange beasts.

One interesting fact is mentioned in connection with Norton's Sound; on its shores are many low clayey bluffs, which, as they are annually undermined by the surf and chiselled by frost, fall in heavy masses on the beach, thereby exposing deposits of the bones and tusks which apparently belong to the mammoth. From time immemorial the Innuits have used this ivory for tipping their spears, lances, and arrows.

The illustrations, as we have before said, form a very prominent feature in this volume, which we commend to the reader's notice as both interesting and pleasant reading.

ANTIQUITIES OF SPAIN AND PORTUGAL

Les Ages préhistoriques de l'Espagne et du Portugal. Par M. Émile Cartailhac. Imperial 8vo, with 450 cuts and 4 plates. (Paris: Reinwald, 1886.)

ANTHROPOLOGISTS and archæologists will gladly hail this handsome volume from the pen of the editor of the "Materiaux pour l'Histoire primitive de l'Homme." It relates to two countries of the primæval antiquities of which but little is generally known, and the literature concerning whose early relics has hitherto been but scanty. It is true that we have various essays on the prehistoric antiquities of Portugal by Carlos Ribeiro, Delgado, and the Geological Commission; while those of Spain have been treated of by Signor Tubino and Dr. Vilanova y Piera, and, so far as Andalusia is concerned, by Signor Gongora y Martinez; and, as to some of the caves, by Mr. MacPherson and the late Mr. Busk. The work, however, of M. Cartailhac is far more general and comprehensive than that of any previous author. It will be well perhaps to give some sort of summary of the contents of his book.

After some preliminary considerations, he attacks the subject of the quartzite and flint flakes, which have been considered by some to prove the existence of man in Portugal in Tertiary times, but after a fair examination of the facts, not only in Portugal but in France, he regards the proofs as not sufficiently convincing, and remarks that unexceptionable traces of Tertiary man remain still to be discovered. Probably not a few of those who visited the plain of Otta on the occasion of the Prehistoric Congress at Lisbon in 1880 will agree in this verdict of M. Cartailhac.

The existence of Quaternary man in Spain has evidence in its favour of a far more satisfactory character. Sections of the remarkable valley-gravel deposits of the Manzanares at San Isidro, near Madrid, are given, as well as cuts of some of the implements there found, which, so far as form and material are concerned, might have come from the valley of the Somme. Some other implements of the same class have also been found in Portugal. Instruments both in flint and bone similar to

those from the caves of the Dordogne, including needles and the peculiar barbed harpoons, have been found in caverns in the north of Spain; but at present no remains of reindeer have been found associated with them. Notwithstanding this fact, the caves would appear to be of about the same age as those of La Madelaine.

The remains of Neolithic age found within the Iberian Peninsula form the subject of the next portion of M. Cartailhac's book. Foremost among these he places the shell-mounds, which in some parts of the valley of the Tagus attain to considerable dimensions. Those at Mugem were visited by many of the members of the Prehistoric Congress, and it is somewhat remarkable that mollusks, of the shells of which the *Kjökken möddings* principally consist, no longer are occupants of the Tagus near the mounds, but are only to be found much lower down the river, where the waters are more salt.

The principal worked flints that occur in the mounds have much the appearance of having been chisel-shaped arrow-points. Curiously enough, the mound which was thrown up as a refuse-heap by the living has been also utilised as a cemetery for the dead—intramural interments having probably not been forbidden. Some of the caves have furnished remains of pottery covered with a raised reticulated pattern, as well as objects in stone, bone, and shell. Many of them have also been the site of Neolithic interments, and the Casa da Moura has furnished one of those remarkable skulls on which trepanation has been begun but not finished. Large flat lance or javelin points of flint were found in this cave, having both faces polished after the manner of some Irish specimens. Indeed, there is a considerable resemblance in the *facies* of the flint antiquities of Portugal with what prevails in Ireland, and this somewhat corroborates the view of there having been in ancient times Iberian settlers on the shores of Hibernia. The resemblance between some of the bronze implements of the two countries is also worthy of notice. A number of ornamented pendants of slate, some of peculiar plume-like form, have also been found in the caves, the devices upon them being formed of notched and plain triangles and zigzags of almost identical character with the ornaments upon some of the Irish bronze celts.

Some imitations of stone or possibly bronze celts mounted on handles, as adzes, are very remarkable. They are carved in marble or soft stone, so that they could hardly have been used as cutting tools, but they may have had some symbolical meaning. The most interesting of the burial-places are the *Antas* or dolmens, of which a considerable number exists, some of large dimensions. In their general character they much resemble the megalithic monuments of France and Britain. Chambered barrows and *allées couvertes* are also known. In them have been found arrow-heads not unlike some of the Danish forms, with very long curved barbs and no central stem, as well as others of more simple triangular forms. In the dolmens also some of the chisel-shaped tips like those from the shell-mounds have occurred.

Traces of the old copper-mining industry of Spain have been found in the shape of large mauls of stone, with a groove or channel around them destined to receive the withe which formed the handle. The bronze swords and daggers much resemble those of Southern France and Italy, while the flat celts of bronze and of copper are like those of Ireland. The palstaves, however, or flanged hatchets, have frequently a loop on either side, instead of one only as is commonly the case in most European countries. The socketed celts have also frequently two loops, a peculiarity which is more common in parts of Russia than in other countries of Europe.

Coming down to what our author calls protohistoric times, various weapons and ornaments of the Early Iron period are figured, as well as some slabs of stone inscribed with what are apparently Phœnician letters. Of these, however, no interpretation is given. The concluding chapter is devoted to anthropological remarks, and full particulars are given of a series of skulls from some of the caves, together with photographic illustrations.

The preface to the work is from the pen of M. A. de Quatrefages, who, however, goes far in advance of M. Cartailhac in his acceptance of the discoveries of Tertiary man.

Those who are interested in the early history of mankind, and in comparative archæology in general, will do well to consult M. Cartailhac's book, in which they will find many other points of interest besides those which have been summarised in this brief and imperfect notice. J. E.

OUR BOOK SHELF

Educational Exhibits and Conventions at the World's Industrial and Cotton Centennial Exposition, New Orleans, 1884-85. Special Report by the Bureau of Education. Part I. Catalogue of Exhibits. (Washington: Government Printing Office, 1886.)

THE extensive collection of everything connected with education which was to be made at the Exhibition held at New Orleans, and also the remarkable success of the United States Bureau in obtaining and dispersing educational information, have been referred to more than once in this journal. The Hon. John Eaton, Commissioner of Education, accepted the post of Superintendent, and the Government encouraged him to do everything in his power for the success of the undertaking; and this not unwisely, for the excellence or otherwise of the education exhibits of any locality is regarded as an attraction or warning by the most valued class of emigrants. Accordingly he made use of a visit to France, Belgium, and England to gain exhibitors, and in France he was very successful. At the Exposition he addressed large assemblies of teachers, and to himself as well as to the Bureau which he represented were awarded "Grand Diplomas of Honour" for valuable contributions. An illustrated catalogue of apparatus lent by the Bureau for experiments in the leading departments of physics is given in the Report. Among these the electrical instruments, as also a solar microscope, were particularly attractive at the Exhibition. Each State was urged to send specimens of the work, as also any objects which illustrated the growth and present condition, of its University; of its normal schools; of its schools of each grade; the work, on uniform paper, of children in every subject and standard; photographs and ground-plans of its best schools; school literature published in the State; technical work also, and both the methods and the performances of special schools, as for the blind, &c. Though not many States responded fully to this wide invitation, yet the fact that over nine thousand specimens (many of them *volumes* of school-work) were exhibited by Ohio alone, with regrets that a more complete set from all cities could not be got together, shows that a worthy response was made in some cases.

As much school *matériel* was exhibited as manufacturers could be induced by a circular from the Bureau to show gratis, and naturally the smaller articles were profusely sent in. Where specimens were deficient, as in the case of heavier furniture, heating and ventilating apparatus, &c., they were not unfrequently purchased and supplied by the Bureau, as was also a fully equipped laboratory arranged so as to economise space in schools.

Among the objects supplied by American exhibitors, were statistical charts of every educational subject. Manual training, a matter of special value in the Southern States, was carried on in the building, and the boys' products attracted particular interest. An effort was made that household industry, in its four departments of nursery, kindergarten, kitchen-garden, school of cookery, with sewing, &c., should be fully illustrated, but the first and fourth were not found practicable. A model kindergarten, in which sixteen children were being taught by means of choice objects in each important department of knowledge, instead of with books, and so furnished that it looked the brightest and pleasantest room in the building, was exhibited by the Commissioner; and kitchen-"garden" instruction, *i.e.* in domestic servants' work, was given on four afternoons a week during March and April.

Gymnastics and physical education with apparatus for exercises of various degrees of severity were shown, with lessons and illustrations several times a day. Library appliances, as well as every description of educational works, were largely exhibited in this land of the free library. Specimens of work from reformatory schools, boots, brushes, wood-work, and clothing made by boys had their place beside photographs, publications, kindergarten work, sewing and fancy work done by girls. Washington exhibited a collection of apparatus for showing the simpler scientific experiments, made by public school pupils, the illustrations of which, given in the Report, show how brain and fingers have worked together there. From the same city also was sent a miniature copy of a school recently erected there, set up as a "model" school in both senses of the word, but plans of it are not given in this Report.

One of the most important exhibitors was Prof. Ward, of Rochester, N.Y., of whose museum of natural history, though it comes under the head of commercial department, a full-page ground-plan is given. It consists of a well-balanced collection of specimens of recent stuffed and extinct restored animals; specimens of minerals found in the United States; and models of the most important geological features from all the best known parts of the globe.

An item worth notice in grammar-school, *i.e.* second-grade, education, is a collection of maps made by the boys under the master's instructions, showing countries in relief, with their natural productions denoted by little pieces of minerals, or grains of rice or corn.

A Text-book of Pathological Anatomy and Pathogenesis. By E. Ziegler. Translated and edited by Donald MacAlister, M.A., M.D. Part II. Special Pathological Anatomy, Sections IX.-XII. (London: Macmillan & Co., 1886.)

THIS, the third volume of the work, fully justifies the high opinion we expressed of its predecessors. In point of excellence of treatment, lucidity of description, general arrangement of the subject, fullness of detail, and abundance of excellent illustrations, it gives to the work as a whole a completeness and thoroughness which, we believe, have not been attained by any previous work, in English or foreign tongues. The pathology of the urinary organs is described in Section IX. (Chapters lxiv.-lxxv.); Section X. (Chapters lxxvi.-xc.) treats of the diseases of the respiratory organs, the thyroid and thymus glands; Sections XI. and XII. (Chapters xci.-ciii.) of the pathology of the central and peripheral nervous system. If amongst all that is good in the volume we had to choose what is best, we should name the chapters on the pathology of the lung and central nervous system. The classification and the detailed description of the morbid changes of these two organs are most excellent in every respect.

As in the previous volumes, so also in this, a carefully collected summary of the more recent references is given in connection with each subject. A useful index, both of the names of authors cited and of the subjects treated, concludes the volume. The illustrations are copious, representative, and well-chosen. Those illustrating the pathology of the kidney and respiratory organs are in point of printing far above the illustrations one is accustomed to see in English text-books.

As a text-book for students, and a book of reference to workers in pathological anatomy, it is unequalled.

E. KLEIN

Hours with a Three-Inch Telescope. By Capt. Wm. Noble, F.R.A.S., F.R.M.S. (London: Longmans, Green, and Co., 1886.)

THE present volume, which is to a great extent a reprint, is designed for the help and instruction of those who, possessing a small telescope, are at a loss as to how best to use it. On the whole, the book well fulfils its author's purpose. Clear, simple, straightforward, and practical, it gives just that elementary instruction in the use of a small instrument which so many require, and which has hitherto been provided for them nowhere else, and it will undoubtedly serve as a good introduction to more advanced books, such as Webb's "Celestial Objects." Occasionally a rash statement needing correction is met with—*e.g.* the footnote on p. 84—but for the most part the book has been carefully written. It is illustrated by a good map of the moon, and by over one hundred woodcuts. The latter are clear, but possess no special merit otherwise; indeed, the representations of Jupiter and Saturn are poor; but, despite a few such slight blemishes in detail, the volume cannot fail to be useful.

Lunar Science. By the Rev. Timothy Harley, F.R.A.S., Author of "Moon-Lore," &c. (London: Swan Sonnenschein, Lowrey, and Co., 1886.)

THIS little book contains a clear and interesting account of the essential facts known about the moon in ancient and modern times. Having referred, in the introduction, to some of the more general aspects of his subject, the author proceeds to discuss, in separate chapters, the moon's distance, its size, shape, substance, formation, condition, surface, and motions. In the chapter on the moon's motions, the writer has a good deal to say about the use which has been made of the moon as the measurer of time. "The etymology of the word," he says, "is full of meaning. 'Moon' and 'Month' are twins, whose parentage was Sanskrit." The truth, of course, is, not that "their parentage was Sanskrit," but that "Moon" and "Month" and the Sanskrit word "Mâs," the measurer, have the same root. As kindred words appear in several other Aryan languages, it may be assumed that the moon served as a chronometer to the Aryans before they dispersed. The Athenians began their year upon the first new moon after the summer solstice, and this year they divided into twelve months, containing alternately thirty and twenty-nine days. Each month, again, was divided into three decades. The Romans also divided their months into three parts, and, says Mr. Harley, "the first day was called *Calendæ*, from an old verb meaning 'to call out,' because a pontiff then made proclamation to the people that it was new moon. These *Calendæ* have given us our word 'calendar.'" Among the North American Indians, time is computed by moons or months, and they talk of the "beaver moon," the "buck moon," the "buffalo moon," and so on, exactly as the Greeks used to talk of the "planting moon," the "reaping moon," the "[illegible] moon," and the like.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Mr. Wallace on Physiological Selection

In the September issue of the *Fortnightly Review*, Mr. A. R. Wallace published an article criticising the theory of physiological selection, and subsequently published a letter in NATURE conveying the substance of that criticism. Having now replied to all my critics in the current issue of the *Nineteenth Century*, I will here give the substance of my answer to Mr. Wallace.

"(1) Mr. Romanes makes a great deal of the alleged 'inutility of specific characters,' and founds upon it his extraordinary statement that, during his whole life, Darwin was mistaken in supposing his theory to be 'a theory of the origin of species,' and that all Darwinians who have believed it to be so have blindly fallen into the same error. I allege, on the contrary, that there is no proof worthy of the name that specific characters are usually useless, and I adduce a considerable series of facts tending to prove their general utility."

Now, in this matter I not only "allege," but prove, that I have upon my side Darwin himself ("Origin of Species," pp. 171, 176, 421; "Descent of Man," p. 61) and more or less "all Darwinians." Moreover, I have shown that the arguments whereby Mr. Wallace seeks to justify his own individual views are quite unworthy of their distinguished author.

"(2) In support of his view as to the swamping effects of intercrossing, Mr. Romanes objects to the assumption of Darwin, 'that the same variation occurs simultaneously in a number of individuals,' adding: 'Of course, if this assumption were granted, there would be an end of the present difficulty'; and his whole argument on this branch of the question rests on the assumption being false. I adduce evidence—copious evidence—that the supposed assumption represents a fact, which is now one of the best-established facts of natural history."

The "copious evidence" here alluded to consists merely in a reference to the well-known observations of Mr. J. A. Allen upon the kinds and degrees of individual variation exhibited by certain species of American birds. I am able to show that none of these observations have any bearing upon the "difficulty" in question; and that so far from the "assumption" in question representing "a fact which is now one of the best-established facts of natural history," even so accomplished an ornithologist as Mr. Seebohm displays so sublime an ignorance of its establishment as to affirm, in his criticism of my paper, that "it is seldom that the difficulties of natural selection from fortuitous variations have been so clearly, so impartially, but so candidly set forth." And he adds, *speaking specially of birds*, "So far as is known, no species has ever been differentiated without the aid of geographical isolation," *i.e.* without some check upon free intercrossing.

"(3) Mr. Romanes states, as the special feature of his physiological varieties, that 'they cannot escape the preserving agency of physiological selection.' He gives no particle of proof of this, while I show that, on the contrary, it is hardly possible for them to survive to a second or third generation."

The objection here is that the chances must be greatly against the "physiological complements" (or the suitably varied individuals of opposite sexes) happening to mate, and, even if they did, that their progeny should likewise do so often enough to start a permanent variety.

In answer to this objection I first of all adopt my critic's assumption, namely, that in all cases physiological selection must depend on the chance unions of physiological complements, relatively very few in number, and scattered over areas occupied by large species. Upon this assumption I agree that the sexual variation, "whenever it occurs, is almost certain to die out immediately," after which the paper proceeds as follows:—

"Granting it is shown that the union of these physiological varieties of opposite sexes is a matter of enormously rare occurrence, is it not also true that *the origin of a new species is an enormously rare event?* Not a few existing species have remained unchanged from remote geological time; the life of all species is incalculably long as compared with that of their constituent individuals; and in every generation of individuals there are, in the case of most species, millions of fertile unions. Therefore, so far as we can form any estimate on a subject where all proportion seems to fail, we may safely conclude that the ratio between the number of species which have appeared upon this earth, and the number of fertile unions between their constituent individuals, can only be represented by unity to *billions*.

"In view of this fact I am not afraid of any calculation that can be made, in order to show how many chances there are against the confluence of those conditions on the occurrence of which my theory supposes the origin of a species to depend. According to Mr. Wallace's estimate, the chances against the suitable mating of these physiological varieties 'may be any number of *thousands* to one'; so that, in view of the considerations above given, and the large number of species existing at any one time, we might conclude that Mr. Wallace supposes the birth of a new species to be an event of almost daily occurrence. Therefore, looking to what we all know are the real facts of the case, even if it were true that whenever one of these physiological varieties occurs, 'it is almost certain to die out,' this *almost* may be here quite sufficient for all that is required. Thus, upon the whole, and under my temporary acceptance of Mr. Wallace's assumptions, I confess it appears to me a somewhat feeble criticism to represent that the conditions which my theory requires for the origin of a new species are probably about as rare in their occurrence as is the result which they are supposed to produce.

"So much, then, for my first answer. My second answer simply is that from its beginning to its end this criticism is wholly in the air. Hitherto I have been considering his assumptions merely for the sake of argument. But they are not *my* assumptions; they form no part of my theory; and, therefore, I repudiate them *in toto*. The paper which Mr. Wallace is criticising clearly and repeatedly sets forth that I do *not* suppose the mating of physiological varieties to be wholly a matter of chance. Whether or not it is a matter of chance will depend on the causes which determine the variation. When these causes are of a kind which act simultaneously on many, on most, or even on all individuals occupying the same area, the element of chance is proportionally excluded. One very obvious, and probably frequent, instance of what may be termed collective variation in the reproductive system—or a variation due to a common cause acting on many individuals simultaneously—is actually quoted from my paper by Mr. Wallace himself, namely, changes in the season of flowering or of pairing, which insure that any section of a species so affected shall be fertile only within itself. Collective variation of this kind may be directly due to the incidence of some common cause, such as changed conditions of life with respect to food, climate, station, &c.; or, as in the case of bud-variation, it may be due to a single 'sport' affecting all the blossoms growing *upon the same branch*. But besides such *direct* action of a common cause, it is easy to see that natural selection, use and disuse, &c., by operating in the production of organic changes elsewhere, may not unfrequently react on the sexual system *indirectly*, and so induce the sexual change required in a number of individuals simultaneously. All the parts of an organism are so intimately tied together, and the reproductive system in particular is known to be so extraordinarily sensitive to slight changes in the conditions of life, or to slight disturbances of the organic system generally, that in their work of adapting organisms to changes of their environment all causes of an 'equilibrating' kind must be calculated more or less frequently to affect the reproductive system in the way required. . . .

"If I have succeeded in making myself intelligible, it will have been seen that Mr. Wallace's objection to my theory admits of a twofold answer. In the first place, it is impossible for him to 'show' that the origin of a species is any more frequent than it ought to be, even upon the assumption which he has imputed to me—namely, that such origin is always due to the chance mating of more or less extremely rare varieties. And, in the next place, this assumption on his part is wholly gratuitous—or rather, I should say, directly opposed both to my own statements and to all the probabilities of the case.

"From which it is easy to perceive the inevitable inference, or, if not, by stating it I will furnish a cue to future critics. *The real difficulty against my theory is precisely the opposite of that which Mr. Wallace has advanced.* This real difficulty is that the differentiation of specific types has not been of nearly so frequent

occurrence as upon the theory of physiological selection we should have antecedently expected. Looking to the great sensitiveness of the reproductive system, to the many and the varied causes which affect it, to the frequency with which these causes must have been encountered under Nature, to the fact that whenever a collective variation occurs of the kind which induces physiological selection it must almost certainly leave a new species to record the fact—looking to all these things, the only real difficulty is to explain why, if physiological selection has ever acted at all, it should only have done so at such comparatively rare intervals, and therefore have produced such a comparatively small measure of result. If my critics had adopted this line of argument I should have experienced more difficulty in meeting them. But, as the case now stands, it seems enough to remark that I do not know of any way in which an adverse criticism admits of being more thoroughly exploded, than by showing that the difficulty which it undertakes to present is the precise opposite of the one with which an author is in his own mind, and at that very time, contending.

"Seeing how remarkable has been the misunderstanding displayed by such competent readers as Mr. Wallace and Mr. Seebohm—a misunderstanding on which they both found their only objection to my theory—I should have been compelled to suppose that my paper failed in clearness of expression, were it not that (as above shown) they have disregarded the literal construction of my sentences. Nevertheless, it is probable enough that I may not have sufficiently guarded against a misunderstanding which it never occurred to me that any one was likely to make. For I supposed that all readers would have perceived at least that the main feature of the theory is what my paper states it to be—namely, that sterility with parent forms is one of the *conditions*, and not always one of the *results*, of specific differentiation. But, if so, is it not evident that all causes which induce sterility with parent forms are comprised by the theory, whether these causes happen to affect a few individuals sporadically, a number of individuals simultaneously, or even the majority of an entire species?"

GEORGE J. ROMANES

Meteor of December 28, 1886

THE meteor referred to by your correspondent "J. M. H." (NATURE, January 6, p. 224) was also observed at Bristol at 10h. 28m. The path was from 95° + 9½° to 106½° − 6°. A train of sparks was thrown off from the nucleus as it slowly fell.

Comparing the apparent course of the meteor as recorded at Sidmouth and Bristol, it is evident that its radiant-point was at about 77° + 30°, near β Tauri. It belonged to a shower which appears to have a very extended duration, and has been specially referred to, with diagrams, in NATURE, vol. xxxi. p. 463.

This recent meteor affords unmistakable proof that the radiant near β Tauri continues active until the end of the year. The relative paths at Sidmouth and Bristol show that the meteor was about 97 statute miles high at its first appearance over a point in the English Channel some 28 miles off the Isle of Wight. Moving with a very slight inclination west of north, it disappeared 10 miles south-west of Niton, Isle of Wight, when 39 miles high. It traversed a path of 62 miles at an inclination of 69° to the earth's surface.

The duration of the meteor was about three seconds, so that its velocity appears to have exceeded 20 miles per second, which is greater than that of a body moving in a parabola, though the difference may quite possibly have been induced by observational errors. As regards visible effect, the meteor can lay no claim to the dignity of a fire-ball, but it is one of considerable interest as belonging to the remarkable display of β Taurids.

Bristol, January 7 W. F. DENNING

The Production of Ozone

I SHALL be much obliged if you can inform me through your paper—

(1) What apparatus would be most conveniently and easily worked by ordinary persons for the production of ozone in a room? I have tried a four-cell Smee's battery with a Siemens' ozone tube. This produces the required quantity of ozone, and works well in the hands of people used to scientific apparatus, but the general manipulation (especially as regards keeping the battery in working order) is above most people.

(2) Is there any battery you know that would give good results and be easily worked by people wholly unused to scientific apparatus (domestic servants for instance)? The quantity required is what would keep the air of an ordinary sitting-room, say 18 × 16 × 11 feet so charged, that ozone would be always just sensible to the smell.

I see by the advertisements of the hotels in the Engadine, that the air in their corridors is kept constantly ozonised. (3) Could they adapt their electric light dynamos for this purpose? (4) If so, how?

I may say I have no "trade purpose" in making these queries. I am a sufferer from phthisis, and find relief in the inhalation of ozone, but I want an apparatus that I could leave to my servants to manage. W. H.

"Brading," Madeira Road, Bournemouth

JOHN ARTHUR PHILLIPS, F.R.S.

BY the sudden death of this chemist and metallurgist on the 5th inst. geology loses one of its ablest leaders in a department where the labourers are not very numerous here, and at the same time one of the kindliest and most helpful among the students of science. Mr. Phillips was born in Cornwall, and among the metalliferous rocks of that county began the scientific researches which he has since prosecuted with so much success. Having early shown his taste for mining and metallurgy, he was sent to obtain his training in these subjects at the École des Mines of Paris. As far back as 1841 he began to contribute papers to the scientific journals. His early essays were almost wholly devoted to chemical and metallurgical subjects. His studies among the Californian goldfields, however, led him to investigate wider questions in physical geology. By degrees he turned into the domain of petrography, and for the last sixteen years it has been mainly in that branch of science that his original researches have been carried on. His papers on the eruptive rocks of the south-west of England are admirable illustrations of the value of the union of chemical and mineralogical qualifications in petrographical inquiry. Most of his time during the last two or three years had been devoted to the production of large and important treatises. Of these his volume on "Ore Deposits," published in 1884, has taken its place as a standard English work of reference. At the time of his death he was busy with the preparation of a new edition and expansion of a work on "Metallurgy," which he had published when still a young man. In this task he had associated Mr. Bauerman with himself, in whose competent hands the volume is sure to see the light in a form worthy of its author's reputation. Those who were personally acquainted with Mr. Phillips, while they lament the loss to science which his sudden death has inflicted, mourn still more the extinction of a life of singular simplicity, earnestness, and kindliness. He was a large-hearted and open-handed man, fond of taking every chance that came in his way of doing a good deed and helping every one to whom his help could be of service.

BOTANICAL FEDERATION IN THE WEST INDIES

IN the nearest of our tropical colonial possessions, which comprise the group of islands generally known as the West Indies, the dominant industry for the last hundred years has been that of the sugar-cane. Sugar and rum are indissolubly connected with these islands, and, under the circumstances which existed fifty years ago, there is no doubt that lowlands in the West Indies were better suited for the remunerative culture and growth of the sugar-cane than any other plant. Owing to a variety of causes, among which the abolition of slavery and the extension of sugar plantations in other lands are the chief, sugar-growing in the West Indies has suffered numerous reverses of fortune. Latterly, the difficulties of planters

have been greatly increased by the improved production of beet-sugar in Europe.

The chief sugar islands at present are Barbados, Antigua, St. Vincent, Trinidad, St. Lucia, and Tobago. At Jamaica, sugar and rum are still the staple industries, and form 39 per cent. of the exports, the balance being made up by other industries, such as coffee, fruit, and dye-woods. At Trinidad cacao is largely grown, and the export value of this article is nearly two-thirds that of sugar. Grenada, once a large sugar-growing colony, is now almost entirely devoted to cacao. Montserrat is becoming noted for its lime plantations, and exports of lime-juice; while Dominica exports concentrated lime-juice, cacao, cocoa-nuts, and tropical fruits. The Bahamas have a large tropical fruit trade with America, supplemented by the export of sponges, to the value of £60,000 annually. In spite of these smaller industries, however, there is no doubt that the chief business of the West Indies is still that of sugar. A capital of something like fifty millions sterling is invested in it, and the people are naturally reluctant to relinquish an industry which has, in the course of a century, become thoroughly established, and which is familiar in its details to all classes of the community. But, after all, it is impossible to overcome the logic of facts: and it is admitted on all sides that sugar, under present circumstances, can with difficulty be grown and manufactured to pay a profit. Hence it is not surprising that there is a strong desire to enter upon other cultivations; and it is well for the future prosperity of the West Indies that this should be so. The depression in the past and the comparative poverty of the present are no doubt due to the exclusive cultivation of one plant; for under such circumstances, when the sugar-market is depressed, everything is depressed. If improvements in cultivation were adopted, and if such high scientific skill as is applied to the manufacture of beet-sugar were applied to the manufacture of cane-sugar, it is the opinion of many that the planters would again become prosperous. But something more is necessary. With the exception of two islands in the whole group—namely, Antigua and Barbados—it is estimated that more than one-half of the actual surface of the West Indian Islands is suitable for other cultivations than sugar-cane. This being so, the people injure their best interests by neglecting the resources at their disposal.

In purely sugar islands, such as Barbados and Antigua, permanent improvement is to be sought in more economic and improved systems of cultivation, added to which there should be a concentration of all purely manufacturing processes under what is known as the *Usine* system. This latter system is already in existence at Trinidad, St. Lucia, British Guiana, and in the French island of Martinique; and it is proved beyond question that where the manufacture of sugar is treated as a highly specialised industry, finer and better qualities are produced, and the expenses are considerably diminished. Planters are therefore recommended to confine themselves as much as possible to the cultural operations of a sugar estate. Under such a division of labour there would follow a more careful trial of different varieties of the sugar-cane, adapted to the different soils, a more scientific application of special manures, and such general regulation of all cultural operations as would produce canes of the highest saccharine richness. In Barbados, Trinidad, and Jamaica, there are already Government analytical chemists, who are qualified to give valuable information to planters as regards soils and manures; and from a report recently prepared at Barbados by Prof. Harrison it is evident that much good would result from a larger utilisation of chemical knowledge as applied to sugar cultivation, both in the interest of the individual and of the general community.

During the last five or six years efforts have been made to increase the efficiency of West Indian industries by a wider and more general application of scientific methods not only to the sugar-cane but to all other plants which may be found suitable to the circumstances of the several islands. Hitherto two botanical establishments have been maintained for the West Indies—one at Jamaica and the other at Trinidad. From these centres, but especially from that of Jamaica, economic plants and information by means of annual reports and other publications have been regularly furnished, and such agencies have greatly assisted in enlarging the scope of experimental culture.

In the Report of the Royal (West Indian Finance) Commission, appointed in 1883, it was stated that there was a growing inclination on the part of the planters in other West Indian colonies to apply for seeds and plants to the Botanical Establishment in Jamaica, which could supply each island with what it required in the most economical manner. Sir Joseph Hooker, commenting on this report, expressed the opinion that there could be no doubt that the future prosperity of the West Indies would be largely affected by the extension to other islands, unprovided with any kind of botanical establishment, of the operations so successfully pursued in Jamaica. And it was suggested by Mr. Thiselton Dyer that, in addition to the distribution of plants, there might be organised a regular system of botanical bulletins, containing practical hints as to the treatment of economic plants, and the conditions under which they might be best utilised as objects of remunerative industry.

At the instance of the Secretary of State for the Colonies, it was ultimately decided that the whole of the West India Islands should be asked to co-operate in a systematic endeavour to promote and extend the cultivation of economic plants, and thus to develop more fully than heretofore their natural resources. This proposition was duly laid before the Governments of Barbados, the two groups of the Leeward and Windward Islands, and the colony of British Honduras. On account of the want of direct and regular communication, it was found impossible to include the Bahamas, while British Guiana is already supplied with its own botanic garden. The conditions on which the islands lying within the West India group were asked to join in this industrial federation were, first, the provision of an annual grant for the maintenance of a local station to discharge the functions of a scientific outpost and a nursery; and secondly, the contribution of small sums towards the support of operations at the central establishment. These small sums were intended to cover the special expenses incurred in behalf of each island in maintaining a depot for seeds and plants, and to pay the cost of publishing the botanical bulletins, which were intended to form an important feature in the scheme. The Legislative Council of Jamaica has recently expressed its willingness to give effect to the principle of the scheme as regards making the Botanical Establishment in that colony one of the central points of action; and it is anticipated that, while granting valuable aid to the smaller islands, Jamaica itself will derive, both directly and indirectly, considerable benefit from such vigorous and systematic working as would naturally arise in its own area, as well as from a larger interchange of plants and seeds with the neighbouring islands.

It is hardly necessary to observe that, in reply to the Secretary of State's despatch, the smaller islands were not slow to express their desire to be included in the scheme, and steps were taken in several to give effect to this desire by the establishment of local stations. Barbados was fortunate in possessing favourable means for starting a botanical station in connection with the Boys' Reformatory at Dods, where land was already under experimental cultivation in canes and in food-plants suitable to the district. This station is now at work, under a committee whose business is to supervise operations, and to communicate directly with the central establishment.

Grenada, which is in a fairly prosperous condition, has enlarged the original idea of a botanic station by making provision for a small botanic garden, which is now in course of being laid out under the charge of a trained superintendent (originally from Kew, but with Jamaica experience) at the Paddeck, within easy reach of the town of St. George. At St. Vincent the proposal to utilise the old botanic garden of the colony as a botanical station has been adopted, but the provision at present made is insufficient for the purpose, and will require to be slightly increased.

St. Lucia, to the north-west of Barbados, has shown a spirit of commendable energy in taking up the idea, and has given practical effect to it through the operations of its well-organised agricultural society. An experienced curator, also from Jamaica, has recently been appointed to the charge of the station, and good results are anticipated. At Dominica the botanical station has not yet assumed a practical form owing to the depressed state of the finances; but there is little doubt that ultimately such a station will be established, and the resources of this fertile island more largely developed.

Further north, Antigua, more especially concerned in the cultivation of the sugar-cane, has joined the scheme, and apparently is only waiting the completion of final arrangements at the central establishment. British Honduras, which has already benefited by its intercourse with the Botanical Establishment in Jamaica, has the site for a station, and a managing body has been appointed to begin operations at an early date.

To give a certain cohesion and uniformity of action to these several agencies, it was thought very desirable that a visit should be made to the islands concerned by the head of the Jamaica Department. This was accomplished in the early part of last year by the writer of these notes, who was happy to devote a short holiday, on retirement from Jamaica, in visiting the islands at his own expense.

During this visit sites for stations were examined and discussed, and suggestions made for their working on the lines best suited to local circumstances. As a practical instance of the feasibility of a botanical federation of the West Indies, it may be mentioned that recently an inquiry has been made, by general consent of the local Legislatures, into the condition of the indigenous forest growths of these islands, by Mr. E. D. M. Hooper, of the Madras Forest Department.

The Reports on Jamaica and St. Vincent are already published, and they are of such a practical and useful character that they cannot fail to have an appreciable effect upon the treatment and management of the forests both as reserves of timber to supply future wants, and as a means of maintaining a due humidity of climate and protecting the sources of springs and rivers. These Forest Reports, when completed, will add greatly to our knowledge of West Indian timbers, their nature, extent, and distribution; and they will also afford for the first time in history the actual economic and meteorological conditions of the interior of several islands beyond the confines of the present areas under cultivation.

In many instances the natural forest trees, as at Barbados, the Virgin I lands, and some of the islands of the Grenadines, have been nearly exterminated; those once very common, and represented largely in collections of botanical travellers of the last century, are now almost unknown. If the botanical stations are carried on with due regard to the industrial wants of the community, and are not allowed to degenerate into mere nurseries for ornamental plants, they will indirectly do much to enlarge knowledge as regards local floras, and bring to light many indigenous plants likely to prove useful on account of such medicinal and economic properties as they may possess. In the year 1824 it was laid down as one of the objects of the then Botanical Garden, at Jamaica, that it should devote attention "to the investigation of many unknown native plants of the island, which, from the properties of those already known, it is reasonable to infer would prove highly beneficial in augmenting internal resources by supplying various articles either for food, for medicine, or for manufacture, . . . by means of which great commercial advantages might be obtained; among others, the various vegetable dyes claim particular attention, as promising a fruitful field of discovery." As indicating the direct bearing which this one field of inquiry (vegetable dyes) among many others had upon the future of Jamaica, it is interesting to note that while no dye-woods whatever were exported from the island in 1824, a small trade of the value of 1859*l.* was started in 1833, which since that time has steadily increased, until now it has assumed relatively large dimensions. The exports of dye-woods in 1870 reached a gross value of 112,313*l.* ("Jamaica Handbook," 1884-85, p. 375).

Similar results in more recent times have attended the increased attention given to the cultivation of fruits that had been neglected in Jamaica. The export of these in 1875 amounted to 14,912*l.*, in 1884 the total value had increased to 273,534*l.*

Results such as these, although obviously of a special character, justify any attempt that may be made to improve the circumstances of the West India Islands; and they afford also a striking instance of what is capable of being accomplished in these islands when careful investigation and judicious and enterprising effort are made to fit local circumstances to the demands of the outer world.

As regards the carrying out of a scheme of local enterprise in the West Indies, it may be mentioned that the recent appointment of Mr. William Fawcett, a highly-qualified botanist, to the post of Director of the Botanical Department in Jamaica, and the transfer of Mr. Hart, late senior Superintendent at Jamaica, to the post of head of the Botanic Garden at Trinidad, appear to offer every hope of success to a botanical federation of the West India Islands. Jamaica and Trinidad, as the two foci of operations, could very well group round them the lesser islands, and the full realisation of such a scheme as is here indicated only requires such working out of details as may well take place at an early period.

It is important, however, to bear in mind that the success of the Jamaica Botanical Department, which has acted for several years as the centre of botanical and economical operations in the West Indies, has been in a great measure due to the valuable suggestions and the moral and material support which for many years it has received from Kew. It was from Sir William Hooker that Jamaica received its first supplies of seed of the several species of Cinchona, which have laid the foundation of the only English Cinchona enterprise in the New World. It was from his illustrious son and successor at Kew, Sir Joseph Hooker, that Jamaica received its tea plants and seeds, india-rubber plants, coca plants, fibre plants, and regular and large supplies of all the economic and medicinal plants which have flowed through Kew for distribution to various portions of the British Empire. Few can realise the eminent services which have been rendered by Kew in this direction, both by its correspondence and contributions, but there is every reason to believe that the results will ultimately be apparent in the greater prosperity of the inhabitants of the West Indies, and in the larger development of their rich and varied resources.

D. MORRIS

ART AND SCIENCE IN A NEW LIGHT

MR. BRETT is an artist of reputation and of remarkable industry. His pictures are popular, and meet with appreciative purchasers. He is enrolled among the Associates of the Royal Academy, and no doubt looks forward to be in due time raised to the dignity of Acade-

mician. At the request of the Fine Art Society he has this winter allowed a series of about fifty sketches painted by him on the west coast of Scotland last summer to be exhibited in the New Bond Street rooms. These sketches show that he has recently spent a long holiday among some of the most delightful scenery in the British Isles. As a man who has evidently got on in the world, looking back upon a distinguished past and forward to perhaps a still more distinguished future, he might reasonably be expected to smile pleasantly on the world that has used him so well. If the keen eyes that stand him in such good stead in landscape-painting reveal to him the weaknesses and frailties of his fellow-men, one might at least anticipate that they would blink hard at these shortcomings and rather turn to the good side of men and of things. But apparently Mr. Brett sees only too vividly what he conceives to be the impostures and ignorances around him, and his soul is stirred within him at the sight. The exhibition of his last year's sketches has furnished him with the occasion for discharging the vials of a wrath which, like that of Tam o' Shanter's wife, he must have been nursing for a long while to keep it so warm.

The Exhibition (now closed) was illustrated by a pamphlet, which on the title-page is described as "An Explanatory Essay," and on the first page is more emphatically designated as "The Commentaries." Mr. Brett, apparently with some presentiment that this literary effort of his might not meet with the same kind reception that attends his pictorial labours, stipulated expressly, as he tells us in a "Prefatory Note," that his paper should be published exactly as it left his hands. We cannot therefore plead for him that his essay was hurriedly thrown off in a fit of ill-temper. He ostentatiously goes out of his way to accept the responsibility of its matter and its style. A description of each picture, from the artist's point of view, with a running commentary on his method of working, the difficulties in Nature to be overcome, and his way of grappling with them, would have been interesting to the general public and valuable to artists and students of art. He seems to have started with the idea of writing some such commentary. But by the time he gets to the second page he catches sight of the red rags of imposture and ignorance, and without more ado rushes madly at them. The first victims of his fury are press critics of art. Nothing is too contemptuous to be said of them. Mr. Brett looks on them as a set of ignorant charlatans, too idle to work, too proud to beg, but who are glad to earn the slender pay allowed to them by careless editors. Some wretched scribbler had pronounced his work to be "laborious," which we would have thought rather a complimentary epithet; but Mr. Brett cannot forgive it. The writer who used it he stigmatises as a "bell-wether," and those who blindly followed his lead are described as "enlightened tom-tom players, who have gone on sounding the same note for a quarter of a century or more."

After this onslaught the painter tries to find his way back to where he was, and for a little while the reader begins seriously to entertain the hope that the promised commentary is coming. But the author gets upon the subject of clouds, and instantly a bigger bunch of red rags looms in front of him. Down goes the head, and with one triumphant howl of derision the infuriated writer rushes at scientific men in general, and the Royal Society in particular. After this second outburst he hardly calms down again till the end of the performance. No sooner does he turn from the treatment of the clouds to the ground beneath us than geological theories in all their hideous deformity and crass ignorance stare him in the face. The text is not roomy enough to contain all that he has to say about the misdoings of the geologists, so that he has to overflow into a footnote. Next comes the turn of those misguided astronomers who have led mankind wrong about the moon and the planet Mars.

One is tempted to ask what is the meaning of all this sound and fury. What relation has it to the pictures it is meant to preface? What object can the writer have had in indulging in it? Men of science are, no doubt, often wrong. But at least they take the trouble to try to be right. Their greatest aim is to get at the truth, and they welcome whatever will lead them nearer to that goal. They will even willingly learn from Mr. Brett if he has anything to teach them, though he laughs them to scorn, and derides them as "scientific Johnnies," "lovers of jargon," makers of "real gibberish," by whom various "forms of silliness are palmed off as science disguised in Greek or Latin." If the meteorologist turns for suggestions to Mr. Brett's essay, he there learns that "the fundamental phenomena of evaporation have always been misrepresented," and that he and his gaping fellow-students of Nature will learn more about clouds from the pictures of a well-known landscape-painter "than from all the Transactions of the Royal Society put together." If the geologist inquires what Mr. Brett has to say for his consideration regarding the "laws of the rocks," he is told that water is a "recent formation," that upheaval is a "childish conception," and that geologists "ignore the moon." If the astronomer in turn asks what the author of "The Commentaries" has to say in his department of knowledge, he is informed that Mr. Brett defies him "to point out a single instance of a volcano or a volcanic crater in the whole disc" of the moon. The "jargon" and "real gibberish" of modern science not only afflict the artist's own soul, but they disturb the peace of his family. "One professor the other day," he indignantly exclaims, "learnedly instructed my boy that aqueous vapour was formed by evaporation!" Hapless youth! Let us hope that his father has found time to instruct him in "the fundamental phenomena of evaporation."

After such a tirade against scientific men, one might suppose that Mr. Brett would be disposed rather to avoid them, or at least not to show himself ostentatiously in their company. And yet the reader will be amused to discover him, in the midst of these rabid denunciations, contriving to find room for a statement that he himself has written a scientific paper which has been published in a scientific journal, and that this important fact may not be missed, he quotes the paper in a footnote! Is Saul also among the prophets? There would be something pathetic, were it not so ludicrous, to see the proud paternal way in which the artist brings forward his feeble little scientific bantling. We should not be surprised if he thought more of it than of some of the pictures that have made his fame. His contempt for "lovers of jargon" and "real gibberish" is apparently equalled by his profound satisfaction with his own achievements. Not content with indicating the artistic value of his work, he claims that, "if these sketches have any distinct peculiarity worthy of notice, it is that they are optically correct, or at least are intended to be so, and that intention, strange to say, is new in pictorial art"! It would be interesting to hear the painter's defence of the "optical correctness" of some of the pictures. Did he ever see, for instance, a castle standing as he has depicted one in No. 22? Of his peculiar greens and blues we need not speak. They are part of his "confirmed mannerism," to use his own phrase, and are characteristic of his canvas, no matter under what skies and among what seas and rocks he may paint.

The pamphlet to which reference has been made in this article would not, of course, have been noticed here but for the name of its author. Science owes much to art, as art in turn lies under many obligations to science, and it should be the aim of each to help forward the other. That a man of Mr. Brett's artistic attainments should have gone out of his way to pen this "form of

silliness" is to be regretted chiefly for his own sake. He has injured his reputation for common-sense, and this even a great genius cannot afford to do.

THE NATIONAL SCIENCE COLLECTIONS

THE following Report of a Committee appointed by the Government to consider the housing of the objects illustrating the physical sciences belonging to the nation has recently been printed and circulated. The Committee consisted of Sir F. Bramwell (Chairman), Lord Lingen, Colonel Donnelly, C.B., and Mr. Mitford, C.B. :—

1. We, the Committee appointed by the Lords Commissioners of Her Majesty's Treasury to consider certain questions that have arisen in regard to the Scientific and Technical Collections at South Kensington, now beg leave to present to their Lordships our Report thereon.

2. The appointment of the Committee included the name of Sir Francis Sandford, K.C.B. ; but this gentleman, in consequence of the pressure of other public business, has been unable to attend any of our meetings, and he has authorised the other members to proceed with the inquiry, and to report, in his absence.

3. Our instructions were conveyed in a letter, dated January 14, 1884, and a memorandum accompanying it, from Lord Richard Grosvenor to the Chairman, and were to the following effect :—

"It will be the duty of the Committee (1) to consider and report upon the scope of the Scientific and Technical Collections, including the Patent Museum, and the space required for them, immediately and prospectively ; (2) to suggest plans for housing these Collections in the existing galleries to the south of the Horticultural Gardens, or in new galleries to be built upon their site, and the adjacent ground now the property of the Government."

PRESENT DISPOSAL OF THE SCIENCE COLLECTIONS

4. Before we enter on the consideration of these questions, it will be convenient to explain how the collections are at present housed.

They are contained in five buildings which are shown on the accompanying Plan, Drawing No. I., and are marked A, B, C, D, E ; whereof A, B, C, and D are on the west, and E is on the east side of Exhibition Road.

The buildings A, B, E, coloured yellow on the plan, and their sites, are the freehold property of the Government ; the buildings C, D, coloured blue, and their sites, are the property of the Royal Commissioners of 1851, from whom they are rented by the Government.

5. C is a block forming the centre portion of the galleries to the south of the Horticultural Gardens. It is about 292 feet long, 55 feet wide, and two stories high. It contains 22,000 square feet of available floor-space.

This building is the property of the Royal Commissioners of 1851, and is at present leased from them by the Government for 1500*l.* per annum. The lease terminates in 1890 or 1897, with a power up to January 1888 of purchase for the sum of 30,000*l.*, or, at the option of the Commissioners, for such sum, not exceeding 35,000*l.*, as may be fixed by the President of the Institute of British Architects.

6. A and B are the southern wing-galleries, the former on the east, and the latter on the west side of the central block C, and having short returns or spurs, A′ and B′, to the northward, at their external ends.

These wing-galleries extend about 280 feet in length on each side of the central block ; they are about 26 feet wide, and two stories high.

The returns at each end are each 72 feet long, and one story high.

The whole contain about 29,500 square feet of available floor-space.

These buildings, and their sites, are the property of the Government.

7. D is a building known by the name of the Western Gallery. It is 600 feet long, 33 feet wide, and two stories high. It contains about 36,560 square feet of available floor-space.

This building is the property of the Royal Commissioners of 1851, and is at present rented from them by the Government for the sum of 2000*l.* per annum. We believe, however, it is desired to give up the tenancy if possible.

8. E is a temporary building one story high, abutting on the south end of the permanent buildings of the Museum on the eastern side of the Exhibition Road. It contains 7500 square feet of available floor-space.

It is the property of the Government, but we understand it must be pulled down before long, to make way for more permanent erections.

9. These buildings are not altogether devoted to the Science collections.

The National Portrait Gallery at present occupies 19,040 square feet, partly in the two floors of the eastern wing A (a portion of the freehold), and partly in the eastern section of the central block C (the leasehold portion), of the south galleries. A space of 7500 square feet in the upper floor of the central leasehold block C, is also reserved for examination-rooms.

A portion of the ground floor of the western gallery, D, has been, up to the present time, occupied by the Pitt-Rivers Loan Collection, but this collection is in course of removal to Oxford.

10. The Science collections are now contained in the western part of the ground floor of the leasehold central block C ; in the ground floor and in part of the upper floor of the western freehold wing B ; in the northern end spurs A′ and B′ ; in the two floors of the western gallery D ; and in an unsightly wooden passage K.

This passage runs outside the southern wall of the south gallery, and forms the only approach from Exhibition Road to the Science collections, it not being possible to allow the public to use the Portrait Gallery as a thoroughfare.

The "Patent Museum" is contained in the temporary building E.

11. The total floor-space now occupied by the Science collections is therefore about as follows :—

		Square feet
Total space in C		22,000
,, ,, A, B, and A′, B′		29,500
,, ,, D		36,560
,, ,, E		7,500
		95,560
Deduct Portrait Gallery	19,040	
,, Examination-Rooms ...	7,500	
		26,540
Total occupied by the Collections ...		69,020

12. The Drawing No. I. also shows (marked G and coloured red) the area of land which belongs to the Government south of the present south galleries, which land is implied in our instructions to be available for buildings to house the collections.

SCOPE OF THE COLLECTIONS, AND SPACE REQUIRED FOR THEM

13. We may now proceed to report on the first subject submitted to us, namely :—

The scope of the Scientific and Technical Collections, including the Patent Museum, and the space required for them, immediately and prospectively.

14. A Museum of Science was contemplated as an integral part of the Science and Art Department from its creation in 1853.

Objects were gradually collected, and when the Department was removed to South Kensington in 1858 these objects were, for the first time, arranged together in the Museum for public inspection. They were mentioned by a House of Commons Committee in 1860 as "well worth preserving."

These collections, however, were not developed as much as the Art collections. Some objects were sent away to other establishments; and for want of space in the South Kensington Museum, the greater portion of the remainder were removed to the galleries on the western side of the Exhibition Road, where they have remained till now.

But public attention was frequently called to the subject. The Royal Commission on Scientific Instruction and the Advancement of Science, in their Fourth Report (1874), treated somewhat largely of these collections; they noticed many interesting objects which they contained, but they pointed out the striking contrast between them and other British National collections. They expressed their regret that there was no National collection of the instruments used in the investigation of mechanical, chemical, or physical laws, although such collections were of great importance to persons interested in the experimental sciences. This defect in our collections was, they said, already keenly felt by teachers of science, and high authorities had assured them that, on the Continent, collections of scientific apparatus, when combined with lectures accessible to workmen, had exerted a very beneficial influence on the development of the skill of artisans.

The Commission suggested, in conclusion, that the collections should be completed and consolidated, and placed under the authority of a Minister of State.

In 1876 a Loan Collection of Scientific Instruments and Apparatus was exhibited in the galleries of the Horticultural Gardens. It excited much attention, and a memorial was presented to the Lord President, signed by 140 of the best known men of science in the country, suggesting that it might be utilised in the formation of a National Science Museum. Some of the objects were left in the care of the Department, but no general action was taken.

The question of the development of the Science Collections of the Department remained in abeyance till 1881, when the Lord President, Earl Spencer, stating that "the importance of having a Museum for Scientific Apparatus was amply established," set on foot a series of inquiries to which we proceed to refer.

15. For the purpose of these inquiries, the existing collections were divided into six heads:—Objects for the illustration of Science generally; Naval Models; Objects illustrating Building Construction; Objects bearing on Fish Culture; Educational Objects; and Mechanical Objects.

Committees, composed of persons having specific knowledge in each of these branches, were appointed to examine the several collections, and expressed opinions on their condition, on the development which it would be advisable to give to them, and on the space required.

As copies of the Reports on each head are reprinted in an Appendix (B), it will suffice to give here a general outline of the opinions and recommendations they contain.

Collections of Objects for the Illustration of Science generally

16. The Committee consisted of Mr. Wm. Spottiswoode, President of the Royal Society, Professors Frankland, Goodeve, Guthrie, Huxley, Judd, Chandler Roberts, and Warington Smyth, Mr. Norman Lockyer, and the chief officers of the Science Department. They expressed the opinion that this question was of great importance in relation to the education, the industry, and the science of the country; they reported that the present collection was suitable for a nucleus of the contemplated Museum, and they recommended an examination, by the several Professors and other members of the Council of the Normal School, of the various classes of apparatus and appliances relating to their own subjects respectively.

This examination was afterwards undertaken by a Committee of the various Professors, and the results, as already stated, are given in the Reports. Recommendations were made as to the objects in each department of science, and the following estimate was given of space necessary to be provided:—

	Square feet
Chemistry	6000
Physics	6000
Mechanics	5000
Metallurgy	2500
Geology and Mineralogy	2500
Astronomy, Meteorology, and Geography ...	7000
Agriculture	4000
Biology	4000
	37,000

The Committee also estimated that a further space of 3000 square feet (making 40,000 in all) would probably be sufficient for any reasonable increase within ten years.

Naval Models

17. A Committee consisting of Lord Ravensworth, Sir E. J. Reed, K.C.B., M.P., Mr. W. Baskcomb, Mr. J. H. Morrison, and Mr. Joseph D. A. Samuda, considered this collection, and reported on it on March 1, 1883. They expressed a strong opinion as to the utility of such a collection, gave some general suggestions upon it, and proposed to have it carefully examined in detail.

This examination was carried out, and on April 4, 1883, the Committee based upon it a statement that a space of 10,500 square feet was at once required, and that 10,000 square feet additional should be provided for the increase during the next ten years, making 20,500 square feet in all.

Structural Collection

18. The Committee for this consisted of Mr. (now Sir) Charles Hutton Gregory, Past-President of the Institution of Civil Engineers, Mr. G. E. Street, President of the Royal Institute of British Architects, Mr. James Abernethy, President of the Institution of Civil Engineers, and Major H. C. Seddon, R.E., Examiner for the Science and Art Department in Building Construction. They reported, in 1881, that this collection was of great value in many respects, and recommended its maintenance, revision, and development.

In July 1883 another Committee, consisting of Mr. C. H. Gregory, Mr. Horace Jones, President of the Royal Institute of British Architects, Mr. James Brunlees, President of the Institution of Civil Engineers, and Major Seddon, took up the matter. They put forward detailed proposals in regard to the constitution and arrangement of the collection, and gave an estimate of 15,000 square feet of floor-space for it, to be increased to 25,000 square feet in ten years.

Fish Culture

19. The Committee for this collection were Prof. Huxley (Government Inspector of Fisheries), Sir J. R. G. Maitland, Bart., Mr. E. Birkbeck, and Dr. Francis Day.

They expressed the opinion that it was highly desirable that the existing specimens should be developed into an economic Fish Museum, and they estimated about 5000 square feet as the space required.

Educational Objects

20. The Committee for this were Dr. J. H. Gladstone, Rev. J. W. Sharpe, Mr. J. S. Fitch, Mr. J. Iselin, and Mr. H. A. Bowler.

They stated that the collections would be of great value to School Boards, managers, and teachers, and they estimated 7000 square feet of surface as necessary, not including any allowance for the library.

Mechanical Collections

21. The Committee appointed to consider these collections were Mr. John Slagg, M.P., Sir W. G. Armstrong, Sir J. W. Bazalgette, Mr. James Brunlees, Mr. E. A. Cowper, Prof. T. M. Goodeve, Sir Charles Hutton Gregory, Mr. John Hick, Mr. James Howard, M.P., Mr. Charles Manby, Mr. J. Hinde Palmer, Sir E. J. Reed, M.P., and Mr. (now Sir) B. Samuelson, M.P.

They carefully examined the collections, including the "Patent Museum" (which, under the Patent Act, 1883, had been transferred to the care of this Department on January 1, 1884), and made a comprehensive report, embodying suggestions for the improvement and the arrangement of the whole.

They estimated that from 40,000 to 50,000 square feet of space would be required.

22. Considering that the members of these Committees were selected, on the responsibility of the Government, for their competence as authorities in their respective branches of science, and considering the detailed nature of their inquiries, we assume their conclusions as the basis of our recommendations.

We may also add that similar Committees are permanently retained, under the name of "Committees of Advice and Reference" for the several collections.

23. We need not enlarge on the desirability that such a country as Great Britain should possess a thoroughly good and complete National Collection of Scientific and Technical objects, any more than that it should possess a Museum of objects of Art or of Natural History.

When it is considered how much the prosperity of the nation is bound up with industrial enterprises and occupations, and how largely these depend, for their success, on practical applications of science, it needs no elaborate reasoning to prove that the public exhibition of well-selected and judiciously arranged scientific and technical collections, particularly when used in connection with efficient courses of instruction, justifies its cost.

24. There has long been a National Scientific and Technical Museum in France, well known under the name of the Conservatoire des Arts et Métiers, and this has often been referred to as a type of the institution of a similar nature which ought to be established in England.

We reprint, in Appendix C, an article published in the *Times* newspaper of October 5, 1876, which gives a full account of the nature and scope of the Conservatoire, and we have also received, through the courtesy of the Directors, full information as to the present contents and arrangements of the Museum.

The premises are situated in an area contained between the four streets, Rue St. Martin, Rue Vaucanson, Rue du Vert Bois, and Rue Réaumur. This area is about 200 metres wide by 140 metres deep, thus containing 28,000 square metres, or about 7 acres. These 7 acres are not at present entirely occupied by the Conservatoire, but an enlargement of the buildings is in progress, which will extend them, including the necessary courtyards, passages, &c., over the whole area.

The objects exhibited belong to a great variety of subjects, the following being only a brief indication of their general classification:—

Motors.—Horse-machines, water-motors, wind-motors, steam-engines, hot-air engines. Details and accessories.

Hydraulic Machines.—Pumps, &c.

Descriptive Geometry.—Forms of curves; teeth of wheels. Machines for producing special forms.

Metallurgy.—Working of mines. Minerals. Metallurgical processes. Metals.

Calculating and Counting Machines.

Instruments for Surveying.

Astronomy, &c.—Almanacs and Calendars.

Chronometry, ancient and modern; movements; tools.

Arts of Construction.—Materials, processes, workmen's tools, &c. Constructions under water.

Kinematics.—Machinery. Mechanism. Elements of machines.

Dynamometers and instruments for mechanical observations.

Cranes and other constructions for lifting and removing weights.

Machine Tools of various kinds. Presses, &c.

Engraving, Lithography, Typography, Printing, &c., and paper-making.

Porcelain, Glass, and Pottery.

Physics.—Mechanics. Molecular actions. Heat. Magnetism. Electricity. Acoustics. Optics. Meteorology. Electro-chemistry. Telegraphy.

Agriculture.—Apparatus of all kinds.

Weights and Measures.—French and foreign. Weighing-machines. Instruments of comparison.

Locomotion and Transport on ordinary roads, on railways, and on rivers, canals, and the sea.

Manufactures, various.—Gunpowder. Arms. Chemicals. Bread. Sugar. Cements. Cutlery. India-rubber.

Spinning and Weaving.—Textile manufactures generally.

Preparation, Dyeing, and Printing of Fabrics.

Chemical Arts and Products.—Preservation of Timber. Gas. Distilling. Brewing. Tanning, &c.

Industrial and Fine Arts.—Prints; designs. Photography.

Pictures and Drawings, illustrative of Scientific and Technical matters; a very large collection.

There are in all about 10,000 objects. The collection is remarkably rich, both in historic apparatus and in the most recent inventions. The machinery is shown in motion two days in the week. The objects are used, when required, for the lectures given in the Conservatoire.

Nothing is added unless it can be utilised for teaching; sometimes orders are given for models to be made, and sometimes objects are purchased. When anything is offered as a gift, it is not accepted unless one of the professors will state that it is really required.

The collection is not in any way a Patent Museum. Formerly certain models of patented inventions were exhibited there, but this is no longer done.

(*To be continued.*)

NOTES

THE meetings held yesterday at St. James's Palace and the Mansion House, to which we have not time to refer at length this week, indicate that from the Prince of Wales downwards all interested in the proposed memorial are willing to allow the necessity of making the Institute one on a broad scientific basis. An admirable speech by Prof. Huxley at the Mansion House, following that of the Prince of Wales at the first meeting, shows that there is now no chance of the importance and of the necessity of collecting and arranging *knowledge* being overlooked.

FRENCH geologists have cause to regret the blow which their science has received in the premature death of the well-known geologist of Lyons, C. F. Fontannes, on December 29, at the age of forty-eight. He is best known by his important monograph on the "Stratigraphy and Palæontology of the Tertiary Deposits of the Basin of the Rhone"—a work of laborious research and of great value from the minuteness and accuracy of its details. He established a claim on the gratitude of geologists by the infinite pains he took in the organisation and working of the

national Geological Congress, the success of which has been in large measure due to his active help. His pleasant smile and cheery way of smoothing over personal friction will long be remembered by those who witnessed them at the meetings of the Congress.

SIR FRANCIS BOLTON died at Bournemouth on Wednesday, the 5th inst. He was born in 1831, and entered the army at the age of twenty-six. For some time he served on the staff as Deputy-Assistant Quartermaster-General, and in 1881 he retired with the rank of colonel. He was the inventor of the system of telegraphic and visual signalling which was introduced into the army and navy in 1863, and for these services and other improvements and inventions in regard to warlike material he received in 1883 the honour of knighthood. In 1870 he founded the Society of Telegraph-Engineers and Electricians.

LAST year some of the leading statisticians of Europe combined to form a new Society, the International Statistical Institute. If we may judge from its aims, as set forth in the first article of its statutes, the Institute is likely to do work which will be of the highest service to Governments. It proposes to foster the progress of administrative and scientific statistics: "(1) by introducing as much as possible uniformity of method and classification and of handling statistical material, in order to make the results obtained in different countries comparable; (2) by calling the attention of Governments to those questions which require to be solved by statistical observation, and requesting from them information on subjects which have not yet been treated statistically, or have been only insufficiently treated; (3) by creating international publications intended to establish permanent relations among statisticians of all countries; (4) by striving, through its publications, and, if possible, by public instruction and other means, to promote the spread of sound ideas as to statistics, and to interest Governments and peoples in the investigation of the phenomena of society." The Institute intended to have held its first general meeting in Rome in September last, but was compelled by the spread of cholera in Italy to abandon its design. It has now decided to hold its first meeting in Rome in Easter week of this year, from April 12 to 16. Nearly fifty members have expressed their intention of being present, and it is expected that the attendance will be considerably larger. The Italian Government deserves the greatest credit for the generous and enlightened manner in which it is supporting the Institute. It allows Prof. Boris, the Director-General of the Statistics of the Kingdom of Italy, to act as Secretary, and in this capacity to use the services of his official staff. With the sanction of the Italian Parliament, it has granted a sum equal to 600*l.* to aid the Institute in printing its publications, and another sum of 400*l.* has been contributed to the expenses of the approaching meeting. Moreover, it has been arranged that for the benefit of members who attend the meeting the fares on the public railways to and from Rome shall be reduced by one-half. Signor Grimaldi, the Italian Minister of Commerce, is trying to induce other Governments to act in a similar spirit, and it may be hoped that his efforts will not be wholly unsuccessful.

ON Saturday evening last, Sir John Lubbock delivered, at Toynbee Hall, a lecture on "Savages," the first of a new course. He pointed out that modern savages do not in all respects reproduce the condition of our ancestors in early times. Even the Australians hold now a system of complex rules and stringent customs, which have grown up gradually, and cannot have existed originally. From the study of modern savages, however, we may gain a fairly correct idea of man as he existed in ancient times, and of the stages through which our civilisation has been evolved. The lecturer gave a remarkably vivid and interesting account of some of the leading facts known about the customs, beliefs, and institutions of savage races.

ON Friday evening last the Drapers' Company set an admirable example to other City Companies by entertaining at its Hall in Throgmorton Street the students associated with the Whitechapel centres of the University Extension Scheme. The classes connected with this Scheme at Toynbee Hall are attended by no fewer than 631 students, who receive instruction in physiology, astronomy, history, and English literature. The fee for a course of twelve lectures is one shilling.

THE presidential address delivered at the annual meeting of the American Neurological Association in June last by Dr. Burt G. Wilder has been reprinted from the *Journal of Nervous and Mental Disease*. In this address Dr. Wilder discusses the question as to the need of some improvement in the nomenclature of the brain. He is convinced that the current nomenclature is to a large extent an obstacle rather than an aid to the advancement and dissemination of knowledge concerning a complex organ; and, with regard to the encephalic cavities in particular, he holds that it would be better for the student if the incongruous and misleading *quasi*-descriptive terms, *first, second, third, fourth*, and *fifth ventricle*, could be displaced by totally meaningless, but easily remembered, Chinese monosyllables, like *prau, preu, prin, pron*, and *prun*. Dr. Wilder has obtained an alphabetical list of nearly all the names which have been applied to the parts of the central nervous system, and, allowing for some omissions and duplicates, the numbers are as follows:—Latin, 2600; English, 1300; German, 2400; French, 1800; Italian and Spanish, 900; total, 9000. The number of parts designated by these names is considerably less than 500.

REFERRING to the death of Sir W. W. Heughes, which took place near London on New Year's Day, the *Colonies and India* mentions that practically he initiated the Adelaide University by contributing 20,000*l.* in 1872 for the endowment of two professorships. He also contributed largely to the expedition under Colonel Warburton for the exploration of the interior of the Australian continent. He received the honour of knighthood in 1880.

M. JANSSEN, the Director of the Meudon Observatory, who has been nominated Vice-President of the Paris Academy of Sciences for 1887, will be President in 1888, according to the constant rule.

IT is said that M. Chevreul will resign his membership of the Academy of Sciences, and will return to his native place to spend the last years of his life in retirement. He has already sent in his resignation of the Directorship of the Museum.

ONE of the last letters written by M. Paul Bert was read at the meeting of the French Academy of Sciences on the 3rd inst. In this letter M. Bert complained of the darkness in the town of Hanoi at night. Gas was too dear, and he had tried the use of petroleum. This, however, was a barbarous expedient, and he was anxious to know whether it would not be possible for him to make the Red River, which flows past Hanoi, produce the required illumination. "Would the expense be great?" he wrote. "Only think, if we succeeded we should be ahead of England and Japan!" "Answer," he added, "and answer quickly; my days are numbered." The Academy decided that the letter should be preserved among its archives.

A LARGE number of French scientific Societies are anxious that a building should be erected in Paris for their common use. A circular on the subject has been issued. The lead in the matter is being taken by the Geographical Society.

A GOOD deal of canvassing has been going on recently in Paris, in the Sorbonne, the Medical School, and the Academy

of Sciences, for professorships and seats in the Institute of France. Many superannuated professors have been removed, in consequence of the enforcement of a recent law; others have died. In the Medical School, Prof. Sappey's place has been given to M. Farabeuf, a distinguished anatomist, although entirely devoid of philosophical tendencies. Prof. Gavarret, whose well-known researches, conducted many years ago with Audral, have been of the utmost importance for the physiology of respiration, has seen his place filled by M. Gariel, who has been his assistant for a long time. Prof. Peter has taken the place of M. Hardy, in the Professorship of Clinical Medicine. He is an obstinate opponent of M. Pasteur's theories, but, nevertheless, a good physician, well trained, and skilled in his part of science. Prof. Pagot, the well-known Professor of Obstetrics, resigned his appointment on the day of his seventieth anniversary, and it is likely that M. Pinard will be his successor. M. Pinard is an able obstetrician, a good teacher, an original worker, and is much liked by students and professors. The vacancy caused at the Sorbonne by the death of Milne-Edwards has been filled by the appointment of M. Yves Delage, who has been for a short time Professor of Zoology in Caen. M. Yves Delage, although a very young man, has done a good deal of excellent personal work. His principal investigations bear upon the circulatory system of Crustacea, the life-history and anatomy of Sacculina, a parasitic Crustacean, and the anatomy of the whale. In the Academy of Sciences, M. Sappey was elected soon after his removal from the Medical School. His personal work has been good, and bears upon human anatomy, upon the anatomy of the lymphatic vessels, of the air-reservoirs of birds, and many other points of comparative anatomy. M. Ranvier, the able histologist of the Collège de France, will very likely be elected to the seat of Ch. Robin. One of the competitors for Paul Bert's seat is M. Ch. Rochet, the physiologist, and editor of the *Revue Scientifique*.

A VERY good little guide to the most picturesque streets and buildings in the capital of Egypt, by Major E. T. Plunkett, R.E., has just been published. It is entitled "Walks in Cairo." Major Plunkett's object is to call attention to "sights" which have hitherto been neglected by the writers of guide-books, —out-of-the-way mosques, in which the most graceful Arabesque forms may be found, with choice bits of marble mosaic and fine specimens of cabinet-work, and street corners made picturesque by minarets, overhanging stories, and windows of lace-like lattice-work. If any visitor is in doubt whether he would or would not enjoy the "Walks" described, he is advised to try one of them, and if he finds that uninteresting to try no more.

ON July 28 last, Miss Eleanor A. Ormerod, F.E.S., Consulting Entomologist to the Royal Agricultural Society, received from Revell's Hall, Hertford, specimens of injured barley, which on examination precisely corresponded with the condition caused by attack of the *Cecidomyia destructor*, commonly known as the Hessian fly. A paper setting forth the results of her observations, with the opinions of high authorities in England and America, was read at the Entomological Society of London on December 1 last. An abstract of this paper will be found in the *Entomologist* for January.

IN the January *Zoologist* there is a very good representation of the Greater Horse-shoe Bat (*Rhinolophus ferrum-equinum*). It illustrates an article on "Horse-shoe Bats" by the editor, who remarks that as few really good figures of bats are accessible, those in Bell's work being almost too small to be of much use, it is very desirable that no opportunity should be lost of obtaining correct drawings of the rarer species whenever they can be procured alive or in a fresh condition, so as to secure an accurate delineation of the natural features before they become distorted or shrunk in the process of drying. The plate which he offers as a first contribution to such a series is from a living specimen obtained by the Rev. H. A. Macpherson in South Devon in August last. This specimen weighed little more than half an ounce the day after death.

SEVERAL Arctic species of birds, which do not breed in England or Ireland, breed in Scotland. This fact is explained by Mr. Henry Seebohm in an article in the January *Zoologist*. Most, if not all, of the species in question breed in July, and, roughly speaking, they draw the line a few degrees below 60° F. They do not breed in any locality where the mean temperature for July is as high as 60°, the reason probably having relation to the supply of food. Now, in a map of the world, in Keith Johnston's "Physical Atlas," giving the mean temperature of July in various parts of the earth, the isothermal line of 5[illegible] is drawn. This line separates England and Ireland from Scotland, passes north of the Gulf of Bothnia, through the town of Archangel, extends nearly straight across Russia and Western Siberia, but, east of the valley of the Yenesei, again rises until it almost reaches the coast near the delta of the Lena. Farther east in Siberia it plunges south again, much more rapidly than it rose in Western Europe, and, passing south of Kamchatka, it embraces the Kurile Islands in the latitude of the Pyrenees. This line is almost exactly parallel with what is known of the southern breeding-ranges of the various Arctic birds under consideration. It is not, therefore, surprising that these birds should breed in Scotland; and there is no reason, Mr. Seebohm concludes, for attempting to explain by any other causes than the ascertained climatic cause, the interesting fact that British ornithologists are able to study the breeding habits of so [illegible] species which their Continental fellow-students can only obse[illegible] by travelling 500 miles or more farther north.

THE Journal of the Society of Arts prints an interesting letter from Mr. T. F. Peppe, on the cultivation of the so-called wild silks of India. Mr. Peppe points out that in many parts of India the jungle consists of the plants on which the tussur worm feeds, and that the supply of labour is practically unlimited. At present the work is carried on only by a few tribes who have been accustomed to it from time immemorial; but nearly all the aboriginal tribes of India might be available, if their services were in demand. The chief obstacle to the rapid development of the industry is the difficulty of procuring seed-cocoons, which have to be sought for in the wild state in the jungles. This difficulty, however, Mr. Peppe thinks, will be gradually overcome, since in every cultivated tract there are always a few cocoons which escape detection and collection, and which add to the number of wild cocoons found in the next brood. The industry is precarious, but there are several crops in the season, and if one fails the others may succeed. Mr. Peppe has cultivated tussur for three years, yet he is not prepared to say how many broods are possible in a year. Each brood so overlaps the succeeding one, that it is very difficult to distinguish one brood from another.

A COURSE of five lectures on "Molecular Forces" will be delivered by Prof. A. W. Rücker, M.A., F.R.S., at the Royal Institution, beginning on Thursday, the 20th inst. The remaining lectures will be delivered on the 27th inst., and on February 3, 10, and 17.

MESSRS. W. WESLEY AND SON have issued the seventy-ninth number of their "Natural History and Scientific Book Circular." The most important part of the Catalogue appears under the heading "Ornithology."

WE have received the "Year-book of Photography and the Topographic News Almanac for 1887," edited by Mr. Thomas Bolas, F.C.S. It contains, besides a calendar for the year and lists of photographic societies, a large number of notes and

articles likely to be interesting and useful both to beginners in photography and to advanced practitioners.

THE Severn Fishery Board has issued an Almanac for the year 1887, which is intended to show the law as to fishing in the Severn fishery district, and to indicate to water-bailiffs, fishermen, and others interested in fishing, what they may look for in different months of the year. The information on which the statements in the Almanac are based was collected by the Board's officers.

THE seventh volume of the Transactions of the Sanitary Institute of Great Britain, 1885-86, presents a full report of the proceedings of the Congress of the Institute held at Leicester from September 22 to 26, 1885. The papers read at the Congress were divided into three sections—(1) Sanitary Science and Preventive Medicine; (2) Engineering and Architecture; (3) Chemistry, Meteorology, and Geology. Mr. John F. J. Sykes, Honorary Secretary for the first section, recommends that a special day, or part of a day, should be devoted to the consideration of domestic sanitation and ambulance. In both of these subjects ladies take great interest, and Mr. Sykes is of opinion that his suggestion, if adopted, would add immensely to the success of future Congresses.

THE amount of the rainfall at Ben Nevis Observatory during 1886 was 107·85 inches, the greatest monthly fall being 14·57 inches in November, and the least 2·84 inches in February. In 1885 the annual rainfall was (see vol. xxxiii. p. 347) 146·50 inches, the largest monthly fall being 24·33 inches, and the least 4·97 inches, the rainfall of 1886 being thus very much less.

WE understand that complaints have been made to the Fishery Board for Scotland that steam-vessels have been recently prosecuting beam-trawling overnight in the waters closed by the Board's by-law against this mode of fishing. Some time since the Board instituted legal proceedings against parties who had infringed the by-law, some of whom were fined, and they also posted placards at the different harbours and creeks in the prescribed waters giving notice of the terms of the by-law, and it was hoped that the illegal practice would have been thereafter discontinued. The Board's cruiser *Vigilant* has done what she could to protect these waters, but owing to her being a sailing-vessel she cannot do this so effectively as a vessel with steam power. In the circumstances the Board have instructed H.M.S. *Jackal*, at present cruising on the west coast, at once to proceed to the east coast and protect the inclosed areas there, as well as to take a general superintendence of the fisheries. The prescribed waters include the Firth of Forth, St. Andrews Bay, and Aberdeen Bay. The present *Jackal* is a new, powerful, and swift vessel, and is provided with the electric light, which will enable her to sight vessels at a considerable distance on dark nights. The Board's cruiser *Vigilant* will at once proceed to the west coast and take up fishery duty there, assisted by H.M.C. *Daisy* tender.

THE Report of the Swiss Commission for the Reform of Gymnasial Instruction has just been issued. The Commission recommend that the teaching of Latin shall begin in the fifth class, and shall be continued, for five hours weekly, up to the highest class; that instruction in Greek shall depend upon the expressed desire of parents or guardians, and shall begin in the fourth class; and that all scholars who do not learn Greek shall learn either English or Italian. Two spare hours gained by pupils in English or Italian are to be spent in the study of natural science and mathematics.

MR. EDISON, the electrician, of New York, is reported to be seriously ill.

THE additions to the Zoological Society's Gardens during the past week include two Barn Owls (*Strix flammea*) from South Africa, presented by Mr. E. Hume; a Black-headed Gull (*Larus ridibundus*), British, presented by Mr. W. S. Rawlinson; two Eyed Lizards (*Lacerta ocellata*), European, deposited; four Bramblings (*Fringilla montifringilla*), British, purchased.

OUR ASTRONOMICAL COLUMN

THE SIX INNER SATELLITES OF SATURN.—Appendix I. to the volume of Washington Observations for 1883 contains an important memoir by Prof. Asaph Hall on the orbits of the six inner satellites of Saturn. Of these, the two innermost have been known to us about 100 years, but the other four for more than 200. Owing, however, to the difficulty of making accurate observations of them, their orbits were but rough approximations until the publication of Bessel's work on the orbit of Titan, which appeared in vols. ix. and xi. of the *Astronomische Nachrichten*, and from which that value of the mass of Saturn was derived which has been generally used up to the present time in computing the perturbations produced by this planet. Bessel likewise commenced, but did not live to complete, a memoir on the "Theorie des Saturns Systems," of which Prof. Hall justly remarks that it "is still the most comprehensive investigation we have of the differential equations of this system, and of the various forms of the perturbative function arising from the figure of the planet, the ring, the action of the satellites on each other, and the action of the sun." M. Tisserand has shown, however, in a short but important paper, "Sur le mouvement des absides des satellites de Saturne et sur la détermination de la masse de l'anneau," that Bessel's determination of the mass of the ring from the motion of the line of apsides of the orbit of Titan was seriously in error, since he neglected the influence of the figure of the planet. We were, therefore, ignorant of the true value of the mass of the ring, but if the inner satellites moved in orbits which were decidedly eccentric, so that the motions of the lines of apsides could be accurately determined, the mass of the ring and figure of the planet could be deduced. It was therefore a matter of great interest to determine these orbits as accurately as possible; and Prof. Hall therefore undertook the observation of those satellites with the great refractor of the Naval Observatory, Washington. The observations of Titan, given in Prof. Hall's paper, were made at Washington during the eleven years, 1874 (in which year Prof. Newcomb observed the satellite) to 1884. During the years 1875, 1876, and 1877, Prof. Hall observed differences of R.A. and declination of Saturn and Titan at the same time and in the same manner as he observed Iapetus, to which satellite he found the method well adapted. Rhea, Dione, and Tethys were observed by Prof. Newcomb in 1874 and by Prof. Hall in 1875, whilst for Mimas and Enceladus observations extending over the years from 1874 to 1879 have been used. In the reduction of the observations of Rhea, Dione, and Tethys, the observed places have been compared with places computed from the elements for these satellites given by Dr. W. Meyer, of Geneva, and corrections to his elements are deduced therefrom. The corrected orbits show in each case a practically insensible eccentricity, and the observations of Mimas and Enceladus also can be satisfied within the limits of their probable errors by circular elements. Prof. Hall, however, draws attention to the fact that for the three innermost satellites the eccentricity of the orbit, and consequently the position of the line of apsides, cannot be determined with any certainty from the observations at his disposal. Some more accurate method of observation than that of the filar micrometer should be adopted; possibly observing the conjunctions of the satellites with the ends of the ring, the Cassinian division, and with the sides of the ball, might prove more efficient. A heliometer, if one existed of sufficient aperture, would probably furnish the most satisfactory means of all.

The orbits of the five inner satellites being thus sensibly circular, any consideration of the motions of their lines of apsides is placed out of the question. These five satellites also appear to move in the plane of the ring. It is therefore easy to furnish tables of their motions, and Prof. Hall supplies them for the period 1875-1950, together with the elements of the ring, at the close of his paper. For the mass of Saturn, from the motions of Titan, Rhea, Dione, and Tethys, he finds the reciprocal to be $3478{\cdot}7 \pm 1{\cdot}10$. The best previous determinations have been

as follows:—Bessel 3501·6, Leverrier 3529·6, Meyer 3487·45, and Prof. Hall, from the motion of Iapetus, 3481·3 ± 0·54.

Prof. Hall carefully searched for additional satellites moving in the remarkable gaps between Rhea and Titan, and Hyperion and Iapetus, but without result.

STELLAR PARALLAX.—The second Appendix to the Washington Observations for 1883, contains a second memoir by Prof. Asaph Hall, not less interesting and valuable than the above. It will be remembered that Prof. Hall published a volume in 1882, containing determinations of the parallaxes of Vega and 61 Cygni from observations made by himself with the great 26-inch refractor at the Washington Observatory. Prof. Peters, of Clinton, U.S.A., has since pointed out to Prof. Hall that the temperature correction to his observations had been applied with the wrong sign. Prof. Hall has therefore now reduced his observations afresh, and given a new solution of the equations of condition. For 61 Cygni, Prof. Hall now finds a parallax of 0″·270 ± 0·0101 from 101 observations extending from October 24, 1880, to January 26, 1886. This value is notably smaller than he obtained before, viz. 0″·4783, or than most other investigators have deduced. Thus Sir R. S. Ball had found 0″·4756, Auwers 0″·564, and Struve, Woldstedt, and others values closely according. Prof. Hall appears, however, satisfied with his results, and it should be remembered that Dr. C. A. F. Peters obtained 0″·349 for his absolute value of the parallax, the others being only relative parallaxes. Prof. Hall's value for Vega is also rather small, viz. + 0″·134 ± 0·0055 from 128 observations, but agrees very much better with other modern determinations; Brünnow in 1869 from the same comparison-star, but by measures of distance and position, and not of differences of declination only, having obtained $\pi = 0''{\cdot}212 \pm 0''{\cdot}0098$. Prof. Hall also attacked the parallax of two other stars, 6 (Bode) Cygni, the parallax of which has recently been determined at Dunsink, being one, and the curious star 40 (o^2) Eridani the other. For the former he finds a negative value, whereas Sir R. S. Ball gave $\pi = + 0''{\cdot}422 \pm 0''{\cdot}054$, but only as a "merely provisional" value. The parallax obtained for 40 Eridani, $\pi = + 0''{\cdot}223 \pm 0''{\cdot}0202$ is in fairly close agreement with Dr. Gill's, viz. $\pi = 0''{\cdot}166$. In the early part of this important paper Prof. Hall gives a full discussion, in his usual thorough and painstaking manner, of the value of a revolution of the micrometer-screw employed in the observations.

ASTRONOMICAL PRIZES OF THE ACADEMY OF SCIENCES. The Paris Académie des Sciences have decreed the Lalande Prize to M. O. Backlund for his labours on the motion of Encke's comet; the Valz Prize to M. Bigourdan for his researches on personality in the observation of double stars; and the Damoiseau Prize, for the revision of the theory of the satellites of Jupiter, to M. Souillart, with an *encouragement* to M. Obrecht of a thousand francs from the Damoiseau fund.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1887 JANUARY 16-22

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on January 16

Sun rises, 8h. 1m.; souths, 12h. 9m. 58·8s.; sets, 16h. 19m.; decl. on meridian, 20° 56′ S.: Sidereal Time at Sunset, 0h. 2m.

Moon (at Last Quarter) rises, 23h. 47m.*; souths, 5h. 41m.; sets, 11h. 24m.; decl. on meridian, 4° 14′ S.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury ...	7 23	11 13	15 3	23 55 S.
Venus	8 39	12 55	17 11	19 54 S.
Mars	9 4	13 42	18 20	16 24 S.
Jupiter... ...	1 23	6 27	11 31	11 42 S.
Saturn... ...	15 29	23 35	7 41*	22 1 N.

* Indicates that the rising is that of the preceding evening and the setting that of the following morning.

Occultations of Stars by the Moon (visible at Greenwich)

Jan.	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image ° °
16 ...	65 Virginis ...	6	2 5	3 5	61 193
16 ...	66 Virginis ...	6	2 48	3 57	44 221
16 ...	f^2 Virginis ...	5	7 44	8 35	44 318

Jan.	h.	
16 ...	21 ...	Mars at least distance from the Sun.
17 ...	3 ...	Jupiter in conjunction with and 3° 40′ south of the Moon.
17 ...	4 ...	Mercury at greatest distance from the Sun.

Variable Stars

Star	R.A. h. m.	Decl. ° ′		h. m.	
U Cephei	0 52·3	81 16 N.	Jan. 16,	23 2	*m*
			,, 21,	22 40	*m*
Algol	3 0·8	40 31 N.	,, 16,	2 41	*m*
		and at intervals of		2 20 48	
λ Tauri	3 54·4	12 10 N.	Jan. 16,	22 48	*m*
			,, 20,	21 41	*m*
δ Libræ	14 54·9	8 4 S.	,, 20,	2 42	
U Coronæ	15 13·6	32 4 N.	,, 20,	21 3[illegible]	
W Herculis	16 31·2	37 34 N.	,, 18,	[illegible]	
U Ophiuchi... ...	17 10·8	1 20 N.	,, 20,	2 44	
		and at intervals of		20 8	
β Lyræ...	18 45·9	33 14 N.	Jan. 22,	21 0	m_2
δ Cephei	22 25·0	57 50 N.	,, 18,	23 0	*M*

M signifies maximum; *m* minimum; m_2 secondary minimum.

Meteor-Showers

Near γ Orionis, R.A. 72°, Decl. 4° N. From Coma Berenices, R.A. 181°, Decl. 35° N.; swift streak-bearing meteors. Near χ Cygni, R.A. 295°, Decl. 53° N.; somewhat slow meteors.

GEOGRAPHICAL NOTES

THE opinions of Dr. Junker, who is now in Cairo, as to the best route by which to reach Emin Pasha do not help us much. Indeed, Dr. Junker does not commit himself further than to suggest that by the shortest route, through Masai Land, there would be difficulties as to food. Not more, we are inclined to think, than by any other route. Mr. Thomson passed through the country at an exceptionally bad time, when the cattle of the Masai were dying by hundreds from disease. The country is one of the richest game regions in Africa, and by any route an expedition must, as far as possible, be independent of local supplies. For an expedition of hundreds of men to attempt to cross the Victoria Nyanza in boats would be extremely hazardous. Meantime it is evident both from what Dr. Junker says and from the letter of Mr. Ashe, who has just returned from Uganda, that Emin Pasha is in an exceedingly perilous condition, and that every week's delay risks his life and the lives of those who are with him, for he has no ammunition. We hear, on good authority, that Mr. Stanley has decided to go by the Masai Land route; if so, it seems a pity that the only white man who has explored this route will not be in the expedition.

IT is said that great administrative changes are about to be made in Russian Central Asia. According to the St. Petersburg Correspondent of the *Times*, the whole system of arbitrary military mixed with native government, formerly considered necessary for high political purposes of further conquest, is to be gradually modified and almost abolished by the introduction of Russian civil administration and justice, and the subordination of the various departments to the Ministers in St. Petersburg. There is a proposal that Turkestan and the new Transcaspian province should be amalgamated, the reason alleged being that they will be closely connected by the Transcaspian railway, which, after passing through Bokhara, will terminate at Tashkend. The Transcaspian province will therefore, it is considered, be nearer to Turkestan than to the Caucasus. The scheme is said to have been suggested by General Rosenbach, the Governor-General at Tashkend. It is opposed by General Shepeleff, Director of the Chancery of the Governor-General of the Caucasus, who is of opinion that it would be highly inconvenient to remove the Transcaspian further from the control of the central Government, and that, if alterations are considered necessary, it would be better to make the newly-acquired territory an independent province.

ACCORDING to the *Novoe Vremya*, the trading caravan lately despatched by the Central Asian Commercial Company Koudrine has passed through Kashgar and entered Tibet. This company is likely to play an important part in Central Asia. It has established permanent agencies at Merv and Askabad and in the Persian cities of Kutchan and Meshed, and now it proposes to do the like in Tibet. It has received from the Ameer of

Bokhara a large tract of land on the banks of the Amu-daria, near the Chardjui station of the Transcaspian Railway, for the cultivation of cotton. In the Transcaspian there seems to be a great district suitable for cotton-growing, and there is a general opinion among the commercial classes of Russia that the development of this industry ought to be steadily encouraged by the Government.

THE *Bollettino* of the Italian Geographical Society for November contains an account of a second expedition by Signor E. Modigliani to Nias, which has proved much more successful than his first visit to that island, reported in NATURE, November 16, 1886, p. 60. His primary object was to discover and ascend the Mount Matsua, 600 metres high, seen by Von Rosenberg from the west coast, and figured on his map as the culminating point of the island. But, although no trace could be found of this mountain, the hitherto unexplored south-western district was traversed from Serombu on the west to Lagundi Bay on the south coast. This district was carefully surveyed, and the explorer succeeded in making rich zoological, botanical, and ethnological collections, most of which have been forwarded to the Natural History Museum of Genoa. They include no less than twenty-six human skulls (fifteen of which were obtained at Hili Horo in exchange for a rifle), about 120 birds, 2000 butterflies, 1500 other insects, monkeys, fishes, reptiles, and plants. The journey was made during the summer of 1886, Signor Modigliani's last communication being dated August 10, and forwarded to Europe from Gunung Sitoli, in the north of Nias, where he was then stationed with the intention of continuing his scientific researches in the island.

ON Tuesday evening last Captain Cameron delivered at the London Institution a lecture on "Urua: its People, Government, and Religion." In closing his lecture Captain Cameron said that Urua would shortly come into great prominence, for lately some of the officers of the Congo Free State had followed the river due east, across the great bend of the Congo, showing that it was a navigable river, and that if followed up it would lead to Kasongo's capital. They were frequently hearing of the London Missionary Society's agents pushing up the new great tributary of the Congo on the south, so there could be little doubt that in a short time the Somami would be followed up to Urua, and that traders, missionaries, and others would soon come into the great kingdom of Urua, where there was a great work before them. However, they would have to bear in mind that they would not have to do with a little chief ruling over 200 or 300 natives, but with a powerful monarch who ruled absolutely over his people, and who would allow of no agreement which had not been approved by him. It was to be hoped that, as Stanley had been successful before, he might be successful in his expedition for the relief of Emin Pasha, and also that those who went into Urua would bring civilisation and peace, and be able to do away with the horrors of the slave trade which obtained there owing to the Portuguese and the Arabs. Urua was rich in many kinds of minerals and other products, and the people were a fine race. When the Europeans came into constant contact with them, if they were wisely managed, there would be a great future for them.

WAR AND BALLOONING[1]

THE object which stimulated the practical invention of the balloon was its use in war. I say practical invention, because in theory the balloon was invented before the experiment of Montgolfier. Theory is ever the soil of practice. The idea of the balloon has its starting-point in the principle of the pressure of fluids elucidated by Archimedes, of Syracuse, 200 years before the Christian era. The discovery of hydrogen gas by Mr. Henry Cavendish, in 1760, led Joseph Black, the Professor of Chemistry at the University of Edinburgh, to suggest in one of his lectures that a weight might be lifted from the ground by attaching to it a sphere of hydrogen gas. A fruitful idea once expressed is rarely lost, however casual its first expression. Some years later, Tiberius Cavallo, an Italian merchant, remembered the remark of Dr. Black, and, in 1782, tested its truth by experiment. He first manufactured some paper bags, which he filled with hydrogen gas: to his disappointment, the subtle gas escaped through the pores of the paper. He then collected the gas in soapy water, and the bubble of gas ascended. A soap-bubble filled with hydrogen was therefore the first balloon. The experiment seems to have been repeated by Cavallo at one of the meetings of the Royal Society, and described in the Transactions of that Society; but neither Cavallo nor his colleague pursued the experiment further, and there was still to be found the peculiar kind of energy that would transform the laboratory experiment into a practical reality. Books are indeed the carriers of thought. It is probably due to a work of Priestley, in which were described those discoveries of Cavallo, and which was translated into French, that Montgolfier, the paper-maker of Annonay, was fired to perform an experiment that is historical. He, as most of you know, filled a paper bag with heated air, the consequence being that the bag rose to the ceiling of the room. Montgolfier was not content with such trifling efforts: a patriotic motive stimulated him to attain greater results—the desire to make the invention of use to France in her wars; and the paper bag of 40 cubic feet capacity was succeeded by one of 680 cubic feet; this, again, by one of 23,000 cubic feet. Montgolfier seemed on the high-road to a brilliant success. There was, however, another brain actively employed in eclipsing the fame of Montgolfier—that of Charles, the Parisian, who realised that heated air would never become a satisfactory method of filling balloons, heated air being three-fourths the weight of the air at the ordinary temperature. He therefore took up the experiments with hydrogen gas where Cavallo had left off. Hydrogen gas being thirteen times lighter than air, its superiority in filling balloons was, to his mind, indisputable. He succeeded in making a material gas-proof, and consequently produced the first practical gas-balloon.

From the efforts of Montgolfier and Charles began the history of ballooning. I do not propose to discuss its general history this evening, with its startling incidents of adventure, nor to enumerate the good service the balloon has rendered to science in the hands of such men as Benedict de Saussure, Robertson, and Glaisher, but to make a few remarks upon its use as an adjunct of war.

By many persons, those who advocate its use in war are looked upon as enthusiasts. With many persons, an enthusiast is synonymous with a fanatic. Now, I agree that enthusiasm is sometimes expended on improper subject-matter—on wild incoherent schemes; but give enthusiasm proper subject-matter, truth, and coherency, and it becomes a noble thing; it is, in fact, the life-blood of science and art. It is, in other words, earnestness of purpose. I think the use of balloons in war is worthy of this earnestness of purpose.

I have to bring before your notice this evening, in particular, a somewhat new departure in balloons, in which electricity is so combined with a captive balloon as to render it valuable for signalling-purposes. Before I describe this special use for balloons in war, which I have had the honour of introducing to the English Government, and for which I hold patents in the principal foreign countries, I will say a few words concerning the general use of balloons in time of war.

The way in which balloons have been chiefly utilised in war is for taking observations of the enemy. In such cases the balloons are captive. As early as 1793 the French Government adopted the use of captive balloons. Such balloons were employed with great success in those wars which the French Goverment carried on soon after the French Revolution. There was a regular company formed, called "Aërostiers," and it seems to me that more practical work with captive balloons was done in actual war at this period than has been accomplished since. It was Napoleon who put an end to their career of usefulness in France, and who closed the Aëronautical School at Meudon.

It is this use of captive balloons for observations that has lately been revived by the English Government, and experiments are frequently carried on at Chatham under a Committee of the Royal Engineers. Notably amongst those who have been prominent in the revival of balloons for war purposes we may mention the names of Major Templer, Major Elsdale, and Lieut. Mackenzie, and the country, I think, has reason to thank these officers for the really good work they have done with the means at their disposal. At the Inventions Exhibition there was an exhibit of balloons in the War Department. Perhaps the more important feature of that exhibit was a balloon made of gold-beater-skin, such as was used in the war in Egypt. Gold-beater-skin is an admirable substance for forming balloons, on account of its lightness and capacity of holding gas.

The free balloon has its use in war as well as the captive one.

[1] Lecture delivered by Mr. Eric S. Bruce, M.A. Oxon., at the London Institution, on December 28, 1886.

At the siege of Paris this use of balloons was demonstrated most efficiently. At the time when the Parisians found themselves cut off from all means of communication there were but a few balloons in Paris, but the successful escape of some aëronauts in these few was considered encouraging enough to establish an aërial highway involving a more wholesale manufacture of balloons than has ever been undertaken, the disused railway-stations being converted into balloon manufactories and training-schools for aëronauts. During four months 66 balloons left Paris—54 being specially made for the administration of Posts and Telegraphs—160 persons were carried over the Prussian lines, 3,000,000 letters reached their destination, 360 pigeons were taken up, of which, however, only 57 came back, but these latter brought 100,000 messages. These facts show that free balloons are useful in war. The utility of a free balloon would be largely increased if it could be steered against a considerable wind. Attempts have been made to navigate balloons on two principles: (1) by using the various currents of the air; (2) by some kind of mechanical propulsion. I will say just a word or two on each of these heads.

(1) As regards mechanical propulsion. There are some persons who, when they hear any suggestion regarding a steerable balloon, denounce the idea as impossible ever to be accomplished. I think it a wiser course to reserve a definite opinion as to whether such a thing is possible in the future, as the experiments worth anything which have been made in this direction have been few and far between, and it is unwise to draw conclusions on a basis of inadequate facts. I will, however, say this much, that those who have the task in hand have a difficult problem before them, and that the engineer who first steers a balloon against a strong wind by mechanical propulsion will deserve a high place amongst the heroes of science. I will enumerate some of the difficulties in the way of steering a balloon against the wind by mechanical propulsion, and then proceed to give you a short description of some of the latest experiments that have been made.

There is an essential difference of condition between navigating the water and navigating the air. In the former we have a body moving within the limits of two media, air and water. These two media have different densities and elasticities, consequently resistances. In air-navigation the body moves in one medium only, which renders the motion of a paddle-wheel entirely useless in that one medium—a paddle-wheel moving in the air would effect nothing—therefore, the only available means of propulsion in air-navigation is the screw: this cuts into the medium. Now it stands to reason that this medium must be in a state of comparative rest, or else the work of the screw will be overpowered. A moderate wind is sufficient to overpower a strong screw, hence the obstacle to air-navigation by mechanical propulsion. Capt. Renard has recently sent in to the French Academy an account of his experiments with his so-called navigable balloon *La France*, at Meudon. His experiments were decidedly interesting—in fact, they were in advance of anything yet accomplished in balloon guidance, but there has, I think, been a tendency to exaggerate the results obtained. I think anyone who reads carefully the accounts of those experiments which appeared in *La Nature* will see that the old difficulty with the screw still remains. The experiments to which I refer took place in comparatively calm weather. It is said that out of seven performances the balloon returned five times to the place whence it started. This is certainly more than most balloons do. To accomplish this, much care and ingenuity must have been exercised; but on reading the accounts, we find that great care was taken for the selection of that kind of weather that would not make the work of the screw *nil*. A whole month, in fact, had to elapse between the first ascent mentioned and the second, owing to unfitness of weather. On the day of the second experiment the wind blew from the north-north-west from Paris at a velocity of from 3 to 3'50 metres per second, starting from Meudon. The balloon was directed towards Paris at 4.25 p.m. It crossed the railway-line at 4.55, reached the Seine at 5 o'clock; at 5.12 the balloon entered the *enceinte* by Bastion 65. Then the aëronauts decided to go home. The balloon was easily turned, and, aided now by the aërial current, reached the exact spot whence it had started. The journey going had taken 47 minutes, the journey back took 11 minutes. Such experiments as these, to my mind, deserve praise, because they were conducted in a scientific manner, and because some results were attained; although the result of navigating a balloon against a wind of *considerable* power certainly did not come to pass. One must, it seems, still be content with mere bread-crumbs of aërial navigation.

(2) As regards the second means of navigating the air, by a fit selection of those varying currents that are frequently overlying one another blowing in different directions over the same spot. I think a closer and more methodical study of those currents might lead to satisfactory results. Up to the present time but little has been ascertained concerning them. Unfortunately for aëronautical science its Glaishers have been few, its mountebanks numerous. It is true there has always been a difficulty in the way of studying the aërial currents from a balloon, namely, the difficulty of keeping the balloon at a certain elevation. After expending ballast to make the balloon rise to a certain elevation for the sake of reaching a particular current, some change of temperature produced by the sun or clouds will often affect the delicately-balanced machine, and alter its altitude. If it has risen higher, gas must be sacrificed to reach the lower level; if it has descended, more ballast must be expended. In this way gas and ballast, which a celebrated aëronaut has called the "life-blood of the balloon," is quickly exhausted. It is these facts that make the successful experiment carried out by M. Lhoste last August so worthy of note. In his voyage across the Channel he made use of an apparatus which he called a "*flotteur frein*." This acted as a kind of floating anchor or brake. It was a cylindrical iron vessel with a conical air-chamber at the top, 1 metre 60 centimetres in length, 22 centimetres in width, weighing 10 kilogrammes when empty, and 60 kilogrammes when filled with salt water. The *flotteur* was attached to a bar underneath the balloon, on which a small sail was hoisted. The important function of this *flotteur* is, that by its means the same altitude of the balloon can be maintained when the favourable current is once found. By means of this *flotteur* the water itself can be drawn up into a reservoir in the balloon and utilised as ballast, after sunrise, when the expansion of the gas by the heat of the sun's rays would otherwise cause the balloon to shoot upwards. By this method of adjusting the altitude of the balloon, several important observations of the various currents of air about which we know so little might be taken, and it would, I think, be well if Governments organised experiments with these various currents, as well as with elaborate screws worked with power inadequate for the purpose of propelling a balloon against a powerful wind. Perhaps the aërial machine of the future may be directed by utilising in a thoroughly scientific manner these varying currents. In such a system of aërial locomotion perhaps the screw may be used as a kind of makeshift in a dead calm, when a change of level is not desirable, like the oars when there is no wind to fill the sails.

One of the most practical uses of balloons in war is for signalling. The utility of balloon-signalling consists in the elevation obtainable. Any accepted method of signalling may be used in the car of an ordinary captive balloon, *e.g.* flag-signalling or lantern-signalling. But signalling from the car of a balloon necessitates the use of a balloon of considerable size to secure the required lifting-power. This limits the practicability of such a method. About a year and a half ago it occurred to me to so apply electricity to a captive balloon that a method of flashing signals from a balloon is practicable while the operator remains on the ground. Thus the weight of the operator is obviated, and consequently the balloon can be of such a size as to be extremely portable. It is my wish to thoroughly explain to you this method. In the interior of a balloon which is made of a material that is perfectly translucent and filled with hydrogen or coal-gas are placed several incandescent electric lamps. The lamps are in metallic circuit with a source of electricity on the ground. In the circuit on the ground is an apparatus for making and breaking contact rapidly. By varying the duration of the flashes of light in the balloon, it is possible to signal according to the Morse or any other code. To thus place a source of light in the midst of the gas inside a balloon would not have been possible until the development of the electric light. Many persons even now seem to think the proceeding of showing a light inside a balloon a dangerous one. Therefore, before I describe my invention in detail, I will show you a few experiments, after which I think you will realise that the placing of the incandescent lamp inside a balloon is not attended with danger. [Experiment shown.] If I take a jar of hydrogen in my hands, and insert a taper at the mouth, the gas catches fire, but the taper goes out when I thrust it upwards in the jar. You see, hydrogen gas takes fire under certain conditions, but is incapable of itself of supporting combustion. The flame you have seen

burning at the mouth of the jar is the effect of the great affinity which exists between the atoms of hydrogen and the atoms of oxygen which, in the atmosphere of the room, borders upon the hydrogen of the jar. Further up in the jar the hydrogen atoms have no oxygen atoms wherewith to combine. Now, it may seem a surprising assertion to make, but it is nevertheless true that one could place a red-hot poker in the body of gas in a balloon without setting fire to it. If I were to ask anyone here so to do, I am sure he would decline, and say the gas would catch fire as he placed the poker in the mouth. That is quite true; and, to perform the experiment successfully, he would have to avoid the borderland altogether. Here is a puzzle to put to your friends:—How to put a red-hot poker into the body of a gas-balloon without setting fire to the gas. Now, I will show you how to do this. [Experiment shown.] Here is a glass globe, through which a continuous stream of coal-gas is passing. You see this must be so, for I have ignited the gas jet at the top of the globe. Now I have stretched a little piece of platinum wire across the terminals of an electric battery, and placed these terminals inside the globe. Now I will cause the electric current to pass through the piece of wire, and it becomes white-hot, and we have this condition of things: a piece of white-hot metal unprotected inside a globe filled with gas. Now, if we were to substitute a balloon for the globe, and have a battery of exceeding power, and if we were to place a poker between the terminals of the battery, the red-hot poker in a balloon would be a *fait accompli*. The incandescent lamps which we place inside the balloon consist of a thin filament of carbon inclosed in a glass globe exhausted to a high degree of air. This filament of carbon is raised to a white heat by the electric current. [Experiment shown.] I have thrown the image of a filament of carbon upon the screen, rendered thus incandescent. On my table I have another globe filled with gas inside, which is our incandescent lamp. This is the condition of things we have in the balloon. [Experiment shown.] Now, some person may say: "Suppose by accident you get an explosive mixture of oxygen and hydrogen inside the balloon, and that this fragile little bulb breaks." Well, if it does break, one lamp will be lost; that will be all the damage done, for the oxygen present will at once destroy the carbon filament. [Experiment shown.] I will show you this experiment by breaking an incandescent lamp in the midst of this inflammable piece of tow; you see, as I break the lamp, the light instantaneously goes out, as the action of the oxygen is to destroy that delicate carbon bridge which you have seen depicted on the screen. Now, one more of this series of experiments. [Experiment shown.] Here is another globe filled with gas; in this I discharge a naked electric spark between two platinum points. I perform this experiment to show you that, even if there were a bad connection in the electric arrangements inside the balloon, there would be no danger of firing the gas. However, in the special form I provide, I obviate all chance of any sparking, so that, in case of the contingency of there being an explosive mixture of oxygen and hydrogen inside the balloon, there would be nothing to determine it. That an electric spark can fire a mixture of hydrogen and oxygen in certain proportions I can show you by producing this respectable electric spark by means of this induction-machine, and then bringing near it a jet of coal-gas. [Experiment shown.]

A convenient size for one of these signalling-balloons is a gas capacity of some 4000 cubic feet, or, if required, they can be made smaller than this. Varnished cambric is a suitable material. I have two separate arrangements for suspending the lamps inside the balloon; the first consists of a holder made like a ladder, the lamps being placed one above the other in multiple arc. Here is this arrangement before you, with the lamps lit up. This arrangement is convenient because of the small breadth of the ladder, which is easily admitted into the neck of the balloon. The ladder arrangement casts a small shadow on the balloon. In my opinion this shadow is of no consequence whatever; but I have an alternative method which obviates the appearance of any shadow altogether. It consists of a ball, from which project lamps at various angles; the arrangement is protected from risk of breakage by a wire framework. [Experiment shown.]

The form of contact-breaker which produces the intermittent flashes of light is in form somewhat like a Morse key. In reality it is essentially different. An ordinary Morse key, such as is used in telegraphy, would not withstand the large currents used to light the lamps. In my latest form of contact-breaker I use carbon-contacts. These can be easily renewed at trifling cost when worn away. [Experiment shown.] I have also on my lecture-table another form of contact-breaker [experiment shown], in which there is a rubbing contact faced with platinum. The leads which convey the electric current to light the lamps must be as light as possible, consistent with the current they have to carry, and [experiment shown] here is a special type of cable I have had manufactured for the purpose. By means of the model balloon before you, I will now show you the action of the key. We will flash the words "A Merry Christmas and Happy New Year to you all." [Experiment shown.] On the switch-board which contains the key I have an arrangement to switch on the lights in the balloon continuously, in this manner, because these portable balloons thus illuminated would be useful for other purposes than for flashing signals, viz. for a preconcerted signal, or as a "point-light" to guide advances or retreat.

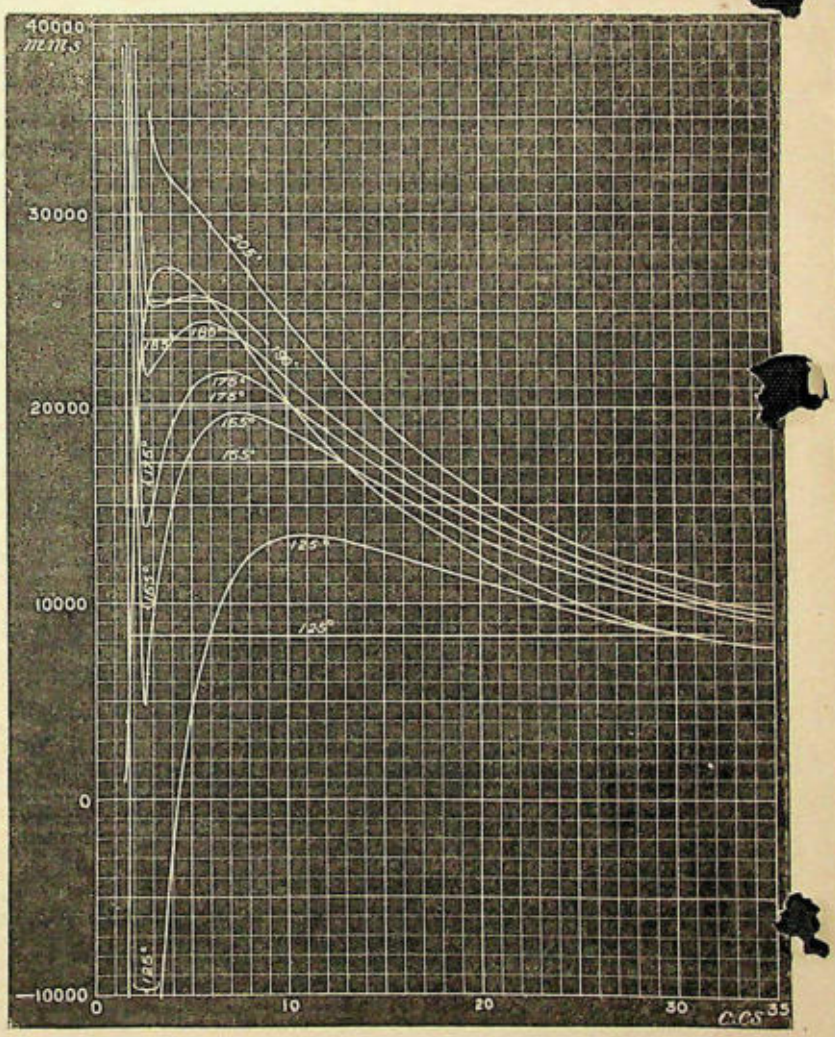
The source of electrical power for working the lamps inside the balloon may be varied according to circumstances. It may be: (1) a small dynamo; (2) a storage battery; (3) a primary battery. Each of these three forms of power can be supplied in portable and convenient form. In some cases, where there is a stationary dynamo-machine in close proximity, storage-cells may be conveniently used, as they can be charged from this stationary dynamo, and brought into the field as required. I used storage-cells just now to light up that ladder of lamps and for working the lights in my model balloon. These storage-cells are, you see, arranged at the foot of my lecture-table. A portable way of obtaining power would be, I think, to use a little gas-engine with dynamo combined, such as, by the courtesy of Messrs. Crossley Brothers, I am enabled to show you this afternoon at work. [Experiment shown.] This might be fixed on the waggon, with all the other apparatus connected with the balloon. The engine would be worked by the gas, which is always a necessary adjunct to the balloon. The gas-supply might be a portable apparatus for generating the gas, or else the method of storing gas in steel bottles could be adopted. This has been done successfully by our own Government. At the Inventions Exhibition a bottle of compressed gas was exhibited in the War Department. I now wish to show you how easily gas may be compressed, stored up, and used when wanted. Here is a small bottle of compressed hydrogen, and I will soon transfer the gas from that to this goldbeater-skin balloon, which now rises to the ceiling. [Experiment shown.] There is another method of lighting these balloons—by using a primary battery. There is a very excellent primary battery now in the market, invented by M. Schanschieff. A good primary battery has long been a great desideratum. For some time I have searched to find one that was anything near the mark for electric lighting purposes. This battery which is before you is the best I have had in my hands, and I am applying it to several of my patent arrangements. I am glad to be able to show you one of these batteries in working order. [Experiment shown.] In this comparatively small compass we have 32 cells. The size of each cell is 3½ inches by 2 inches. In the cells we have a single fluid solution—sulphate of mercury acidulated. There is a sample of the sulphur in this bottle. Now, with most single-fluid batteries we have what is technically called polarisation, which means diminution of electric power. Mr. Schanschieff has overcome this polarisation, and in overcoming it he has done a great deal towards the development of electrical appliances. There is one piece of apparatus connected with the balloon worth mentioning. This is the reel for winding the cable. [Experiment shown.] The electric connection is made, you see, as the cable unwinds.

The advantages which I claim for this method of signalling are, briefly: It facilitates night-signalling; it facilitates signalling to long distances; and in places where the ordinary methods would fail to be of any use, such places as hilly and wooded districts, the apparatus is portable and simple; the balloon shows a large body of light. In order that you may realise the use of a balloon in time of war in a place where ordinary signalling would be of no use whatever, I have prepared the illustrations which my assistants will now throw upon the screen. Here we have a mountainous region. There are supposed to be two friendly armies separated by chains of mountains, and wishing to communicate. Now these two armies might be possessed of every other modern appliance for signalling from the ground without being able to make a signal seen by either side. Therefore, in the scene before you, the signallers of one army are depicted as filling the portable signalling-balloon with gas

preparatory to the ascent for purposes of signalling. The army on the other side of the mountains has already sent up a similar balloon. The next scene shows a nearer balloon ascended to a certain height. Now the two balloons are about to communicate. You see the flashes of light from the balloon.

Although this invention is not two years old, it has already a short history. It was exhibited in model in the War Department of the Inventions Exhibition, and while on exhibition there the method was referred for Government trial under a Committee of the Royal Engineers at Chatham. During the time the model was being exhibited at South Kensington, some experiments were tried with a balloon of 4000 cubic feet capacity at the Albert Palace. In this balloon were placed six lamps worked to 16 or 20 candle-power. The six lamps took a current of some 9 amperes, and the electromotive force was 24 volts. The source of electric power then used was 25 cells of the Electrical Power Storage Company. During this Exhibition the value of the method for long-distance signalling was well tested, the flashes of light from the balloon being observed as far as Uxbridge, a distance of sixteen miles. This was effected by less than 100 candle-power. I used the same apparatus for the Government trial at Chatham, after which trial I received an order from the War Office to supply some of my apparatus to the Royal Engineers. The system was again tried at Aldershot under the Signalling Department. On the day fixed for the trial there was a snowstorm and a fog, two very unfavourable conditions in a system of signalling, but signals were read and answered from my balloon, in spite of snow and fog, by the signallers stationed some few miles off. As I mentioned the other day at a meeting of the Aëronautical Society, I wish, as the inventor of this system, to see it tried to its utmost capacity, and I purpose to put the system myself shortly to the most rigorous of tests. One of those tests will be, I hope, to signal over the Channel, *i.e.* to send up the balloon on some site on the English coast, probably Dover, and observe whether the balloon can be seen on the French coast. The Channel is by no means the most favourable expanse for signalling, for there are frequent fogs in it to obscure the view. The Channel, however, is a time-honoured and popular measure of distance, and I must repeat here the wish I expressed lately at the meeting of the Aëronautical Society, that, if the flashes of light can be observed over that expanse, I hope the public will look upon the accomplishment, not as a sensational feat, but as showing the practical value of balloon-signalling. Up till lately I have only considered my system as being useful to the army. I think, however, it would be also useful to the navy. I have schemed a method of employing these balloons on board ship. Their greatest use in the navy would be, I think, for coast-signalling—signalling round corners; I have been asked to submit this scheme to the Admiralty, and am preparing to do so. The picture now before you represents its use in the navy on board a ship stationed in a bay, which vessel wishes to communicate with another at the other side of the cliffs which form the bay. It is, as you see, night-time. The ship that is not visible to you sends up the balloon, and now the two balloons commence signalling to each other. [Experiment shown.]

You may perhaps be inclined to think that I ought to mention some one particular occasion in history when this balloon would have been useful. I do not think we need look far back to find one example. But a short while ago there was a brave general shut up in a besieged city with a few followers. Near at hand there were friends ready to help, but ignorant of the immediate necessity of that help. Need I name that general and that city? Now, if from Khartoum there could have arisen such an electric signalling-balloon as I have described to-day, its flashes of light in the skies would have told the tale of the events below—a tale that would have been eagerly read—and perhaps that brave general would then have left Khartoum, a conqueror, and with his life spared for the future service of his country.



SOCIETIES AND ACADEMIES

LONDON

Royal Society, January 6.—"Preliminary Note on the Continuity of the Liquid and Gaseous States of Matter." By William Ramsay, Ph.D., and Sydney Young, D.Sc.

For several years past we have been engaged in an examination of the behaviour of liquids and gases through wide ranges of temperature and pressure. The results of our experiments with ethyl alcohol have recently been published in the *Philosophical Transactions*; those with acetic acid in the *Transactions* of the Chemical Society; and the Royal Society have in their hands a similar investigation on ether. We have also finished a study of the thermal properties of methyl alcohol.

In consequence of a recent publication by Wroblewski, of which we have seen only the abstract (*Berichte*, 1886, p. 728, abstracts), we deem it advisable to communicate a short notice of an examination in which we are at present engaged.

We find that with the above-mentioned substances, acetic acid excepted, whether they are in the liquid or gaseous state, provided volume be kept constant, a simple relation holds between pressure and temperature. It is $p = bT - a$. This is evidently a simple modification of Boyle's and Gay-Lussac's laws; for at

low pressures, where volume is large, the term a approaches and finally equals zero, while b diminishes and finally becomes equal to the value of c, calculated from the ordinary equation,

$$p = \frac{cT}{v}.$$

We have as yet only had time to apply this formula with eth… ether to the liquid state; and as we are not yet quite certa… whether the relation holds for volumes between 4 and 20 c.c. … 1 gramme of ether, we are at present engaged in measureme… of volumes and pressures at temperatures between 220° and 280°. Assuming the above relation to be true (and it is at all events a close approximation to truth), it is possible to calculate those portions of isothermals included within the liquid-gas area, and represented in Andrew's diagram by horizontal straight lines. We have calculated a few of these isothermals for ether, and find that the areas above and below the horizontal lines (see woodcut) are equal, when measured by a planimeter.

Reserving a full discussion of the subject until the completion of our experiments, we would here point out the similarity between the equation $p = kt - a$ and those proposed by Clausius and by van der Waals to represent these relations. Clausius's formula is

$$p = \frac{RT}{v-a} - \frac{c}{T(v+\beta)^2},$$

and van der Waals'

$$p = \frac{RT}{v-b} - \frac{a}{v^2}.$$

In these formulæ Clausius's a and c are equivalent to van der Waals' b and a respectively, but R has a different signification.

We find that a somewhat similar formula agrees better with experiment than either of the above; it is

$$p = \frac{RT}{v-b} - \frac{a}{Tv^2},$$

where R, b, and a have the same meaning as in van der Waals' formula. This formula expresses the results of experiments with great accuracy, where the volume of 1 gramme of ether occupies not less than 25 c.c.; but at smaller volumes it ceases to represent the facts.

It is to be noticed that both Clausius's equation and ours introduce T into the denominator of the second term; they evidently differ from our first equation $p = kt - a$, in which a is independent of temperature.

We shall soon be in a position to communicate the results of this investigation, giving full data.

PARIS

Academy of Sciences, January 3.—M. Gosselin, in the chair.—A new method of determining the constant of aberration, by M. Loewy. M. Nyren having shown that none of the methods hitherto adopted are free from systematic error, the author here proposes a process by which all instrumental errors may be avoided. It also eliminates the effects of precession and nutation, and enables the observer to take accurate account of the proper movements of the stars without depending on their approximate values drawn from the catalogues. Lastly, it neutralises the parallactic effect of the stars, dispensing with the numerous experiments needed to determine the instrumental constants. In a word, it calculates directly the phenomenon of aberration itself, without employing any physical constant.—On the relations of the lactiferous vessels with the fibro-vascular system, and on M. J. Vesque's aquiferous apparatus of Calophyllum, by M. A. Trécul. Further researches are described confirming the conclusion already announced by the author regarding the numerous points of contact between the milk-yielding vessels and the various elements of the fibro-vascular system in a large number of plants. It is further shown that the anatomical results described by him in the year 1865 are amply confirmed by M. Vesque's recent note on the aquiferous apparatus of *Calophyllum Calaba*.—Actinometric observations made during the year 1886 at the Montpellier Observatory, by M. A. Crova. The comparative study of these observations (made by M. Houdaille with the author's actinometer) with those of the three previous years confirms the conclusions already arrived at regarding the annual variations of calorific intensity in the solar rays.—Note on the diurnal nutation of the terrestrial globe, by M. Folie. The important consequences of the existence of this phenomenon for geology, astronomy, and geodetics are pointed out, and it is shown that it places beyond doubt the fluid state of the interior of the globe surrounded by a solid outer crust.—Note on the Maclaurin series in the … by M. O. Callandreau.—On a class of … by M. Emile Picard.—Observations rela… to a note on a geometrical theorem, by … error is pointed out in M. Serret's … correspondence between the lines of … with reciprocal vector rays.—Note on … distribution, by M. H. Poincaré. The … ective character of the method proposed by MM. … warz, and Harnack for solving this difficult problem.—Remarks respecting M. Hirn's observations on the flow of gases, by M. Hugoniot. The author returns with regret to this subject, and makes some final remarks on M. Hirn's paradoxical inferences, calling upon him to present a complete statement of his experiments, and of the causes of the errors he professes to have detected in the calculations of the upholders of the kinetic theory.—Note on the specific heats of a perfect gas, by M. Félix Lucas. On theoretic grounds it is argued that the two specific heats of a perfect gas become increasing functions of the temperature.—On the nature of the electric actions in an insulating medium (second communication) by M. A. Vaschy. These problems of electro-statics are brought into general relation with those dealing with the equilibrium of the ether regarded as an elastic body. It is hence inferred that the electric perturbations must be propagated with a uniform velocity, just as a mechanical concussion is propagated in an isotropic body, and this velocity must be that of light.—On electric pressure and on electro-capillary phenomena, by M. P. Duhem.—On a phosphate of hydrated silica, by MM. P. Hautefeuille and J. Margottet. From three analyses made with specimens obtained from different preparations it is shown that the formula of this substance is $SiO_2,2PhO_5,4HO$.—Action of sulphur on ammonia and on some metallic bases in the presence of water, by M. J. B. Senderens. These researches have been carried out in continuation of MM. Senderens and Filhol's studies in connection with the action of sulphur on the saline solutions and on those of soda and potassa.—Note on the maxima vapour tensions of acetate of soda, by M. H. Lescœur. M. Berthelot's conclusion that there is no isomery either between the solid salts or between the diluted solutions of the various acetates of soda, are fully confirmed by the results here obtained by a different process.—On the preparation of the isobutylamines, by M. H. Malbot. It is shown that the three isobutylamines are formed in proportions differing little from each other, the operation constituting an effective method of preparing all these amines simultaneously.—Isomery of the camphols and camphors, by M. Alb. Haller. Here the author deals with the camphols of madder, of Borneo (*Dryobalanops camphora*), and of yellow amber.—Heat of formation of some alcoholates of potassa, by M. de Forcrand. Determinations are given for the heat of formation of the propylate and isobutylate of potassa.—On some points relating to the action of saliva on the grain of starch, by M. Em. Bourquelot.—Experimental researches on mercurial intoxication, by M. Maurice Letulle. The paper deals especially with the paralytic accidents and lesions of the surface nerves caused by this intoxication (chronic hydrargyrism).—Studies of the relations existing between the cranial nerves and the cephalic sympathetic nerve in birds, by M. L. Magnein.—Note on the red and white muscles in the rodents, by M. L. Ranvier.—Observations relative to M. Maupas' recent note on the multiplication of *Leucophrys patula*, by M. Balbiani. It is shown that the peculiar process of fissiparity in these organisms is not such a rare phenomenon as is supposed by M. Maupas.—On the line of development followed by the embryo of bony fishes, by M. L. F. Henneguy. The author's researches confirm the conclusions already arrived at by Kupffer and Ellacher.—On the amphipod crustaceans of the west coast of Brittany, by M. Edouard Chevreux.—Observations relative to M. Viguier's note on the so-called ophite rocks of the Corbières, and to M. Depéret's communication on the Devonian system of the Eastern Pyrenees, by M. A. F. Nogués.—Microscopic examination of the ashes ejected by the Krakatão volcano, by M. Stanislas Meunier.—A critical examination of certain rare minerals, by M. A. Lacroix. Descriptions are given of pterolite, villarsite, grangesite, and gamsigradite.—The death was announced of M. Francisque Fontannes, a distinguished geologist, who was awarded the Academy's Grand Prize for the Physical Sciences in 1883.

BOOK NO. 1063

BERLIN

Physical Society, November 19, 1886.—Prof. du Bois-Reymond in the chair.—Prof. Liebreich reported on phenomena he had observed in the course of experiments respecting slowly-proceeding chemical reactions. If hydrate of chloral were mixed with an alkaline solution, then was chloroform formed in the shape of a white precipitate. This reaction occurred with all alkaline solutions, only the time varied according to the alkali. While, however, chemical reactions usually ensued in the whole mass of the reacting substances, it was here observed that, when the process of mixture was effected in a test-glass, the uppermost layer remained clear, no turbidity and precipitate formation occurring in it. This layer, which the speaker named the "dead space" ("todter Raum"), was bounded on the upper side by the meniscus of the fluid, and on the lower side by a sharp boundary, having, apparently, a curve opposed to the meniscus. In the capillary space between two glass plates, the dead space displayed itself in very beautiful formation. In horizontal capillary tubes the dead space came into shape at both ends, and in very short capillaries the reaction failed entirely. If from the dead space a little clear fluid were withdrawn and warmed, then did the reaction set in. This showed that in the dead space both fluids were contained, and that it was only their chemical action that was prevented. The dead space showed itself in drops at the edge of the curve. In the capillary space between two menisci was found an external ring, and the middle clear, while reaction occurred only in a small ring. If tubes were closed by a membrane above and below, and filled with the mixture of hydrate of chloral and alkali, then did the dead space appear both at the top and the bottom. The same phenomenon presented itself likewise in animal membranes—for example, in a rabbit's bladder or in an intestine. On the other hand, the dead space was observed neither in a gutta-percha alembic nor in a similar shaped glass retort. The speaker also discussed many other sorts of phenomena in respect of the dead space, both with the fluids already named and with other fluids, demonstrating a large part of them by experiments. In conclusion, he set up the hypothesis that, in the experiments referred to, the chemical reaction was hindered by phenomena of surface-tension, a matter which should be further investigated by additional experiments. A lengthy discussion followed this paper.—Dr. Weinstein then reported on a publication of the Normal Standard of Weights and Measures Commission, "Construction and Repeated Trial of the Principal Standards and the Control Standards" ("Die Herstellung und Wiederkehrende Prüfung der Hauptnormalen und der Controllnormalen"). He brought out that in this publication the idea of weight was officially defined by a mass, the unit of which, the kilogramme, was equal to a cubic decimetre of distilled water at 4° C. The trial of the normal metre of platinum resulted in the establishment of its invariability. The kilogramme of platinum was likewise unchanged, while, on the other hand, the control standard-kilogramme showed a slight increase of weight through oxidation. The examination of the dry measures resulted in showing a considerable diminution of volume, a fact which would have to be ascribed to elastic and thermal after-effects in the material that had been employed for the standard dry measures.

Physiological Society, November 26, 1886.—Prof. du Bois-Reymond in the chair.—After the re-election of the President and Council, in accordance with the statutes of the Society, and the disposal of several business motions, Prof. Falk communicated a case taken from his forensic practice, which was not without physiological interest. A boy was run over by a heavy van and in a few minutes died. A *post-mortem* showed a gaping rupture of the thyroid and of the cricoid cartilage, the entrance of blood into the air-passages—causing death by suffocation—and into the digestive organs. It was, now, a remarkable and physiologically interesting fact that the blood had penetrated not only into the stomach, but into the small intestine, and that, as far as the neighbourhood of the cæcum. Seeing that the abdominal organs were perfectly intact, and the intestines even to a high degree anæmic, the blood must have proceeded from the stomach, and that during the brief time of the agony; for peristaltic movements appeared indeed after death, but in no case in the stomach, and the passage of the contents of the stomach into the intestine was never observed after death had set in. The speaker had, on the other hand, observed very violent swallowing movements as well as increased peristaltic movement in the intestine and stomach in men, and especially in his experiments with animals during the agony of suffocation. In the discussion following, Prof. Zuntz corroborated the fact of the appearance of increased peristaltic movements, and of the abnormally far advance into the intestine of the contents of the stomach during death by suffocation, citing, as he did, some earlier experiments he had not yet published. By way of testing the assertion proceeding from the laboratory of Prof. Ludwig, that acid chyme was normally found in the small intestine of animals, he had instituted experiments in which very soon after death he opened the abdomen of animals, and by a ligature isolated the small intestine from the stomach; he then in every case found the contents of the intestine neutral or alkaline. If on the other hand he poisoned the animals, as in the case of Ludwig's experiments, with curare, then were the contents of the intestine acid. The cause of that, however, was that the animals had died from suffocation, and that the asphyctic blood had induced a lively peristaltic movement of the smooth intestinal muscles not paralysed by curare, and so, therefore, an abnormally rapid propulsion of the contents of the stomach into the small intestine.

BOOKS AND PAMPHLETS RECEIVED

Mind, January (Williams and Norgate).—The Cruise of the *Marchesa* to Kamchatka and New Guinea, 2 vols: F. H. H. Guillemard (J. Murray).—Proceedings and Transactions of the Royal Society of Canada for the Year 1885, vol. iii. (Montreal).—Journal of Anatomy and Physiology, January (Williams and Norgate).—Elements of Harmony and Counterpoint: F. Davenport (Longmans).—Bees and Bee-keeping, vol. i., parts 11, 12, 13; vol. ii., parts 1, 2, 3, 4: F. R. Cheshire (Gill).—Journal of the Chemical Society for January, and Supplementary Number (Van Voorst).—Journal of the Scottish Meteorological Society, third series, No. 3 (Blackwood).—Le Mesure du Mètre: W. de Fonvielle (Hachette, Paris).—Annalen der Physik und Chemie, 1886, No. 12 (Leipzig).—Beiblätter zu den Annalen der Physik und Chemie, 1886, No. 11 (Leipzig).—Text-book of British Fungi: W. D. Hay (Sonnenschein).—Hand-book of Practical Botany: Strasburger.—Hillhouse (Sonnenschein).—Historical Basis of Modern Europe: A. (Sonnenschein).—The Primula: Report on the Primula Conference (Macmillan).—Resa till Grönland: Nils O. Holst.—Proprietà Industriale (Roma).—Beiträge zur Statistik der Blitzschläge in Deutschland: Dr. G. Hellmann (Berlin).—History and Biology of Pear-Blight: J. C. Arthur.—An Address before the American Association for the Advancement of Science: T. C. Chamberlin (Salem).—Jahresbericht Am., 25 Mai, 1886, dem Comite der Nicolai-Hauptsernwarte (St. Petersburg).—Grundzüge einer Theorie der Kosmischen Atmosphären: W. Schlemüller (Prag).—Ueber die Allegemeine Beugungsfigur in Fernröhren: H. Struve (St. Petersburg).

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THURSDAY, JANUARY 20, 1887

THE IMPERIAL INSTITUTE

FOR some time before the scheme of the Prince of Wales's Committee was before the public, there was a feeling that it seemed only too probable that the Imperial Institute would be merely a show-place for the amusement of sight-seers and for the benefit of the showmen. Happily this danger has been averted. Prof. Huxley and others have sounded a note which has now brought the real basis of trade and commerce to the front. It is possible that the mere trade-product view will now give way, so that we may hope the scheme in its final form will be hardly less scientific than that sketched by us in the first of our articles on "Science and the Jubilee" (p. 217). If this anticipation is realised, the Institute will be in every sense a worthy memorial of the fiftieth anniversary of the Queen's reign, and will prove to be of e during benefit to the whole Empire. There cannot be the slightest doubt as to the necessity for a vital change in our national way of regarding scientific as they were opposed to industrial methods. There was a time when England, with her r nopoly of coal and iron, had practically no competitors in the great markets of the world. By the splendid achievements of her inventors, and by the energy and promptitude of her manufacturers and traders, she had got so far—having such a monopoly of raw material—ahead of her rivals that the foremost place in commerce seemed to belong to her by a sort of natural right. Within the lifetime of the present generation all this has been changed. France, Germany, and other nations gradually became aware that they also, if they pleased, might play a prominent part in the industrial movement, and they set to work in the right way to fit themselves for the new conditions of modern life. Recognising that permanent success could be accomplished only by knowledge and organised effort, they provided for the education both of employer and employed by the establishment of schools, and by every means at their disposal encouraged the development of science. The consequence is that England has been driven from some markets in which she was formerly supreme, and that in others she finds it hard to maintain her ancient predominance. There is not the faintest chance that she will recover the ground she has lost unless she chooses to adapt herself to the altered circumstances by which she is surrounded In commerce, as in all other relations, it is the fittest that survives; and if raw material fails, then greater knowledge alone can triumph; and the fittest commercial nation is the nation which equips its workers with the most exact knowledge, the most alert intelligence, and the most thorough technical skill. If the Imperial Institute is founded and carried on in accordance with the best and most characteristic ideas of our time, it may make Greater Britain greater yet, if it helps to bring British industry under the dominion of the scientific spirit; and to secure for it this magnificent position ought unquestionably to be the aim of all who undertake to press its claims on the attention of the public.

This aspect of the subject was kept prominently in view by all the principal speakers at the meetings in St. James's Palace and the Mansion House last week. The Prince of Wales laid the strongest emphasis on the fact that, in all parts of the civilised world, commerce and manufactures have been profoundly affected by the progress of science. "I have, on more than one occasion," he said, "expressed my own views, founded upon those so often enunciated by my lamented father, that it is of the greatest importance to do everything within our power to advance the knowledge, as well as the practical skill, of the productive classes of the Empire. I therefore commend to you, as the leading idea I entertain, that the Institute should be regarded as a centre for extending knowledge in relation to the industrial resources and commerce of the Queen's dominions. With this view it should be in constant touch, not only with the chief manufacturing districts of this country, but also with all the colonies and India. Such objects are large in their scope, and must necessarily be so, if this Institute is worthily to represent the unity of the Empire."

Prof. Huxley spoke at the Mansion House and, of all the speeches delivered there, his was the most striking. As the present needs of the nation, and how an Imperial Institute might be made to help us, are never likely to be more lucidly or more impressively stated, it seems to us that we shall do our readers good service by printing the speech in full. Seconding the resolution proposed by Lord Rothschild, "That this meeting pledges itself to take all practicable steps to assist in the formation of the Imperial Institute, and to support it when brought into existence," Prof. Huxley said:—

"He wished to state, very briefly, his opinion of the value of the proposed Institute from the point of view of a man of science. The epoch coincident with Her Majesty's reign was remarkable above all corresponding periods of human history that he knew anything about for two peculiarities. One was the enormous development of industry, and the other was the no less remarkable and prodigious development of physical science, which two developments, indeed, had gone hand in hand. The opinion which he was now expressing was not one formed *ad hoc* for the purpose of this meeting. It was one which he expressed two or three years ago when taking leave of the Royal Society. It was a matter which was perfectly obvious to any person who had paid attention either to the history of science or to the history of industry, that there had been nothing, not only in any period of fifty years, but in any century, in the slightest degree comparable with the magnitude and the importance of the growth of those two branches of human activity which had taken place since 1837. His memory went back far enough to call to mind with great vividness a period when industry, or, at least, the chiefs and the leaders of industry, looked very much askance at science. The practical man then prided himself on caring nothing for it, and made it a point to disbelieve that any advantage to industry could be gained by the growth of what he was pleased to call abstract and theoretic knowledge. But within the last thirty years more particularly that state of things had entirely changed. There began in the first place a slight flirtation between science and industry, and that flirtation had grown into an intimacy, he might almost say courtship, until those who watched the signs of the times saw that it was high time that the young people married and set up an establishment for themselves. This great scheme, from his point of view, was the public and ceremonial marriage of science and industry. It

was the recognition on the part of those persons who were best able to judge of what were the wants of the industry of the time, that, if they were to be developed in a way proportionate to their importance, they must be developed by scientific methods and by the help of a thoroughly scientific organisation. A great distinction was commonly drawn by some philosophic friends of his between what they called militarism and what they called industrialism, very much to the advantage of the latter. He by no means disputed that position; but he would ask any one who was cognisant of the facts of the case, who had paid attention to what was meant by modern industry pursued by the methods now followed, whether, after all, it was not war under the forms of peace? It was perfectly true that the industrial warfare was followed by results far more refined in their character than those which followed in the track of military warfare. It did not break heads and shed blood, but it starved. The man who succeeded in the war of competition and the nation which succeeded in the war of competition beat their opponents by his starvation. It was a hard thing to say, but the plain simple fact of the case was that industrial competition among the peoples of the world at the present time was warfare which must be carried on by the means of warfare. In what respect did modern warfare differ from ancient warfare? It differed because it had allied itself with science, because it trusted in knowledge, organisation, and discipline, and not in mere physical strength and numbers, because it took advantage of every scientific discovery by which the weapons of offence and defence could be perfected, and because it required the highest possible information on the part of those who were engaged in that warfare; and if the peaceful warfare of industrialism was to succeed it must follow the same methods. The operations of the leaders of industry must be organised; they must call to their aid, as military leaders were doing, every possible help which was to be gathered from science. They all knew what help science was already giving to industry; it would not do to remain contented with this accidental aid, but those who conducted industrial operations should be trained and disciplined in those different branches of human knowledge which dealt with the needs and wants of nations and with the distribution of commodities. This country had dropped astern in the race for want of that education which was obtained elsewhere in the highest branches of industry and commerce. It had dropped astern in the race for want of instruction in technical education which was given elsewhere to the artisan; and if they desired to keep up that industrial predominance which was the foundation of the Empire, and which, if it failed, would cause the whole fabric of the State to crumble—if they desired to see want and pauperism less common than unhappily they were at present, they must remember that one of the chief means of diminishing those evils was the organisation of industry in the manner in which they understood organisation in science, that they must strain every nerve to train the intelligence that served industry to its highest point, and to keep the industrial products of England at the head of the markets of the world. He looked, therefore, on the Institute as the first formal recognition of this great fact—that our people were becoming alive to the necessity of organisation of industry and the improvement of industrial knowledge. It was on that ground that he supported the proposition. It appeared to him that it would be a worthy and fitting memorial of Her Majesty's reign, if they created an institution which permanently represented that which was the great and characteristic feature of the period, that which would mark the Victorian epoch in history as the epochs of Augustus and Pericles had been marked. An Institute having such objects and purposes as had been described appeared to him to be a monument not only more lasting than brass but one which for centuries to come would hold before the people an image of the objects after which they had to strive, if they desired to organise their activities in such a manner as would lead to their perennial welfare."

This admirable statement by Prof. Huxley it is to be hoped will be read by everybody interested in the welfare of Greater Britain. It will not be enough, however, to see that the army of peace is alone organised within one Institute only, however Imperial it may be.

Our chief want now is knowledge in high places. We do not forget that in our present Prime Minister we have a patient student of science, and one who knows the need of it for the country. But there are a thousand ways in which the ignorance, or rather let us say the want of scientific instruction and of appreciation of the fact that a modern State can only be great on account of its commerce and of its superiority in all international relations, and that greatness in these directions depends upon *knowledge*, is doing this country great harm.

We are not without signs that this also is being recognised. The *Times*, in a remarkable leading article the other day, pointing out the importance of meteorology—and the moral it draws would have been equally true of any other branch of knowledge—writes as follows:—

"Meteorology is a science of great practical importance and of great speculative interest, which is pursued in this country under considerable disadvantages. The Atlantic starves it on one side, and the Treasury on the other. It exists within an area of permanent depression. The Government does dole out something for its support, but it takes a large part of it back in the shape of telegrams. While the Atlantic curtails our horizontal information of the condition of the atmosphere, Nature has given us mountains which offer valuable opportunities for vertical investigation. A few earnest men of science and public-spirited citizens have set up an observatory on Ben Nevis at a cost of more than five thousand pounds, and, beyond allowing twopence in the shilling upon telegrams despatched from the top, the Government, we believe, does nothing for its support. It even charges a heavy rent for the telegraph-wire. This nation thinks nothing of wasting, by improvident method, in the building of a single ironclad as much money as would maintain all our scientific establishments for a decade. But while there is the most indefensible squandering of public money at the War Office and the Admiralty, there is the meanest parsimony towards science and scientific education—the only things that, as Prof. Huxley pointed out the other day, can save us from being crushed in the fierce competition of peace, which kills as surely as that of war. The Treasury knows in a vague sort of way what an ironclad is, but we doubt whether there are three men in the department who could give an intelligent definition of physics."

Assuming that the *Times*' estimate of the knowledge available at the Treasury is exact, our point is that it is the system and not the individuals who should bear the blame. Nor is the Treasury the only department in which a knowledge of science is imperative, or in which successive Ministries have taken no action to provide it.

It is well that all these questions should now be raised, and the more questions of this order are raised by the Institute movement the better for us will it be.

THE BLASTOIDEA

Catalogue of the Blastoidea in the Geological Department of the British Museum (Natural History); with an Account of the Morphology and Systematic Position of the Group, and a Revision of the Genera and Species. By Robert Etheridge, Jun., and P. Herbert Carpenter, D.Sc., F.R.S. Illustrated by 20 Lithographic Plates, &c. (London: Printed by Order of the Trustees, 1886.)

THIS important memoir is in all but in name a monograph of the interesting group of extinct Echinoderms first called Blastoidea by Thomas Say in 1825. It originated, the authors tell us, some seven years ago, in a desire to investigate the structure and relationships of this group by the light of the recent advances made in our knowledge of their living representatives.

Echinoderm structure owes much to the genius and labours of Johannes Müller, and a knowledge of the results of his inquiries largely influenced Prof. F. Roemer in preparing his classical work on the Blastoidea. Recent investigations have added enormously to our knowledge of the structure of the Stalked Echinoderms, so that a renewed morphological examination of their extinct allies was in every way desirable, and this we have now before us. The authors were indebted for much kindly aid in the examination of specimens to a whole host of friends, among whom it seems desirable to mention more especially Mr. Wachsmuth, who sent from America a selected series of forms from his fine collection of American Blastoidea, thus enabling the authors to form their own views on many points of structure. He also supplied them with recent information as to the progress of his own investigations among the American species.

The memoir begins with a chapter on the bibliographical history of the group, commencing with the paper by Say in the Journal of the Philadelphia Academy of Natural Science for 1885. Roemer's monograph appeared in 1852. Billings, in 1869, published a series of important memoirs, in which he suggested that the remarkable lamellar tubes beneath and between the ambulacra appeared to have served the function of respiration, and designated them as "hydrospires;" the summit openings in connection with them were called "spiracles." Wachsmuth's valuable contributions commenced in 1877, while in 1882 the present authors began a series of memoirs, which have now culminated in the present work. A second chapter treats of the Stem and Calyx. The stem of the Blastoidea would appear to be but little known, since individuals in which the stem remains attached to the calyx are rarely found. Mr. Wachsmuth has a slab of Pentremites, in which three specimens have stems of between 5 and 8 inches in length, and the best preserved stem examined by the authors is figured as occurring beneath the calyx of *Granatocrinus norwoodi*, where it is seen to consist of some small thin discoidal joints, which are so little characteristic, that if found isolated it could not be certainly said whether they belonged to a Blastoid or a Crinoid. Though all the Blastoids may have had stems in their early stages, some appear to have had no stem in their adult state. It will be remembered that the adult Comatula shows no trace whatever of having at one time been a stalked form. The calyx is described at great length and with great clearness, and the views of Wachsmuth and others are criticised. Chapter III. is devoted to the study of the Ambulacra, and the fourth chapter to the Summit Plates. These latter were first discovered by Owen and Shumard (1850) forming a conical covering of small plates over the oral and ovarial apertures on a specimen of *Pentremites godoni*. With the exception of Hambach, no recent palæontologist disputes that these plates are an integral part of the organisation of a Blastoid. The chapter on the Hydrospires and Spiracles is full of interest. The former can in no way be regarded as a respiratory portion of the ambulacral system, while the analogy of recent Crinoids goes to show that the ambulacral groove of the Blastoids was a ciliated food-groove, and that it was not occupied by any portion of the generative system; but the authors adopt Ludwig's comparison of the marsupial pouches (genital bursæ) of Ophiurids with the Blastoid hydrospires. The zoological position of the Blastoids is still regarded as a subject of discussion, though it would seem that Say's opinion is correct, and that the Blastoidea may be regarded as a group intermediate between the Crinoidea and Echinoidea. As to the distribution in time, there is no certain evidence of the existence of true Blastoidea anterior to the Upper Silurian period, and it is curious that all the known species of this period are confined to North American strata. The Devonian rocks of the British Islands have yielded but imperfect traces of them. The Lower Devonian rocks in France and in Belgium have each yielded a single Blastoid, but the great centre of their development in Europe during this geological period was in the north of Spain. In North America they were, on the contrary, largely represented, both in generic and specific forms. Regarding the Blastoids of the Devonian system from a general point of view, the number of genera was largely increased at the close of the Silurian period, and all the families are to be found represented in the Devonian period. Pentremites, which is the type form of the class, did not make its appearance until the Devonian. The Carboniferous rocks of the British Islands are rich in Blastoid forms, which are also to be found in Belgium, and were well developed in the sub-Carboniferous rocks of North America. No Blastoid is common to America and Europe, and in Europe the range of specific forms is very limited, though one species is found common to the Devonian of Spain and Germany, and one to the Carboniferous rocks of Britain and Belgium.

A most useful stratigraphical list of all known species, arranged geographically, is given, and then follows the descriptions of the species, to which it is not needful to allude further than to state that the greatest care has been taken, not only with the diagnoses, but with the synonyms and the distribution. A copious index and twenty beautifully executed plates complete the volume. Some sixteen of the plates were drawn on stone by the aid of a grant from the Government Grant Fund of the Royal Society, and, with the approval of the Council, and certainly to the advancement of science, were transferred to the Trustees of the British Museum, by whose order this "Catalogue" has been published.

TEA-PLANTING IN CEYLON

The Tea-Planter's Manual. By T. C. Owen. Pp. 162, with Coloured Lithographed Plates of an Iron and a Wood and Stone Tea Factory drawn to scale. (Colombo, Ceylon: A. M. and J. Ferguson, 1886.)

EIGHT years ago, on account of the depression in the coffee industry of Ceylon, the prospects of the colony were of a sufficiently gloomy character. A great improvement has, however, been effected by the partial substitution of tea and cinchona for coffee, and by the general attention given to cacao, cardamoms, and other subsidiary subjects. Ceylon has also been fortunate in possessing a practical scientific institution in the Botanical Gardens of the colony; and its local press is enterprising and well-informed.

It is well to mention here that the excellent growth made by tea plants at the Peridenlya and Hakgala Gardens fully justified the advocacy of tea-planting in Ceylon by the late Dr. Thwaites in his Annual Reports, while it is also due to the Colonial Office to state that through Lord Blachford it warmly supported the introduction of Assam tea plants into Ceylon in 1867. In 1877 Ceylon tea in commercial samples was submitted, through the Royal Gardens, Kew, to the Indian Committee of the Society of Arts, and the Report of this Committee clearly foreshadowed the high place which Ceylon tea has since taken in the London market.

The present manual is one of a series issued by the *Ceylon Observer* press, and is intended to be a complete hand-book to all the multifarious duties of a successful tea-planter. Colonel Money's "Essay," and the "Tea-Planter's Vade Mecum" both publications having special reference to the circumstances of Indian gardens, have hitherto been the only books on the subject.

As stated in the preface, Mr. Owen's manual "is more a compilation of the opinions of others and the results they have arrived at than an original work." The very valuable notes of one of the earliest and most successful of Ceylon tea-planters, Mr. Armstrong, of Rookwood, form an important portion of the book. The compiler wisely avoids an extended disquisition on the original home of the tea plant and on the question whether the "Assam tea tree" and the "China bush" are specifically distinct. In the latest works on the subject they are both included under *Camellia theifera*, Griff. There is no doubt that the Assam tea tree—for in a wild state it often reaches 40 to 50 feet in height—is indigenous to the mountainous district lying between South-Western China and the River Brahmaputra. It is probable also, although not clearly proved, that the China tea plant—of a somewhat shrubby habit—is derived from the same stock; although, as we now know, it was greatly altered by persistent cultivation for several centuries in a soil and climate different from those of its original home. The China tea plant has been found wild in no part of China. Under cultivation in Ceylon the Assam variety is suited to the plains, a hybrid form is sought for mid-elevations, while the China variety is useful only for the highest elevations up to 6000 and 7000 feet. Mr. Owen recommends that for all new plantations the best "jat" of Assam or hybrid plants should be obtained, as "no amount of care or skill will make up for a bad class of plant put into the garden at the outset." To a beginner in Ceylon, or to a planter in any other country, unacquainted with the particular methods pursued on Ceylon estates, the book would prove at first somewhat perplexing. Too much knowledge is assumed on the part of the reader as regards the important questions involved in the selection of land, while as regards the details of cultivation the particular "fads" and "fancies" of individual planters are too largely dwelt upon. It would have been more to the purpose to present a clear and simple statement of the first principles upon which the growth and culture of the tea plant, as a plant, should be based, in order to produce the best results. As regards the details of the manufacture of tea, quoting authorities is no doubt the best course, for the process of manufacture consists of a series of purely empirical operations, and a statement of principles alone would not meet the case. After discussing selection of land (Chap. I.), varieties of the tea plant (Chap. II.), seed and nurseries (Chap. III.), lining, holing, and planting (Chap. IV.), field cultivation (Chap. V.), topping and pruning (Chap. VI.), plucking (Chap. VII.), and manufacture (Chap. VIII.), the writer devotes the remainder of the book to buildings and machinery (with plans), and to statistical returns connected with yield and cost of production.

The rapid progress made by the tea industry in Ceylon is exemplified by the fact that, while in 1878 only 282 pounds of tea were exported, during the past year (1886) the exports reached over 7,000,000 pounds. The probable exports in 1887 are placed at 12,000,000 pounds, while in 1888 they are expected to reach 30,000,000 pounds. So far, the price of Ceylon tea has maintained a slight advantage over Indian teas—the average price during 1885 being 1*s.* 3½*d.* per pound for Ceylon tea, as against 1*s* 1½*d.* for Indian teas. The combined effect of large shipments of Indian and Ceylon teas will no doubt lead in time to a displacement of much that now comes from China. And while the general character of tea obtainable in European markets will improve, there obviously must come a fall in prices for which both Indian and Ceylon tea-planters must be fully prepared. At the Colonial and Indian Exhibition, thanks to the energy of Mr. J. L. Shand, Ceylon tea was admirably brought before the English public. Tea from Natal, Fiji, and a small sample from Jamaica were also shown; but the tea from Fiji possessed such special qualities that we shall probably hear more of this promising article.

To return to the subject of this notice, the "Tea-Planter's Manual" is a useful summary of the knowledge gained respecting tea-planting in Ceylon, and it embodies much valuable information for the use of practical planters. What fault there is to be found is not with the book itself, but with the system of cultivation it inculcates—a system which unfortunately appears to be adopted in the treatment of most tropical economic plants by European planters. These plants are treated too purely as so many "rupee-making" machines. Too little attention is given to the characteristics and habits of the plants as living subjects, and too much to the details of an unsympathetic and essentially artificial system, already proved in Ceylon to be unsuited to the coffee plant, but into which there is now a strong tendency to force the

tea plant. As there are diversities of soils and climates, so there are also diversities of industrial plants exactly suited to them. Where all such considerations are ignored, there is danger both to the plants and the planter; and this danger ought in the present case to be avoided. D. M.

GEOMETRY

The Elements of Euclid. Books I.-VI. and part of Books XI. and XII. By H. Deighton. (Cambridge: Deighton, Bell, and Co., 1886.)

Euclid Revised. Book I. with Additional Propositions and Exercises. Edited by R. C. J. Nixon. (Oxford: Clarendon Press, 1886.)

Euclid Revised. Books I. and II. (Same Editor and Publishers.)

First Lessons in Geometry, for the Use of Technical, Middle, and High Schools. By B. Hanumanta Rau. (Madras: Addison and Co., 1885.)

The Origins of Geometry. By Horace Lamb, F.R.S. (Manchester: Cornish, 1886.)

THE author of the first of these books attempts to "give a translation of the Greek text of a somewhat more modern form than the mere verbal ones [what does he mean?] in general use; and, whilst strictly adhering to Euclid's methods, to render his reasoning as clearly and concisely as possible." Hence our presentment of the title-page is supplemented in the original work by the words "newly translated from the Greek text with supplementary propositions, chapters on modern geometry, and numerous exercises." It will be evident that this is Euclid pure and, as far as the author is able to render it, unadulterated; there is no *revision* here such as Mr. Nixon provides for the reader. Mr. Deighton has, however, studied the "Syllabus" (of the A.I.G.T.) and has here and there introduced, with fitting acknowledgment, extracts from it. Further, the author is evidently actuated by the same motives as those which lead the Association to attach so much weight to the solution of geometrical problems as evidence of a student's grasp of the text. A strong feature is the large number of exercises (1419 in all, besides worked out examples), especially of an elementary character, in close proximity to the propositions upon which their solution depends. At the end of the first book are given the enunciations of several propositions which certainly should be mastered by anyone who wishes to gain a sound acquaintance with elementary geometry. Following, it may be, the example of other recent text-books, an excellent collection of the most important propositions on the radical axis, poles and polars, harmonic proportion and centres of similitude are given; there is also a chapter on transversals. The selection of exercises is not confined to Cambridge papers, but levies have been made on the well-known works of Catalan, Rouché, de Comberousse, and Spieker. There are also remarks on plane loci and on the solution of geometrical questions. The letterpress is clear, and the figures are in the main distinctly and carefully drawn, but several monstrosities appear in the third book, as of old, and the drawings on pp. 115, 153, 186 are incorrect as to relative measurements. Perhaps when Mr. Nixon has examined the present book he will modify a statement in his preface (p. vii., we refer to the work reviewed in these columns, vol. xxxiv. p. 50, by R. B. H.) to the effect that "there does not exist a modern edition which gives *Euclid pure and simple*."

The second and third books are the corresponding portions of the larger work referred to above, reprinted page for page, with the addition of an appendix, in which are given proofs of omitted propositions, and also of i. 5 and of i. 8 as a deduction from i. 7. "This addition is made at the request of several teachers. It is of course a concession to the omnipotent examiner; and, as such, is made with much reluctance." One can only regret that a writer who has taken up so advanced a position should have yielded on this point.

The fourth book is interesting as giving evidence of how a modern movement has taken hold of able mathematical teachers of the mild Hindoo. Mr. Rau candidly repudiates all claim to originality for his matter, as in its compilation he has consulted the best English and French text-books both for pure as well as for practical geometry. "If 'Euclid's Elements' is unsuited for beginners who study it in their own native tongue, how much more so should it be in this country, where it is taught in classes consisting generally of lads between ten and twelve, before they have had time to master the difficulties of a foreign language, and before too, I may add, they can benefit by its rigorous logic. The result, as may be anticipated, has been highly prejudicial to the study of geometry and of mathematics in general. With a view, if possible, to remedy the evil, of which I had become painfully conscious in the course of my several years' experience as a mathematical teacher in schools and colleges, I had long been anxious to attempt a departure from the established route." The work consists of the notes he drew up for the pupil-teachers and students under his charge. "My success in the experiment is my justification for publishing this little volume." The figures are roughly drawn, and the cover is a paper one, but the contents are carefully arranged, and furnish a very fair amount of geometrical information for the class aimed at all the propositions being looked at with an eye to their practical utility. Such a class should know how to hold an object "in an oblique position, not permitting it to retrograde to the perpendicular."

"The Origins of Geometry" is an address delivered at the opening of the Owens College session, October 5, 1886. The Professor of Mathematics casts "a rapid glance over the early history of our science, more especially of that branch of it which was first cultivated with success, geometry." Taking Hankel as his guide, he glances rapidly at matters of which Dr. Allman has treated in much fuller detail; he then treats of what has proved "the most formidable obstacle to the further progress of Greek mathematics, the divorce between geometry on the one hand, and arithmetic and algebra on the other. This had its origin in the discovery of incommensurable magnitudes by Pythagoras and his successors." He, by the way, notes that "the greatest advances in mathematics have been made by men whose interest in the subject was of a speculative kind." The address winds up with the question, "What is likely to be the relation of mathematics to the science of the future?" Prof. Lamb

answers this question only as regards physical science, and his answer is "contained in that to another question, What is the object of the physical sciences?" The whole concludes with words of the late Prof. H. Smith on the function of mathematics in education.

ACOUSTICS

Hand-book of Acoustics. By T. E. Harris, B.Sc., Lecturer on Acoustics at the Tonic Sol-fa College. (London: J. Curwen and Sons.)

A FEW years ago some wiseacre had the temerity to propound the idea that the scientific and historical data on which music is founded have no bearing on music itself, and need form no part of the knowledge to be acquired by a musician. It is quite true that a man may get through life very comfortably as a singer, a fiddler, or a pianoforte-player, without ever having heard of sound-waves or of the Greek modes; but as regards a knowledge of music in a higher sense the idea is absurdly untrue. The moment we approach the *theory* of music we find the scientific and historical elements confront us at every step, and all attempts to form an intelligible explanation of musical structure without reference to them have been, and must be, failures. In fact, no rational theory of music can exist unless founded on such a basis. This fact is now pretty generally acknowledged by those who have to do with musical education. All examining bodies of any weight require an acquaintance with the data referred to, and all well-constituted courses of teaching include them.

The book now before us is a remarkable instance of this. The Tonic Sol-fa movement is what we may call ultra-practical: its supporters aim at teaching music to the great masses of the people, and their system is purposely contrived to facilitate its practical acquirement, and to bring it down to the proverbial "meanest capacity." Yet the Tonic Sol-fa authorities think it right to have a Lecturer on Acoustics, and to publish a hand-book of the science for the use of their millions of pupils. This is certainly about the severest reproof that could be given to the foolish "practical" notion that would exclude intellectual topics from musical study.

There is not much to say about the book itself. It is an unpretending compilation of the most important facts of the science, gathered from various authentic sources, intelligently stated, and without any crotchetiness or affectation of originality. The peculiar feature, of course, is that the musical illustrations are, wherever possible, given in the Tonic Sol-fa notation. Perhaps, in the 286 closely-printed pages, there is more elaboration of detail than the students may care for; but this is to a certain extent counterbalanced by a condensed summary being added at the end of each chapter.

It would have been an advantage if more copious and complete references had been given to other and more original works, from which the matter has been taken. It is, or should be, one of the most important objects of a "hand"-book to enable students, if they desire it, to put more complete treatises on their study-table. There is no date either on the title or in the preface—a very bad habit of music publishers.

OUR BOOK SHELF

Old or New Chemistry: Which is Fittest for Survival? By Samuel Phillips, F.C.S. (London: Wertheimer, Lea, & Co., 1886.)

THIS small book is a collection of essays more or less bearing on the subject indicated by the title, and may perhaps be also described as a sort of protest against a grievance. The elevating and spurring effect of the possession of a grievance is well known, and it must be admitted that in this case it has, apparently at least, contributed to the production of a very entertaining little book, which will no doubt, as it is intended, "wake up" chemists generally to a clear perception of their absurd and useless theories of chemical constitution.

It is, however, doubtful whether the book will [illegible] do anything to forward the science of which the author professes to be such an ardent lover. As to Avogadro's law and the laws known as Dulong and Pettit's, however scanty a basis they may have in experimental facts, they have been useful, and will be until they are supplanted by wider-reaching theories. It is exactly here that the author seems to be too conservative. We not only want more facts—as many facts as we can get—but we want theories as well, if they will only again lead to new facts. And, moreover, what is wanted in this country is for chemists to *work*. There is no lack of problems waiting to be solved.

What we do not want is any further multiplication of "fads." Nothing is gained by writing "Ph" for C_6H_5, and the "equivalent symbol" for "etholo-aceto-acetic acid," viz.,

$$\left.\begin{matrix}432\\432\\45\end{matrix}\right\}1294, O.HO,$$

at page 19, is no advance but retrogression.

Lectures and Essays. By the late W. K. Clifford, F.R.S. Edited by Leslie Stephen and Frederick Pollock. With an Introduction by F. Pollock. Second Edition. (London: Macmillan and Co., 1886.)

THIS collection of lectures and essays is already so well known that it is now necessary only to note the fact that a second edition has appeared. Two essays have been omitted as being rather mathematical than philosophical, namely, those on "Types of Compound Statement" and on "Instruments used in Measurement." They have found a more fitting place in the volume of "Mathematical Papers" published in 1882. The admirable biographical Introduction by Mr. Pollock has been revised, and some additions and omissions have been made in the extracts there given.

Lives of the Electricians. By William T. Jeans. (London: Whitaker and Co., 1886.)

AN extremely well-compiled and interesting book; but why did the author commence with the life of a living professor, who is not an electrician? Faraday, as the brightest electrical light of this or any other age, should have headed the series. The author has a rich store of names to draw upon—Gilbert, Coulomb, Arago, Snow Harris, Franklin, Cavendish, Galvani, Volta, Henry Davy, Ronalds, Oersted, Ampère, De la Rive, Ohm, Schilling, Gauss, Weber, Daniell, Crosse, Steinheil—without trenching on living celebrities. The work is very impartially written. The life of Morse might have been written by an enthusiastic American, while Wheatstone's friends cannot complain of the eulogy of their hero.

Some statements want revision. The inauguration of the cable system can scarcely be fairly narrated without mention of Messrs. Crampton and Wollaston. Varley's long artificial cable and great experiment shown at the Royal Institution are accredited to Prof. Tyndall (p. 95). The statement attributed to Sir Robert Inglis (p. 285)

that in 1847 England was behind America must surely be wrong. The Electric Telegraph Company in England was then in full swing.

As this is the jubilee year of the telegraph in England, it is well to be reminded that Cooke and Wheatstone made their first practical and successful trial on July 25, 1837, between Euston and Camden, while Morse did not file his *caveat* (*i.e.* did not apply for his patent) until October 5 of the same year.

We wish the book every success, and shall be glad to see further instalments.

LETTERS TO THE EDITOR

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.

[The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.]

Normal School of Science and Royal School of Mines

I AM directed to request that you will be so good as to allow me to state, through the medium of your columns, that the number of applications for admission to the Normal School of Science and Royal School of Mines at South Kensington, at the commencement of the present session, having been considerably in excess of the accommodation which the School can afford, it has become necessary to adopt some process of selection for the future. Hereafter, applications for admission should be sent to the Registrar of the School before the end of May, accompanied by a statement of the studies which the applicant has already pursued, the examinations he has passed, and the name of a teacher (or teachers) to whom reference may be made. Such applications will be considered by the Dean and Council of the School, who will decide on them according to their merits. A knowledge of elementary mathematics, such as is required of all Royal Exhibitioners and national scholars, will be held to be of the first importance for those who desire admission to the course for the Associateship of the School; while for occasional students, who propose only to take up certain specific branches of science, some preliminary knowledge of them will have weight. J. F. D. DONNELLY

Science and Art Department, January 14

The Cambridge Cholera Fungus

THE letter published by Dr. Klein in your issue of December 23 (p. 171) having incidentally referred to my views as to the nature of the fungus present in choleraic tissue, I should be glad to be allowed to make some further remarks upon the subject.

At an early stage of his investigation Prof. Roy brought for my inspection one of his preparations of intestinal mucous membrane, which clearly demonstrated the presence of certain foreign organisms, and especially drew my attention to a form which he took to be the more usual and typical one. Such a structure might perhaps best be described as consisting of a thin and somewhat moniliform filament which at one end exhibited a distinct nodular swelling. Being struck with a certain (and, as I now fear, a somewhat superficial) morphological resemblance to a group of the Chytridiaceæ, I suggested that the organism might possibly be a Chytridium, and this view was perhaps too confidently adopted by Messrs. Roy and Sherrington in their paper. The appearance of Dr. Klein's letter has naturally led me to carefully reconsider the whole question, and on further consideration I entirely abandon the idea of the organism being a Chytridium. I believe, on the contrary, that it is a Bacterium, and that the structure described by Prof. Roy and seen by myself is that particular phase in the life-history of the Bacterium which is known as an involution form. Such forms are described, for instance, in Zopf's article "Die Spaltpilze," in Schenk's "Encyclopædie der Naturwissenschaften," as *Bacterium aceti* and *Bacterium zooogenum*. Indeed, the involution form assumed by the latter Bacterium recalls very vividly to my mind the structure shown to me by Prof. Roy.

In conclusion, I may assure Dr. Klein that the fungus is certainly neither a Penicillum nor of the nature of a mould, and that I do not believe it is in any way associated with *post-mortem* change. WALTER GARDINER

Royal Gardens, Kew, January 11

Snowstorm of January 7, 1887

A MOST extraordinary snowstorm occurred here to-day (January 7). In fifty years' experience I have seen nothing like it, nor has anyone else in this neighbourhood seen any similar phenomenon. It would be impossible to realise the gigantic size of the snowflakes without seeing them. I can only compare them to a fall of oranges, though the diameter of an orange would be small in comparison with thousands of these snowflakes; in this immediate neighbourhood (*i.e.* within sight of the place of observation) at 50 yards off it produced a dense snow-wall. The wind was south, and almost calm, and the largest snow came down nearly perpendicularly. The temperature was 32°·6, and the air completely saturated with moisture. Before the storm the temperature was 34°·1. Snow had been falling with a slight thaw from 10 a.m., the snowflakes being small. Suddenly, at 12h. 12m. p.m. they became 2½ inches in length;[1] at 12h. 14m. they had increased to 2¾ inches; and one flake that was caught measured 2¾ inches by 2½ inches, and was $\frac{1}{16}$ of an inch thick. At 12h. 16m. the flakes had increased in size to 3½ inches (and several measured were 4 inches across, and there were several larger ones not near enough to be caught); at 12h. 19m. they were somewhat less, and at 12h. 20m. though large, were not gigantic. Fortunately I was measuring and weighing snow at the time, with two assistants, and had a number of flat circular glasses kept cold ready for the purpose of catching crystals, and for measuring the snow that fell upon these glasses. As is usual when very large flakes are falling, there were many of smaller size, though when the flakes were from 2½ to 3½ inches, the majority of the next size were about 2 inches, and the very large flakes would be within 12 inches of each other. A dozen of these large flakes were caught, each on a separate piece of glass, measured and removed under cover, my two assistants giving valuable aid. Of three of these flakes one yielded 14 drops of water, a second 15, and a third 16 drops; and these were not the largest flakes seen.[2] The water from seven flakes weighed a quarter of an ounce within 2 or 3 grains. The weight of ten varied from 13 to 16 grains each; most of the flakes were about a third longer than broad, one flake that was 3½ inches long by 2½ broad was estimated (before it touched the glass) to be 1½ inch thick, when flattened by the force of its descent it was ¼ of an inch thick.

The flakes were not a mass of broken pieces, but were composed mainly of perfect crystals, and there must have been hundreds of these crystals in each flake; they were clinging together at every conceivable angle, though a much larger percentage were more horizontal than vertical. A terrestrial radiation thermometer, buried a fifth of an inch within this snow, marked a temperature of 32°·4.

The snow which fell during the last six minutes of this great storm was just under one-fifth of an inch in depth, and yielded ·030 of an inch of water, falling at the rate of 1 inch of water in three hours and twenty minutes (yielding 1 inch of water from 6 inches of snow).

There was a great snowstorm here on December 27, 1886, which varied considerably in places near to each other, *i.e.*—

	Amount of rain and snow	Depth of snow Inches	Melted snow alone
Shirenewton Hall ...	1·55	7	0·97
Dennil Hill	1·07	5	0·71
Wirewoods Green ...	0·86	3	0·42
Piercefield Park ...	0·96	4	—
Chepstow (The Mount)	0·70	—	—

The drifts above here are very great, and a large number of men are still engaged in cutting through them.

The following measurements will show the number of inches

[1] The breadth was less than the length, and the thickness less than the breadth; more or less flattened, and curled over on the edges.

[2] Besides these drops, the wetted glass shall count for two more drops.

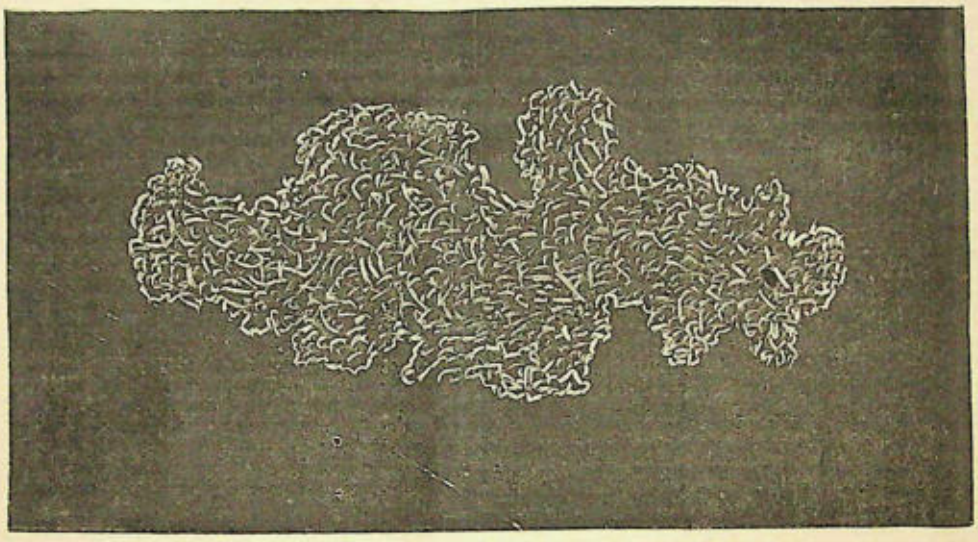
of snow required to yield an inch of water from observations taken here :—

1886, January 23, snow 2 inches, melted ·063 (*i.e.* 33 inches for 1 inch of water); March 1, snow 7 inches, melted ·800 (*i.e.* 9 inches for 1 inch of water); December 26, snow 7 inches, melted ·967 (*i.e.* 7 inches for 1 inch of water). 1887, January 4, snow 3¼ inches, melted ·379 (*i.e.* 8½ inches for 1 inch of water); January 7, ½ inch, melted ·030 (*i.e.* 6 inches for 1 inch of water).

The damage done on December 26 was unusually great, the snow being very heavy, as much as 5 lbs. weight on a square foot of a cedar-branch; this, when moved by the wind, caused much breakage.

January 8.—Since sending my note yesterday I find that at Chepstow and at Itton the snowflakes were larger than anyone had before seen, so that probably the storm had an extended area; at all events it was 5 miles broad.

The present storm is a very similar one to that recorded by myself in January 1838, except that the largest flakes in 1838 did not exceed 2 inches. In that storm the largest flakes fell more rapidly and more perpendicularly. I then pointed out that large snowflakes were produced by two upper currents driving the flakes together; and afterwards, by the largest falling with increased velocity and more perpendicularly: they were thus able still more to augment their dimensions by adding smaller ones to their bulk. This was well seen on January 7, when an estimate was made as to the velocity and angle of their descent. Not only were a number seen to be added as they fell upon them, but it was thought that small flakes when near to the large ones were attracted to them. The flakes were, however, large whilst at a considerable distance from the ground.



Shape and size of snowflake. (There were more of a somewhat similar form to this than the more circular ones, though there were very many more circular and less indented.)

Several flakes were sketched before they began to melt, and one of the sketches is sent as an illustration. The glasses were at a temperature of freezing, and therefore it was some time before the snow melted, and not thoroughly so until they had been 5 minutes in a hot-house.

January 13.—The snowflakes folded over on the edges, boat-like, and this curling over caused the thick look observed. There was a slight zigzag in their downward course of some 2° or 3°. This storm passed over Chepstow, Itton, and Monmouth in this county; Wirewoods Green, Tidenham, and Dennil Hill, all in Gloucestershire, and Bath: in all of these places the flakes are spoken of as the largest ever seen. One correspondent at Chepstow reports them as larger than the hailstones in the storm of May 1848, which were larger than hens' eggs, and broke the shop windows, and destroyed the glass of hot-houses near Chepstow.

E. J. LOWE

Shirenewton Hall, near Chepstow

Auroras

THE account, in NATURE for December 16 (p. 159), of a bright cloud "emitting brilliant rays of light," that suddenly appeared at Hamar, in Norway, on the night of November 3, recalls the fact that on November 2 there was at Lyons, New York, an aurora which at one time during the evening consisted entirely of detached luminous clouds, as was noted in NATURE for November 18 (p. 54). It is stated that on November 4 one of the finest auroras of the year was visible at Throndhjem, Norway.

M. A. VEEDER

Lyons, N.Y., January 3

A Solar Halo

IN the weather report issued on Friday evening, the 14th inst., a solar halo is recorded as "observed in Jersey during the day." Between noon and 12.30 I observed a very complete and well-defined halo, of radius about π/8, in this neighbourhood. It was not perceptibly tinted, but the duskiness of the interior, as compared with the clear sky exterior to the luminous ring, was more pronounced than I ever remember to have noticed it on other occasions—so much as to suggest comparison with the "curtain" of the aurora: "Solem quis dicere falsum audeat!"

J. J. WALKER

Hampstead, N.W., January 15

THE NATIONAL SCIENCE COLLECTIONS[1]

II.

25. REVERTING to this country, the "Patent Museum," now under the charge of the Science and Art Department, is a collection of a peculiar nature; and in order to explain its origin, and the objects it was intended to serve, we may make some extracts from the Report of a Select Committee of the House of Commons, appointed in 1864, to inquire as to the most suitable arrangements to be made respecting the Patent Office, Library, and Museum. The Committee said:—

The second point to which your Committee directed their attention was that of the Patent Museum, having regard especially to its formation, its present state, its relation to the Patent Office and Library, and the nature of its contents, so as to render it practically useful.

Your Committee found that the Patent Museum was formed by Mr. Woodcroft, the Superintendent of Specifications, by the request of the Commissioners of Patents, and that it consists of models and machines belonging partly to the Commissioners of Patents, partly to the Commissioners of the Exhibition of 1851, and partly to Mr. Woodcroft himself, and various private persons.

[1] Continued from p. 254.

This collection has been exhibited since 1857 in the iron building at South Kensington.

Your Committee are of opinion that the term Patent Museum (which is generally applied to this collection) tends to give an erroneous impression as to its character and object.

Various suggestions have been made by witnesses respecting the nature of a Museum connected with the mechanical arts, which may be summed up as follows:—

(*a*) That it should illustrate the history of those arts by a collection of original machines from an early period to the present time.

(*b*) That it should exhibit all known inventions respecting machinery and manufactures.

(*c*) That it should show the present state of all machinery and manufactures.

(*d*) Some of the witnesses suggested that the collection should be restricted to the machinery and manufactures of the United Kingdom; whilst others proposed that it should be extended to those of foreign countries.

(*e*) Some, again, proposed that the collection should contain all the objects of each class, whilst others proposed that a selection only of the most important objects should be exhibited.

(*f*) There was no less diversity of opinion respecting the primary purpose for which any collection or exhibition should be made; some of the witnesses considered that it should be for the purpose of conveying instruction in the mechanical arts, either in a cursory way to people who might visit the Museum, or to students in mechanics, or to persons desirous of applying themselves to the discovery of improvements in machinery and manufactures.

(*g*) Other witnesses deemed the Museum chiefly desirable for the information of persons intending to take out or purchase patents, in aid of the information afforded by books and specifications, to assist them in ascertaining whether the contemplated patent would be valid as a new invention.

(*h*) On the other hand, two witnesses, Mr. Carpmael and Mr. Johnson, gave it as their opinion that for all purposes of the patent law a museum of models would be practically valueless.

Your Committee are of opinion that any special collection of patented inventions made for the purpose of evidence, illustration, or record of patent rights is not so connected with a general museum of mechanical inventions as to render the neighbourhood of such a museum to a patent office and library, or law courts, necessary.

It appears to your Committee that the chief purpose of a general museum is to illustrate and explain the commencement, progress, and present position of the most important branches of mechanical invention; to show the chief steps by which the most remarkable machines have reached their present degree of excellence; to convey interesting and useful information, and to stimulate invention.

In forming an illustrative collection of inventions it would be necessary to adopt the principle of selection. This, however, does not appear to your Committee to be an insuperable objection, especially as no one proposed to substitute models for specifications, which for all the purposes of administering the patent law would still have to be consulted, and bear the stamp of authority.

Such a collection should contain a selection of models of moderate size, which should illustrate different departments of inventions, and also a selection of models of current patented inventions.

The Patent Collection, although it was placed in premises belonging to the South Kensington Museum, remained in the hands of the Commissioners of Patents until January 1, 1884, when, by the "Patents, Designs, and Trade Marks Act, 1883," 46 and 47 Vict. c. 57, it was transferred to the Science and Art Department.

The title "Patent Museum" was never accurate; the collection might with greater propriety have been called the "Woodcroft Museum," from the name of the gentleman, formerly Clerk to the Commissioners of Patents, who originated the formation of it. It contains objects illustrating steps in the history of mechanical inventions, and contrivances of importance and interest, without regard to whether they have been patented or not. Among these, for example, are the earliest locomotive and stationary steam-engines; the first engine used in steam navigation; the first reaping-machine; Arkwright's original spinning-machinery; all Sir Charles Wheatstone's original apparatus, showing a complete history of the various steps by which he perfected electric telegraphy; many of Edison's original electrical inventions; some old clocks dating from 1325; and other objects of similar interest.

Inventions embodied in future patents may be added to this Museum, pursuant to Sections 41 and 42 of the Patent Act above mentioned. These sections enact as follows:—

(41) The control and management of the existing Patent Museum and its contents shall, from and after the commencement of this Act, be transferred to, and vested in, the Department of Science and Art, subject to such directions as Her Majesty in Council may see fit to give.

(42) The Department of Science and Art may at any time require a patentee to furnish them with a model of his invention, on payment to the patentee of the cost of the manufacture of the model; the amount to be settled in case of dispute by the Board of Trade.

We do not consider it to be feasible to combine a complete museum of patented inventions with a methodical collection of objects illustrating practical science, and we infer from the language of Parliament in the provisions just quoted that this is the view taken in the recent Patent Act, which enables, but does not oblige, the Department of Science and Art to acquire specimens of patented inventions.

26. We conceive that it will be useful for the curators of all the collections to bear in mind that their primary and indispensable scope is to provide apparatus and specimens for the instruction given in the Normal College of Science, and for the teaching of science generally throughout the United Kingdom.

Cases may doubtless arise where the acquisition or reception of other objects may be expedient, in the interest of science or of the arts; but in these cases, in order to prevent the unnecessary occupation of space, we recommend that due regard be had to existing public collections elsewhere, so as not unnecessarily to duplicate the provision for illustrating science.

27. Referring now to the space required, we adopt the following figures given by the Reports of the different Committees, adding some estimates for the future where they have not been stated:—

	Space now required	Estimated increase of space required in ten years	Space required at the end of ten years
	Sq. ft.	Sq. ft.	Sq. ft.
Various science collections	37,000	3,000	40,000
Naval models	10,500	10,000	20,500
Building construction	15,000	10,000	25,000
Fish culture	5,000	1,000	6,000
Educational collection and library	7,500	1,000	8,500
Mechanical collections...	45,000	15,000	60,000
	120,000	40,000	160,000

In framing their estimates, the Committees generally took, as the basis of their computation, top-lighted galleries 30 feet wide, which afford a large amount of well-

lighted wall-space in proportion to floor-area. But with galleries side-lighted, in which some part of the collections must necessarily be housed, an increase of floor-area will be required.

28. In adopting these estimates, we think an indefinite series of demands for accommodation, involving an indefinite extension of space, ought not to be contemplated. The pleas commonly put forward for such extension at the close of every Exhibition are the number of articles which are either offered as gifts or are said to merit acquisition. We think that merit alone should be the ground of admission, and that even this ground must be subject, in the first place, to the consideration of space, and next, to that of scientific arrangement. If space is to be in any degree limited, and scientific arrangement to be maintained, it is evident that exclusion and depletion, as well as completion, must be kept in view; and that while the Department of Science and Art is left all possible freedom in determining what the contents of its collections shall be, it should be strictly confined to the area which is represented to be sufficient for the future.

In the due appropriation of this area we do not consider that, as a rule, and except in cases of historic interest, engines and machines of the original size should be acquired, or even accepted on terms implying that they will continue to be exhibited otherwise than in models.

29. Comparing now the estimates of space required with the area at present available, we find as follows:—

The total available floor-space in the present buildings, assuming the Western Gallery, D, to be given up, and the building E to be abolished, is 51,500 square feet.

This is 17,480 feet less than the collections at present occupy, and less than half what the Committees estimate for them when fairly completed.

It is clear, therefore, that new buildings are absolutely required.

Provisions for Housing the Collections

30. The second duty confided to us is:—

To suggest plans for housing the collections in the existing galleries to the south of the Horticultural Gardens, or in new galleries to be built upon their site, and the adjacent ground now the property of the Government.

31. In considering this matter, we have had the valuable assistance of Mr. Taylor, the Surveyor to Her Majesty's Office of Works, who has, in accordance with our suggestions, carefully examined the existing buildings, and prepared sketch-plans and estimates to meet the circumstances of the case.

32. We have already referred to the land available. It is shown on the Drawing No. I., marked G, and coloured red, and it consists of a plot of ground to the south of the South Galleries A, B, C, containing 4 acres and 23 square yards.

This land, as well as the site and ground of the Natural History Museum to the south of it, was purchased by the Government, in 1864, from the Commissioners of the Exhibition of 1851, and the particulars of the transaction are fully set forth in the Fifth Report of the Commissioners, dated August 15, 1867.

33. In this Report (p. 31) the Commissioners say:—

"We have set forth in detail all the circumstances connected with the sale by us to Her Majesty's Government of the site of the Exhibition of 1862, with the sanction of Parliament, and under the special condition that the site in question shall be permanently devoted to purposes connected with Science or the Arts."

This condition is fully and strongly carried into effect in the deed of conveyance, which is published as an Appendix to the same Report; so that the appropriation of this land for the erection of a Science Museum is in strict compliance with the conditions of its acquisition.

34. The buildings forming the southern range A', A, C, B, B', although not of first-rate character, will yet last in good order for many years to come, as will also the Western Gallery D.

We are, however, of opinion that a plan should be prepared to include the eventual reconstruction of the whole southern range.

But it should be a plan capable of being carried out by degrees, as and when necessity demands.

35. Drawing No. II. shows a ground plan of a design which fulfils these conditions.

It provides for two three-storied buildings of ornamental elevation, forming frontages (with returns) to Exhibition Road on the east, and to Queen's Gate on the west; and for plain two-storied buildings adjacent to these east and west frontages. These buildings, together with the existing southern buildings (A, B, C) will afford the required space until the latter become unserviceable, and permanent structures have to be erected on their site.

These buildings would give room for the collections, with the necessary offices, for the Portrait Gallery, and, if desirable, for examination-rooms.

Measures Recommended

36. The measures we recommend are as follows:—

Section I.—*Alteration of Arrangements in the existing Galleries*

(*a*) Remove the collection from the upper floor of the Western Gallery, D, and place it temporarily on the lower floor of the same building, and in A, B, or C.

(*b*) Remove the Portrait Gallery into the upper floor of the Western Gallery, D; this floor has been used during former Exhibitions as a Picture Gallery, and has given great satisfaction to the artists. This gallery, as it exists, is more secure against accidents by fire than the building in which the pictures are now placed, and can be rendered, at a moderate outlay, practically incombustible.

(*c*) Clear out the ground floor of the Western Gallery, D.

(*d*) Then use this ground floor for examination rooms. When this is done, the entire Western Gallery, D, will be occupied, and none of it will be further available for the collections.

(*e*) Make an opening through the wall which now shuts off the centre building, C, so as to give an approach from Exhibition Road to the western parts of the galleries, and thus do away with the unsightly gallery K.

(*f*) Proceed to arrange the rooms as they are set free.

(*g*) In addition to the access from Queen's Gate to the portrait gallery in D, afford access to it from Exhibition Road through the Science collections.

Section II.—*New Works to be undertaken*

37. The proposed new building is so designed that it may be carried out in separate portions progressively.

The portion to be first undertaken should be on the parts marked L and L', with the temporary entrances, all coloured yellow on the drawing No. II. These buildings may be completed in about eighteen months, and are estimated to cost about 43,520*l.*, which may be distributed over the financial years 1886-87, and 1887-88.

Before the end of 1887, also, the option must be exercised of purchasing the central building, C.

When the above-mentioned first portions of the new building are completed, they will add an available area of 28,700 square feet, which, with the areas already existing in the southern galleries, will make a total of 80,200 square feet.

This will provide, for the Science collections, about 11,000 feet more than they at present occupy, and it will admit of the Patent Museum being removed to the western side of Exhibition Road, and of the building E

glucine may be obtained with a loss of not more than 10 per cent., and in such a state of purity that its equivalent has been found equal to 12·58.—Influence of various diets on the interchange of the gases in respiration, by MM. Hanriot and Ch. Richet. Continuing their researches on the respiratory function, the authors find that respiration increases with the increase of food, but only when this consists of the hydrates of carbon; that the interchange of the gases is but slightly affected by a nitrogenous and fatty diet; that feculent substances increase the absorption of oxygen and especially the production of CO_2; that the centesimal proportions of the absorbed oxygen or of the generated carbonic acid varies little during muscular repose; that the proportion of absorbed oxygen averages about 4·2 per cent., and of generated CO_2 about 3·4 per cent. The subject is illustrated by a diagram showing by a graphic process the influence of a nitrogenous and feculent diet on the respiratory functions generally.—Discovery of a worked flint and a mammoth's tusk at Vitry-en Artois, by M. Ladrière. The position in which these remains were found seems to confirm the author's view that towards the close of the early Quaternary epoch (Mousterian age) *Elephas primigenius* and other large mammals, as well as man, were already spread over the west of Europe.

BERLIN.

Physical Society, January 20.—Prof. von Helmholtz, President, in the chair.—Prof. Oettingen spoke on the interference of electrical vibrations which is produced by the electrical oscillations discovered by Feddersen, during the spark discharge. The discharge oscillations of two Leyden batteries, differing in frequency and amplitude, were allowed to produce an interference in the path of a third spark, and this led to a constant succession of alternatingly increased and diminished intensities of this spark. The phenomenon was analyzed by means of a rotating mirror, which resolved it into its several phases, and the events taking place in each spark were recorded by instantaneous photography. The speaker exhibited a large number of these photographs, both as negatives and as positive reproductions, and explained them fully. In these experiments, as in those described at the previous meeting of the Society on the explosion of an electrolytic mixture of oxygen and hydrogen, Prof. Oettingen had succeeded in obtaining accurate results only when he had replaced the concave rotating mirror by a plane one, whose action he then thoroughly discussed.—Prof. Börnstein exhibited a preparation which he had recently obtained quite by chance, during one of his lectures. When lecturing on the diffusion of liquids, he was in the habit of using a Traube artificial cell. On placing a blue crystal of sulphate of copper in a solution of soluble glass, a precipitate is formed as a film on the surface of the salt, when it comes in contact with the soluble glass. The water from the solution then diffuses through the film, dissolving the salt and stretching the film until it is ruptured at some one point. When this occurs the solution of the sulphate of copper comes again into contact with the soluble glass, a new film is formed at the surface of contact, closing up the aperture, and the diffusion begins again. The film thus grows continually in a tubular form, until it finally permeates the whole solution. When recently repeating this lecture experiment, the speaker noticed that the film did not grow in the usual tubular way, but took the form of flattened parallel membranes which advanced through the solution at right angles to their length. He was at present unable to offer any explanation of this latter phenomenon.—Dr. Budde had recently submitted Clausius's fundamental law of electro-dynamics to a recalculation, while taking into account a large series of special conditions; among these he allowed for the motion of translation of the earth, and found that it had no influence on the validity of the law. At that time he had not calculated the influence of the earth's rotation; he had however, since then, repeated his former work, and gave an account of the results of his calculation, which showed that the rotatory motion of the earth had also no influence on the law. The same speaker finally drew attention to an error which occurs in all text-books, in connection with the determination of the potential of a system of points, and showed how illogical is the usual definition and of deducing of potential energy. Prof. von Helmholtz then directed attention to the fact that he was in the habit of determining potential energy in a different way, and that its derivation from a system of points is fraught with great difficulties.

BOOKS, PAMPHLETS, and SERIALS RECEIVED

Contributions to the Palæontology of Brazil: C. A. White (Washington). Die Entstehung der Arten, i Thiel: Dr. G. H. T. Eimer (Fischer, Jena).—Key to Todhunter's Differential Calculus: H. St. J. Hunter (Macmillan).—Annals of the Astronomical Observatory of Harvard College, vol. xiii. Part 2, Zone Observations made with the Transit Wedge Photometer (Wilson, Cambridge, Mass.).—Calendar and General Directory of the Department of Science and Art for the year 1888 (Eyre and Spottiswoode).—Electrical Instrument Making for Amateurs: S. R. Bottone (Whittaker).—Practical Education: C. G. Leland (Whittaker).—Volapük, or Universal Language: A. Kirchhoff (Sonnenschein).—Geology: Chemical, Physical, and Stratigraphical, vol. ii.: J. Prestwich (Clarendon Press).—Observations made during 1883 at the U.S. Naval Observatory (Washington).—Die Prähistorischen Denkmäler der Provinz Westpreussen und der Angrenzenden Gebiete: Dr. A. Lissauer (Williams and Norgate).—The Shell Collector's Hand-book for the Field: J. W. Williams (Roper and Drowley).—My Telescope: A Quekett Club Man (Roper and Drowley).—Through the Yang-tse Gorges: A. J. Little (Low).—Report on the Administration of the Meteorological Department of the Government of India in 1886-87.—Indian Meteorological Memoirs, vol. iii. Part 2 (Calcutta).—A Manual of the Geology of India; Part 4, Mineralogy: F. R. Mallet (Trübner).—Bulletin of the U.S. Geological Survey, No. 37 (Washington).—The Law of the Universe: G. W. Cleverley (Brown, Hull).—Quarterly Journal of the Geological Society, vol. 44, Part 1, No. 173 (Longmans).—Proceedings of the Linnean Society of New South Wales, 2nd series, vol. ii. Part 3 (Sydney).—List of Contributors to ditto, 1st series (Sydney).—Quarterly Journal of Microscopical Science, February (Churchill).—Journal of the Royal Microscopical Society, February (Williams and Norgate).

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Physical Society, January 28.—Prof. W. G. Adams, F.R.S., Vice-President, in the chair.—In opening the proceedings the Chairman referred to the great loss which the Society had sustained by the death of Dr. Balfour Stewart, their late President, and said that his loss would be deeply felt by the whole scientific world.—The following papers were read:—On the effect of magnetization on the thermo-electrical properties of bismuth, by Mr. Herbert Tomlinson.—On the influence of magnetism and temperature on the electrical resistance of bismuth and its alloys with lead and tin, by M. Ed. von Aubel.—On a water-dropping influence machine, by Prof. S. P. Thompson.—On the price of the factor of safety in lightning-rods, by the same. It is here shown, upon certain assumptions, that the safety against fusion varies as total cost $\times \frac{f s}{\rho d k^2 l}$, where f = temperature of fusion of material above atmosphere, s = specific thermal capacity, ρ = specific electric resistance, d = density, k = cost in pence per lb., and l = length of the conductor. If the total cost and length are supposed to be given, the factor of safety $= \frac{f s}{\rho d k^2}$. Of the common metals iron has the greatest factor of safety, being more than four times that of copper. Such being the case, the author thinks it desirable that the Report of the Lightning-Rod Conference be reconsidered.—On the optical demonstration of electrical stress, by Prof. A. W. Rücker, F.R.S., and Mr. C. V. Boys. A number of lecture experiments were shown illustrating that electrical stress exists in the dielectric separating two charged bodies. The bodies were placed in carbon bisulphide, between two crossed Nicols, and on electrifying them by means of a Holtz machine, light passed through the analyzer. Two concentric cylinders gave a black cross on the screen similar to those seen on interposing a plate of some uniaxial crystal, and a model illustrating a charged Leyden jar was shown.

February 11.—Annual General Meeting.—Dr. J. H. Gladstone, F.R.S., Vice-President, in the chair.—The Chairman read the Report of the Council for the past year, and expressed regret at the losses the Society had sustained by the deaths of Dr. Stewart (their late President), Prof. Kirchhoff, Mr. Coutts Trotter, and Prof. Humpidge. The Council regret that no increase of members has taken place during the past year, and hope that the advantages offered by the Society may be more fully appreciated in future. Obituary notices of Dr. B. Stewart, Mr. Coutts Trotter, and Prof. Humpidge were then read. The Treasurer's Report shows that the financial condition of the Society is very satisfactory. On the motion of Mr. Lant Carpenter, seconded by Mr. Inwards, the Reports were adopted.—The following gentlemen were elected members of Council for the present year:—President: Prof. A. W. Reinold, F.R.S. Vice Presidents: Dr. E. Atkinson, Prof. W. E. Ayrton, F.R.S., Mr. Shelford Bidwell, F.R.S. and Prof. H. McLeod, F.R.S. Secretaries: Mr. Walter Baily, and Prof. J. Perry, F.R.S. Treasurer: Prof. A. W. Rücker, F.R.S. Demonstrator and Librarians Mr. C. V. Boys. Other members of Council: Hon. R. Abercromby, R. H. M. Bosanquet, M.A., W. H. Coffin, Conrad W. Cooke, Prof. F. Fuller, W. N. Shaw, A. Stroh, Prof. S. P. Thompson, H. Tomlinson, G. M. Whipple. On taking the chair the new President expressed his sincere thanks for the great honour the Society had conferred upon him. Prof. Fuller proposed a vote of thanks to the Lords of Committee of Council on Education for the use of the rooms and apparatus of the Normal School of Science, which was seconded by Mr. Shaw, and passed unanimously. A cordial vote of thanks to the Council and officers of the past year, moved by Dr. Blaikley, and seconded by Prof. Ramsay, was duly acknowledged by the President. A similar vote, proposed by Mr. Bosanquet, and seconded by Mr. Hadden, to the auditors for the past year, was passed unanimously.—The meeting was then resolved into an ordinary science meeting, at which the following papers were read:—On the laws of refraction in relation to temperature and chemical composition, by Mr. T. Pelham Dale.—Note on the use of the "resistance" in the description of physical phenomena, by Mr. R. H. M. Bosanquet.

PARIS.

Academy of Sciences, February 13.—M. Janssen in the chair.—On an ancient process for rendering gems and vitrifications phosphorescent, by M. Berthelot. The treatise in which this process is described occurs in the collection of Greek alchemists transcribed in certain manuscripts of the thirteenth and fifteenth centuries (Bibliothèque Nationale, Nos. 2325 and 2327). It contains a series of purely technical receipts analogous to those of the Leyden papyrus, some apparently of great antiquity, explaining certain methods of "colouring artificial precious stones, emeralds, carbuncles, hyacinths, according to the book taken from the shrine of the Temple." Several Egyptian alchemists are mentioned, such as Agathodemon, the pseudo-Moses, Ostanes, and Democritus, and the text leaves no doubt as to the ancient practice of rendering certain gems phosphorescent in the dark by means of surface colouring prepared from substances which are still known to possess such properties.—On the properties of a new hydraulic machine intended for irrigation purposes, by M. A. de Caligny. For this apparatus, which has been for some time in use both at Aubois and on the canal between Mons and La Louvière, the author claims the advantages of great simplicity of structure as well as economy on the first outlay. It may also be utilized for replenishing cattle-troughs, and other secondary uses, at a minimum cost. It was awarded a gold medal at the Antwerp Universal Exhibition.—On the part played by the absorbing power of the soil in the formation of the natural carbonates of soda, by M. Paul de Mondesir. The paper deals with Berthollet's well-known theory regarding the formation of Egyptian natron, and shows that Berthollet's explanation is so far true that the marine salt really furnishes the soda, and carbonate of lime, the carbonic acid. But the reaction is neither direct nor continuous, and is produced in two distinct phases. In the first, the soil reacts on the marine salt, transforming it into chloride of calcium while yielding lime and absorbing soda. In the second, which can set in only after removal of the chloride of calcium, the bicarbonate of lime and the carbonic acid extract the soda from the ground, replacing it with lime. Berthollet's theory is thus left fundamentally intact, but so modified as to become universally applicable. In fact, the carbonate of soda is produced in all permeable calcareous soils in proportion to the quantity of marine salt contained in them.—Observations of the new planet 272, discovered on February 4, at the Observatory of Nice, by M. Charlois. The observations, including right ascension, polar distance, and the positions of comparison stars, extend over the period from February 4 to February 9. When discovered the planet was of 13·5 magnitude.—New observations on the variability of Saturn's rings, by M. E. L. Trouvelot. It is pointed out that the observations made during the last few years by Perkins, Offord, Davis, Stanley Williams, Stroobant, and others, all tend definitely to establish the proposition announced by the author in 1884, that, so far from being stable, the rings of Saturn are on the contrary essentially variable, and subject to constant fluctuations. The same truth is confirmed by the author's own observations made in 1886 and 1887 at the Observatory of Meudon, and here communicated to the Academy.—Theorems on Campbell's algebraic equations and quadratic functions, by Father Aug. Poulain. Newton, or rather Campbell, formulated a very simple rule for determining the existence of the imaginary roots in algebraic equations. The author here proposes a few theorems, by means of which the application of this law may be extended and the accompanying calculations much simplified.—On chemical equilibria, by M. P. Duhem. In a recent note M. H. Le Chatelier announced that the numerical laws of chemical equilibrium, as deduced from the two principles of thermodynamics, may be expressed in a simple way by means of M. Massieu's characteristic function H'. Here it is shown that this law may be thus formulated: The variation imposed on M. Massieu's function H' by a virtual isothermic modification of the system is equivalent to zero. It is further pointed out that the results obtained by M. Le Chatelier are practically identical with those arrived at by the author during a series of investigations spread over several years.—On the mineralizing action of the alkaline sulphides: reproduction of chrysoberyl, by MM. P. Hautefeuille and A. Perrey. During a protracted series of researches on the mineralizing action of the sulphides, the authors have succeeded in obtaining the crystallization of glucine, the separation of alumina and glucine, or inversely the reproduction of the aluminate of glucine, a combination which occurs in nature, and which is known by the name of cymophane (chrysoberyl). A simple process is described by means of which from a combination of glucine and alumina extracted from the emerald the

being abandoned. At the same time the temporary appropriation of the Western Gallery, D, to the Portrait Gallery and the examination-rooms, will give them an advantageous increase of accommodation. Hence, by this first instalment of the new works, a considerable improvement on the present state of things will be effected; but the space will still be much below what has been estimated as necessary by the Committees who have investigated the matter.

38. The next portion to be undertaken may be the building with façades at the eastern end, marked M¹ on the drawing, and coloured red. This is estimated to cost 183*l.*, and it will furnish 33,750 square feet of additional floor-space.

When this is built there will be, in all, 113,750 square feet available, *i.e.* enough not only to accommodate the present collections, with some increase, but also to receive the Portrait Gallery, and to provide examination-rooms, if required.

At this time, therefore, there will no longer be any need to hire from the Commissioners of 1851 the Western Gallery, D, and thus an expenditure of 2000*l.* per annum will be saved.

39. The accommodation can afterwards be extended from time to time, as and when means may be voted for the purpose, by the erection of the other portions shown on Drawing No. II., as follows:—

	Additional space obtained Square feet	Estimated cost £
Interior building at the east end, marked N¹, and coloured brown	28,350	32,930
Building with façades at the western end, marked M, and coloured red	37,950	59,240
Interior building at the west end, marked N, and coloured brown	28,350	32,930

40. The entire floor-space gained by the new buildings, when completed according to Drawing No. II., will be 157,100 square feet. To this must be added the space in the existing southern galleries, which will be assumed still to remain available. They contain, at present (as we have already stated), 51,500 square feet; but, in the process of building the new erections, a portion of the old ones will have become absorbed therein, and the space will be reduced to 41,818 square feet. The total available space will therefore amount to 198,918 square feet.

The total estimated cost of the new work shown on Drawing No. II. is 222,803*l.*

41. In submitting this Report to the Treasury, we desire to state to their Lordships that one of the principal considerations guiding us has been to prepare a plan which admitted of being executed in parts, but which, when completed, should suffice for as long a period as we think it necessary to foresee. We have taken as our starting-point the demand of 160,000 square feet of area, and we have shown how it may be provided without more than a strictly temporary use of the Western Gallery, which does not belong to the Government.

42. We have been invited to express an opinion as to whether there would be space, in the completed plans, to provide for the collections now housed in the Museum in Jermyn Street, and the instruction now given there. We believe that there would be space for the purpose.

We have the honour to be, Sir,

Your obedient Servants,

FREDERICK BRAMWELL
LINGEN
J. F. D. DONNELLY

WILLIAM POLE,
Secretary.

Westminster, July 27, 1885

P.S.—Mr. Mitford dissents, for the reasons appearing in a separate Report handed in by him on the 4th ultimo, which, with other documents relative to it, is inclosed in the letter covering our Report.—F. B.; L.; J. F. D. D.

TRANSMISSION OF POWER BY COMPRESSED AIR

A MOST interesting experiment is about to be tried in Birmingham. A Company, whose engineer is Mr. J. Sturgeon, has obtained Parliamentary powers to supply power from a central station by compressed air through pipes laid in the streets. The application to Parliament was supported by the Birmingham Corporation, and the powers extend over an area of between four and five square miles. It is at first intended to restrict operations to about one square mile and a half. This area will include twenty-three miles of main pipes. The central works are designed for the production of 15,000 horse-power, of which the engines laid down at first will supply 6000 horse-power. The authorised capital expenditure for the whole is 276,800*l.*, of which 150,000*l.* will be spent at once for the initial 6000 horse-power. In this journal we have nothing to do with the financial aspects of the project, but we mention these figures to show that within a short time the system may be expected to be in operation on such a scale as will very fairly test its mechanical efficiency. At a recent meeting of the directors it was determined to start clearing the ground and commencing the foundations for the central station at once, so that by next summer we may see considerable advance made towards the realisation of the project.

This is the first time that an experiment of this kind has been tried in Britain. Power is distributed from a central station at Hull by the hydraulic system, but transmission by air has hitherto only been tried in small installations at mines, quarries, in sinking piers, as at the Forth Bridge, and in tunnel-boring. In mines and tunnels it has very evident advantages, in that it keeps up a continual supply of fresh, cold air where ventilation is very much needed; and therefore its undoubted success at the St. Gothard works does not demonstrate its certainty of success for the distribution of power on a large scale to the workshops of a town where the atmosphere is bearably pure. Moreover, the pipe systems of these small installations have not been sufficiently long and complicated to test in any severe sense the liability to loss by friction, leakage, and variation of temperature.

The results of the present experiment will therefore be of the utmost scientific value to engineers, and will be watched with corresponding interest. No fairer field for such an experiment could be found than in Birmingham, which is marked out from all other towns by the enormous number of its small workshops requiring minute amounts of driving-power, and the total turn-over of each of which is too small to enable the owner to afford skilled tendance to his boiler and engine. In these small shops the power is required only intermittently throughout the day. At times the engine may actually stand altogether for an hour or two, while it is only rarely that it is called to exert more than a comparatively small fraction of its full power. Meanwhile the large loss due to furnace and boiler inefficiency—that is, to waste of heat by radiation and by hot gases passing up the chimney—goes on steadily at a pretty uniform rate. Under such circumstances, the advantages of generating the power at a great central station are so evident as not to require demonstration. The question of chief technical interest is really as to whether the best means of distribution is by air, by water, by electricity, or by cheap gas to be used in gas-engines. That question can only be finally settled by expensive experiment. In passing, the writer may indicate his own opinion that there lies in the future a magnificent field for enterprise on the part of the gas companies of large towns in supplying cheap gas for heating and the production of mechanical power, and it is most decidedly their interest to improve the efficiency and lower the prime cost of gas-engines.

The site of the central works is a triangular plot of ground adjoining Garrison Lane, at the intersection of the

London and North-Western and the Midland Railways. The Birmingham and Warwick Canal forms one boundary of this plot. The fuel to be used under the boilers is gas obtained from Wilson's eight-hundredweight producers. Eighteen of Lane's water-tube boilers will supply six engines to produce the 6000 horse-power aimed at at first. Air is admitted to the furnaces through gridiron sliding shutters, by means of which the supply is hand-regulated. It mixes with the gas in a mixing-chamber immediately below the front end of the furnace. The roof of this mixing-chamber is an arch of perforated bricks, and these bricks becoming highly heated the mixed air and gas is raised to a high temperature before being ignited. No special means have so far been considered necessary to prevent risk of lighting back into the mixing-chamber. The production of gas in the producers is controlled by the steam jet blown in at the foot of each. The steam for these jets is supplied from a special donkey boiler. The whole of the steam jets are throttled down by the action of a governor that runs, so to speak, in equilibrium with the air-pressure in the mains. The engine drives a small air-pump, which forces air into one end of a small cylinder, to the other end of which the air from the mains is admitted. If the pressure rises in the mains above standard, the piston of this cylinder is moved, and this movement is communicated by suitable gearing to the throttle-valve regulating the steam jet to the producers. The production of gas, and therefore the production of heat by its combustion under the boilers, are thus automatically regulated in accordance with the requirements, so that the air-pressure in the mains is prevented from varying outside certain narrow limits. In connection with this part of the scheme we may point out that it seems to be a mistake not to throttle the entrance-areas for the air to the furnaces automatically and simultaneously with the regulation of the gas supply. The chief advantage in using gas instead of solid fuel lies certainly in the power of obtaining perfect combustion by thorough admixture and careful proportioning of air to fuel. This advantage is sacrificed if the air supply is not diminished and increased simultaneously with, and in the same proportion as, that of gas. We suspect also that it will be found desirable not to rely solely on the throttling of the steam blast as at present intended; the more direct and rapid action of a throttle-valve between the producer and the boiler-furnace will be highly advantageous, if not necessary. By means of simple mechanical relays, actuated either by the steam or by the compressed air, there can be no difficulty in controlling these three sets of throttle-valves by the action of a single governor.

The steam-pressure is to be 160 pounds per square inch. Each set of three boilers supplies an engine of 1000 horse-power. The engine is of the triple-expansion type; the high-, intermediate-, and low-pressure cylinders having the diameters 20, 30, and 49 inches, and a common stroke of 48 inches. The areas of the three pistons are thus in the ratios 1, 2¼, and 6. The cranks are at 120° to each other. The high-pressure and intermediate cylinders are steam-jacketed at the sides. The low-pressure cylinder is not jacketed, but a novel arrangement of steam-jacketing its piston is adopted. The piston is hollow, and steam is led into its interior by a tube which is parallel to the piston-rod, and moves to and fro through a stuffing gland in the cylinder cover, projecting into a larger tube screwed on the gland and supplied with steam direct from the boiler. The argument in favour of this arrangement is that side-jacketing of the low-pressure cylinder involves a large absolute waste of heat that goes towards heating the exhaust-steam as it leaves the cylinder on its way to the condenser; this loss of heat by the jacket steam being noxious, not only because it is pure waste, but also because it raises the back pressure against the piston. The fresh steam in the hollow piston sweeps over the inside surface of the cylinder just in front of the incoming working steam, and thus heats the metal and prevents undue condensation of the working steam, while it is comparatively inactive in heating the back-pressure steam. In criticism of this argument, it may be remarked that towards the end of the stroke (during the last quarter of the stroke) this piston-jacket surface giving heat to the exhaust-steam is greater than a side-jacket would offer. For three-quarters of the stroke, however, it is less.

Each cylinder is connected with the fly-wheel shaft by a cross-beam. Over each end of each beam stands a single-acting, air-compressing cylinder of 26 inches diameter and 48-inch stroke. Each engine thus drives six of these air-pumps; and, since the speed is ninety double strokes per minute, the volumetric capacity of the compressors of each engine is close on 8000 cubic feet per minute.

The pressure in the mains is to be 45 pounds per square inch above the atmosphere, and the delivery-valves are expected to lift a little before three-quarters of the compressor piston-stroke is finished. Thus the volume of air compressed to the above pressure delivered per minute by each engine is taken as about 2000 cubic feet.

The ratio of pressures is $\frac{59{\cdot}7}{14{\cdot}7} = 4{\cdot}06$. Thus, if the compression curve were isothermal, the valves would lift, as above assumed, at ·75 of the stroke. If it were adiabatic, this pressure ratio would correspond to a ratio of final to initial volume of ·367, and the valves would lift at ·63 of the stroke. If the curve lay exactly mid-way between these two, or were according to the law $p \propto v^{-1\cdot2}$, the ratio of final to initial volume would be ·31, and the valves would lift at ·69 of the stroke. In the latter case the volume delivered would be ·31 × 8000 = 2480 cubic feet per minute. Calculating simply from the product of this volume by 45 pounds per square inch pressure (*i.e.* from the work the air could do in an air-engine without clearance, without expansion, and without more than atmospheric back pressure), this would give about 487 horse-power delivered in the consumer's engines for each engine developing 1000 horse-power at the central station. Two indicator-cards taken from two air-compressing cylinders at Frood Colliery, near Wrexham, give very different results, possibly because one compressor was near the steam-engine cylinder, and was heated by it, while the other was not. The compression-curve from the one cylinder corresponds with the relation $p \propto v^{-1\cdot39}$, while that from the other corresponds to $p \propto v^{-1\cdot06}$. The latter curve is thus much steeper even than the adiabatic, and would indicate that the air was actually heated by conduction or radiation during its compression. Such heating could hardly have taken place to such an extent as to account for the above very high index, and the more probable explanation is that the air was steam-laden as it was taken in, and that the extra rise of pressure is really due to that of the steam in the mixture consequent on the rise of the temperature.

It is desirable to keep down the compression-curve as nearly as possible to the isothermal line, because by doing so the area of the compressor indicator-card, and therefore the work to be done by the engines, is kept down to its minimum; whereas no advantage can be derived from the increase of temperature obtained by adiabatic compression, because this is rapidly lost by cooling in the pipes long before the air is utilised in the air-engine it drives. It is worth noticing that, because of the air being discharged from the compressors through valves which *automatically* lift when a certain designed pressure is reached, this loss of power due to cooling in the pipes is effected rather by a contraction of *volume* than by a diminution of *pressure*. The decreasing-pressure gradient along the pipes is very small, and is due solely to frictional and viscous resistance to the flow, and to variation of velocity consequent on variation of section.

In order to approximate to isothermal compression,

Mr. Sturgeon has adopted very special cooling arrangements for his compressors. Firstly, the air used is all taken through the roof of the engine-house, and thus heating by contact with the boilers and engines below is avoided. It is filtered of deleterious dirt in entering through the roof. Secondly, the compressor cylinders are surrounded by ample water jackets, through which a continual fresh-water circulation is kept up. Thirdly, the delivery-valve—it is a single large disk of slightly greater diameter than the cylinder—is made hollow, and through it a cold-water circulation is kept up, the water being spread out in a thin radial stream across the valve face over which the air flows as it leaves the cylinder. This cooling-water is supplied to the hollow valve through a tube sliding in a stuffing-box in the cylinder cover. A further development of this system would be a supply of cooling water to the face of the piston after the manner that the steam is supplied to the piston-jacket of the low-pressure engine cylinder; but this refinement has not been deemed necessary in the design as at present adopted.

The compressor piston-face travels a little beyond the position assumed by the flat face of this delivery-valve when the latter is closed. During the momentary pause at the end of the stroke, the valve therefore falls into actual contact with the piston-face, and the two descend together until the valve is landed on its seat. Thus the clearance space is reduced absolutely to zero.

The suction-valves are somewhat similarly arranged so as to reduce the clearance at the other end of the stroke to a very small amount. The cooling-water is circulated by gravity from a tank giving a head of 20 feet. The water is pumped into this tank from the canal, and the power spent in pumping this water is a partial set-off

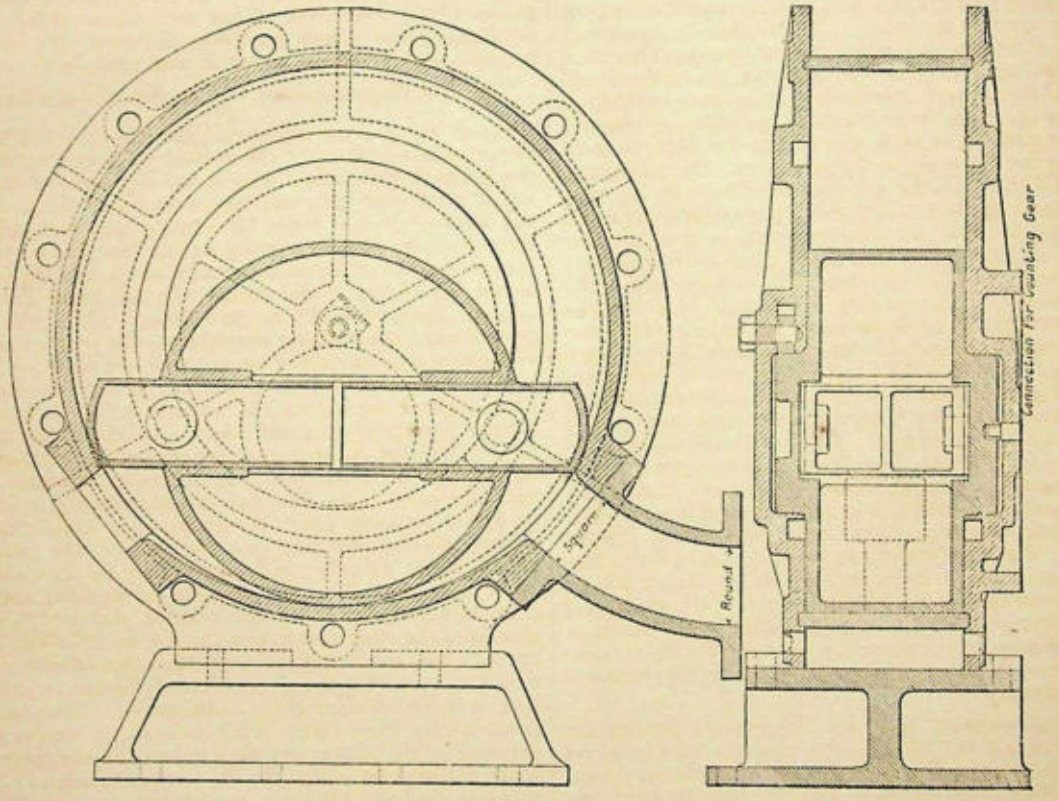


FIG. 1.

against the economy resulting from the approximation to isothermal compression; but the power thus gained greatly outweighs the work spent in this pumping.

As at present designed, the air-pipes are of wrought-iron plate, riveted, but a new design for plate-steel tubes is being considered. The pipes are to be laid in concrete tunnels, which free them from all pressure of superincumbent soil or paving, and will always be very accessible for examination and repair. They are of 24 inches diameter near the central station, and diminish to 7 inches in the smallest branches. The joints are given a small degree of flexibility. In one design they are formed by two angle-irons riveted to the outside ends of the two pipes, a hard rubber ring of circular section being placed between the flanges thus formed, and the flanges being drawn together by bolts. In another design a sort of double-socket coupling-piece covers the ends of both pipes for a few inches; the end of each pipe has formed on it two slightly projecting rings, and between these is poured, in the molten state, through a hole in the socket-coupling, a soft metal that expands during solidification. We rather doubt whether this last design will give sufficient tensive strength to the joint. Tensive strength is required simply because there are necessarily bends in the pipe here and there.

The air is supplied to the consumer through a registering meter. This meter is similar in construction to Beale's gas exhauster. It consists of two cylinders, one inside the other. Both are 4 inches long; the outer one has a diameter of 14 and the inner a diameter of $9\frac{3}{4}$ inches. The outer one is fixed, and is furnished with an inlet and an outlet opening. The inner cylinder revolves freely on a fixed axis, distant $\frac{1}{2}(14-9\frac{3}{4}) = 2\frac{5}{16}$ inches away from the centre of the outer case, so that the two cylinders always touch along a fixed line. Two sliding shutters project from a slot through the centre of the revolving

cylinder. By means of a pin and a pair of sliding blocks running in circular grooves cut on the inner surface of, and concentric with, the fixed cylinder, these shutters are drawn out and in from the revolving cylinder so as always to keep in contact with the fixed one. During one revolution these shutters sweep through the meter a volume of air about '17 cubic feet.

This rotation is reduced three times by worm-gearing in being transmitted to the counter-box, so that a single dial with two concentric circular scales, which are read by two fingers like the hour- and minute-hands of a common clock, is sufficient to register up to a million cubic feet. Fig. 1 shows this meter. It is driven by a small difference of air-pressure between the inlet and outlet.

The Company intend to charge at the rate of 5*d.* per 1000 cubic feet at standard pressure of 45 pounds per square inch. If the air were used in an engine without expansion, without clearance space, and without back pressure above the atmosphere, this would correspond to a cost per hour per indicated horse-power of

$$\frac{60 \times 33000 \times 5}{144 \times 45 \times 1000} = 1{\cdot}53 \text{ pence.}$$

Under the conditions of actual practice the writer calculates that at the above rate of 5*d.* per 1000 cubic feet, assuming intelligent and economical management, each

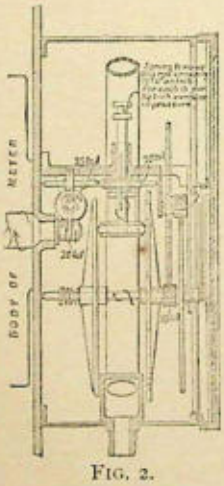


FIG. 2.

indicated horse-power will cost per hour from 2*d.* down to as low as 1½*d.*, excluding cost of engine attendance and depreciation, and interest on first cost of engine.

The standard pressure at which the air is sold at the above price being 45 pounds per square inch, a reduction of price per cubic foot has to be made if the pressure of the supply be less than this pressure. This is effected by introducing a variable velocity-gear between the volume-meter and the dial-counter. This arrangement is shown in Fig. 2.

The rotation is transmitted to a small roller on a spindle capable of sliding in its bearings parallelly to its own axis. It drives a disk on the counter-arbour by rolling contact. The end of the roller-spindle is linked to the end of the tube of a Bourdon pressure-gauge. As the pressure rises, the roller is thus pushed nearer the centre of the disk, and gives this disk, therefore, an increasing fraction of a revolution per revolution of the roller. The roller really lies between two disks, but the one is "idle" and serves simply to support the roller in pressing against the driven disk.

This integrator is wholly wrong in principle, and it is badly designed in detail. The roller has a rubber tyre round it, and therefore touches the disk at different radii, and thus must rapidly wear away, owing to the want of pure rolling action at one or other side of its tread. The wearing might not be of much consequence in itself, except that it gradually vitiates the accuracy of the indication; and besides, the velocity ratio is uncertain because of the contact taking place over a perceptible range of radius. There ought to be an idle roller between the disks opposite the driving roller, and both disks ought to be pressed inwards by springs, instead of one only. But the chief defect is in the principle of the construction, which does not make the dial-indication proportional to PV as it ought to do. If R_0 be the disk radius at which the roller would stand when zero pressure existed in the Bourdon tube, and if C be the inward movement per pound per square inch rise of pressure, and if r be the radius of the roller, then at pressure P the contact radius on the disk will be $R_0 - CP$, and the fractional revolution of the disk per revolution of the roller is $\frac{r}{R_0 - CP}$. This is not proportional to P as it ought to be. Its differential coefficient with respect to P should be constant, whereas it is really $-\frac{Cr}{(R_0 - CP)^2}$. The converse gearing ought to be substituted; that is, the volume-meter should be geared positively with the disk, and the disk should drive

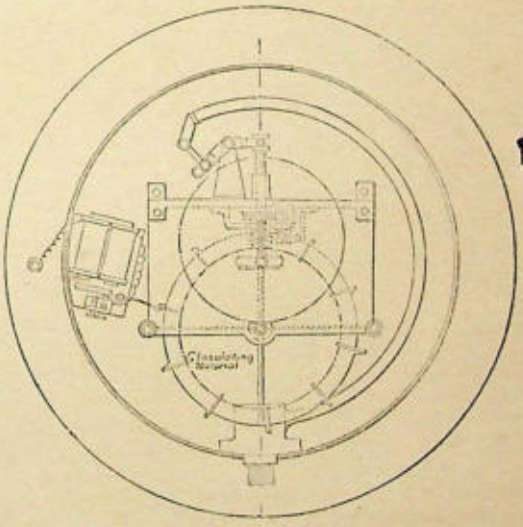


FIG. 3.

the roller, the point of contact for zero pressure coinciding with the centre of the disk. It also seems a pity, when a Bourdon tube that measures the pressure exists in any case in the meter, that its measurement of the pressure should not be made visible by the simple addition of a pointer and graduated dial.

The registrations of all the meters in the whole district are telegraphed to the central station and added up on one large central counter, so that the engineers in charge may have means of continually comparing the actual consumption with the duty of the engines, known from ordinary engine continuous counters, and of detecting any serious leakage that might occur in consequence of breakage of a main or branch pipe. The telegraphing apparatus is shown in Fig. 3. The counting disk is divided into ten equal divisions, each representing 1000 cubic feet, by small metal projections. As these come successively underneath a contact-maker, they allow the passage of a current, which moves the finger of the central counter through a corresponding division. One main wire, with branches to the separate meters, is sufficient for the whole district, the earth return being used. As the counter-disk moves slowly, special means must be taken to break the

contact instantaneously after it is made; otherwise all but one of the indications of several meters, whose times of contact with the tooth on the disk overlapped, would fail to be registered at the central station, and should the stoppage of any one engine in the district happen to occur while this tooth of its meter was in contact the whole registering apparatus would cease to act for an indefinite time.

The contact-breaker is shown in Fig. 3, at the left-hand side. The momentary current caused on making contact magnetises an electro-magnet, which, by attracting its armature, draws the contact-maker (which is mounted on a piece of watch-spring) past the tooth into such a position that it catches behind a small plate of insulating material at the back of the tooth, which prevents it springing again into contact with the latter when the armature of the magnet is released.

Fig. 4 explains the calculation of the thermodynamic efficiency of this mode of transmission of power. It is drawn for unit volume of atmospheric air drawn into the air-pumps. The pressures are reckoned in atmospheres. A B C D E is the indicator-diagram showing the work done by the compressor-pump. The compression-curve C D is taken according to the law $p \propto v^{-1.2}$ because it seems probable that this index may be reached with the efficient water-cooling system adopted. The suction-line A B is taken $\frac{1}{16}$ atmosphere below atmospheric pressure. The point F is taken on the same isothermal as C; thus D F is the loss of volume consequent on the air cooling in the pipes down to atmospheric temperature. The diagram E F G H is the indicator-diagram for an engine driven by the air without loss of initial pressure below the compressor pressure, without clearance, without expansion, and with a back pressure $\frac{1}{16}$ atmosphere above atmospheric pressure. The same back pressure is used for all the other engine diagrams. The diagrams E F I K H, E F L M H, and E F N H are diagrams for engines with similar conditions, and with ratios of expansion $1\frac{1}{2}$, 2, and $2\frac{1}{2}$; that is, with cuts off $\frac{2}{3}$, $\frac{1}{2}$, and $\frac{2}{5}$, the last being that that brings the final pressure down to $1\frac{1}{16}$ atmosphere. The expansion-curve F I L N is taken as adiabatic. If $\frac{1}{8}$ atmosphere be lost in frictional and viscous resistance to flow through the pipes, by obstructions at bends, passage through meter, &c., or by sudden change of section of pipe, then the admission line is lowered to P Q. The effect of clearance is to cut off a part of the diagram by a vertical line at the left-hand end. This vertical line is not drawn in the diagram, because its position varies with the grade of expansion employed In calculating the following results the clearance has in each case been taken as $\frac{1}{10}$ the volume of the cylinder. The area of the compressor-diagram is 1·6, and the efficiency is in each case obtained

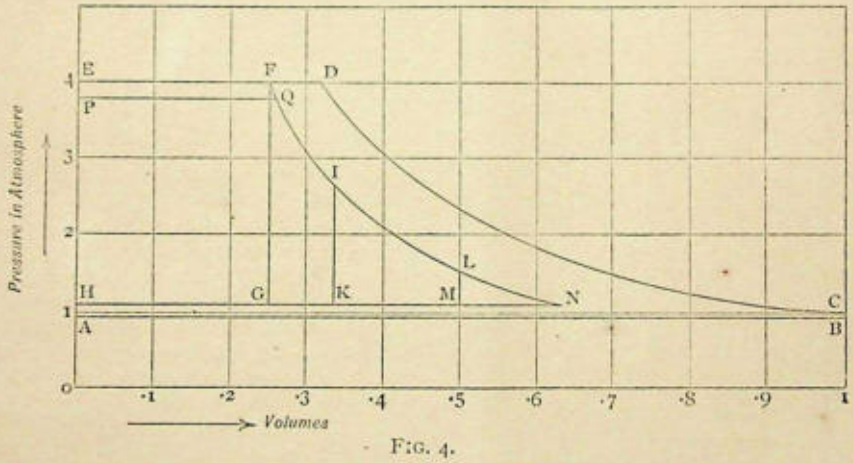


FIG. 4.

by dividing the engine-diagram area by 1·6, and multiplying this quotient by $\frac{9}{10}$. This $\frac{9}{10}$ is the ratio between the compressor-diagram and that of the central station engine which drives it, the mechanical inefficiency of this central plant being taken as $\frac{1}{10}$. The results are most clearly shown in tabular form.

Table of Efficiencies of Transmission of Power by Air compressed to 45 pounds per square inch

Ratio of expansion =	Efficiency 1	1½	2	2½
No loss of initial pressure No clearance Back pressure 1·1 atmos.	·45	·58	·67	·72
Initial pressure 3·8 atmos. No clearance Back pressure 1·1 atmos.	·42	·54	·64	·69
No loss of initial pressure Clearance $\frac{1}{10}$ vol. of cyl. Back pressure 1·1 atmos.	·39	·50	·57	·60
Initial pressure 3·8 atmos Clearance $\frac{1}{10}$ vol. of cyl. Back pressure 1·1 atmos.	·36	·47	·54	·57

The last two sections of this table comprise the limits of practicable results. The highest efficiency shown is 60 per cent. This could only be obtained by avoiding absolutely all loss of pressure between compressors and air-engine. This can hardly be accomplished even if the engine be situated close to the central works. It need hardly be pointed out that the expansion will not usually be carried so far as to bring the working pressure to near equality with the back pressure; in fact, to do so is decidedly very bad practice, and does not lead to economy in the brake-power, especially when depreciation and interest on first cost of the engine is taken into account. With good management, from 30 to 50 per cent. efficiency may be expected.

In a paper read by Mr. Sturgeon before the British Association last summer, he gives a table of calculated efficiencies ranging from ·32 to ·84. These calculations include allowances of 2 per cent. for valve-resistance and leakage past compressor-piston; 13 per cent. for leakage, friction, and wire-drawing in the pipes; and 8 per cent. for clearance and back pressure in the consumer's engine. Except the last, these allowances are much more liberal than those that have been made in calculating the above table. On the same basis as ours have been made, Mr. Sturgeon's calculations would have given considerably higher figures than the above ·32 to ·84. But the higher figures in Mr. Sturgeon's table are obtained by supposing that the consumer heats the air by a gas-stove, before passing it into his engine, up to temperatures from 212° F. to 320° F. How the resulting figures can be in any sense

called "efficiencies" it is difficult to understand. The consumer is supposed to supply a large extra amount of power at his own cost by burning gas to heat the air, and it seems an extremely evident misuse of the word "efficiency" to apply it to the ratio of the diagram so got to the diagram of the central station engine. By a little more liberal burning of gas, the efficiency obtained by this method could quite easily be made higher than unity. On the same principle we might calculate the efficiency of a steam-engine by taking the ratio of the indicator-card from the steam cylinder to that taken from the feed-pump that supplies water to the boiler, and thus obtain an efficiency of, let us say, 50,000 per cent. This is a *reductio ad absurdum* of the method of calculation which is perfectly legitimate and logical. R. H. S.

THE CLASSIFICATION OF THE CÆCILIANS

IN a paper on the structure and affinities of the Amphiumidæ, published in the newly-issued part of the Proceedings of the American Philosophical Society (vol. xxiii. No. 123), Prof. Cope has put forward some views as to the position of the Cæcilians or Apodous Batrachians in the Systema Naturæ, which are worthy of careful consideration. The Cæcilians, Prof. Cope observes, are generally regarded as representing a distinct order of the Batrachian class, which bears the name "Apoda," or "Gymnophiona." The definition of this order given by Mr. Boulenger in his recently published Catalogue of the specimens of these animals in the British Museum is: "No limbs; tail rudimentary; males with an intromittent copulatory organ; adapted for burrowing." Of these definitions Prof. Cope maintains that not one is of ordinal value. "The tail in some Cæcilians is distinct. The intromittent copulatory organ in such species as *Dermophis mexicanus*, *Gymnophis proximus*, and *Herpete ochrocephala* is not a special organ, but merely the everted cloaca. The hard papillæ observed by Günther in *Ichthyophis glutinosus* are wanting in the above-mentioned species, and the protrusion of the cloaca is performed by two special muscles."

As regards the absence of limbs in the Cæcilians, Prof. Cope points out that the extremely rudimentary character of these organs in *Amphiuma* is well known, and that their non-existence has no greater claim to be considered as of ordinal value in the Batrachians than in the adjoining class of Reptiles, where it is in some cases not even a "family" character. Looking to these facts, Prof. Cope proposes to unite the Cæcilians with the Urodele Batrachians, and to class them only as a family, "Cæciliidæ," connected with the more typical forms of the group through the Amphiumidæ.

Messrs. Sarasin, who have recently published a most interesting account of their observations on the development of a species of Cæcilian in Ceylon,[1] seem to have come to nearly the same conclusions as to the correct systematic position of this group of Batrachians.

NOTES

THE Prince of Wales has requested the President of the Royal Society to join the Committee appointed to advise on the organisation of the proposed Imperial Institute.

WE have referred elsewhere to some of the possible results of the meetings held last week in favour of the Imperial Institute. Some very striking features which have been developed in connection with this movement during the last week are, first of all, the considerable desire which has been evinced to enrich various localities with some Jubilee memorial, and, again, the wisdom generally displayed in selecting worthy local objects, such as museums, improved science schools, and the like. All this of course is admirable and entirely to be applauded, but believing as we do that there is a possibility of the Imperial Institute, if properly conducted, doing more good for the future development of science and commerce in Greater Britain than any other single organisation can possibly effect, we hope that it will not be starved in favour of merely local objects. We hear that the women of England have already subscribed a noble sum. This no doubt Her Majesty will hand over to the Institute, if it is organised so as to command the confidence and respect of the various leaders of opinion in this country and in the colonies.

MANY of our readers will attach much importance to Colonel Donnelly's letter, which appears in another column. A large increase in the number of students anxious to enter the Normal School of Science and Royal School of Mines was of course to be expected, and we are glad that this influx has induced the department to take steps to increase the accommodation, and at the same time to insist upon one of the best possible forms of entrance examination; a strict inquiry, namely, into the educational history of each candidate for admission.

THE Norwegian Government has presented a Bill to the Storthing for fixing a standard time for the whole of Norway. The standard time proposed is Greenwich time *plus* one hour.

MR. W. BALDWIN SPENCER, Fellow of Lincoln College, Oxford, has been appointed to the Chair of Biology in the University of Melbourne, and will leave England in about three weeks. Mr. Spencer distinguished himself lately by his important memoir on the pineal eye in lizards.

A NUMBER of eminent men of science have addressed a memorial to the President, Vice-Presidents, and Council of the Royal College of Surgeons of England, suggesting that the legacy bequeathed to the College by the late Sir Erasmus Wilson might with advantage be devoted to the establishment of an institution having for its object "physiological and pathological research." It is pointed out that the want of such an institution in England has long been felt, and more especially of late, when we have had to look to Berlin for information respecting tubercle, and to Paris for experiments on the prevention of hydrophobia. That the Government will do anything in the matter no one is so sanguine as to believe; and it is hardly more probable that the want will ever be supplied by public subscription. There is, therefore, much to be said for the present proposal, and the authorities of the College of Surgeons will, no doubt, give it due attention. It seems strange that in London there should be nothing like the splendid laboratories which exist not only in the capital cities of Europe, but in comparatively small German towns, such as Bonn, Strasburg, and Leipzig.

UNIVERSITY COLLEGE, Liverpool, has reason to congratulate itself on having some remarkably generous and enlightened friends. On Tuesday last it was announced at a meeting of the College Council that Mr. Thomas Harrison, shipowner, of Liverpool, had endowed the Chair of Engineering with 10,000*l*. Only a few weeks ago Sir Andrew Walker, also a citizen of Liverpool, gave 15,000*l*. to build Engineering Laboratories.

ON Thursday last the honorary freedom of the City of London was conferred upon Mr. H. M. Stanley, in recognition of his services as a traveller and explorer in Africa. The presentation was made at a special meeting of the Court of Common Council in the new council chamber at the Guildhall. The City Chamberlain, in making the presentation, referred to "the remarkable development of journalistic enterprise during the Victorian era," observing that Mr. Stanley was the first member of "the

[1] "Ueber die Entwicklungsgeschichte von *Ichthyophis glutinosum*," Arb. Zool. Inst. Würzburg, vii. p. 202 (1885).

class of special travelling and war correspondents" whom the City had enrolled among its freemen. Mr. Stanley was evidently much pleased by the honour done to him, and declared that it would stimulate him to further exertions. After luncheon at the Mansion House, he spoke of the various routes which have been proposed for the expedition for the relief of Emin Pasha.

MR. ALFRED RUSSEL WALLACE lately delivered, at Boston, U.S.A., a course of "Lowell Lectures." He proposes to make a Western tour, in the course of which he will lecture on, among other subjects, "The Darwinian Theory: What it is, and How it is Demonstrated," "The Origin and Use of the Colours of Plants," "The Permanence of Oceans, and the Relations of Islands and Continents," and "The Biological History of Continental Islands, Recent and Ancient." Mr. Wallace is thought by the Americans to be a more effective speaker than most of the eminent Englishmen who have lectured in the United States.

THE Indian Survey Staff seems to be considerably undermanned. The Government of the Straits Settlements recently applied to the Government of India for an experienced officer to advise them on the way of placing the system of survey in the colony on a satisfactory footing. As no qualified officer on the former establishment was available, Mr. J. B. N. Hennessey, now on the retired list, was offered the duty, but as he declined it the Straits Settlements Government had to be told that the Government of India could render no assistance on a work so necessary to the development of the colonial resources, and likely be of so much service to science.

A MOVEMENT is on foot at Gothenburg for the founding of a free University in that city. A large sum of money has already been subscribed.

THE results of the new censuses of France and Germany show a marked falling-off in the rate of increase. In the case of France the rate of increase was low enough before; now it threatens to stop altogether, and in many departments there has been a considerable decrease. The addition to the population in five years has only been 213,857, bringing the total up to 37,885,905. This is equal to an annual rate of only '1 per cent. per annum. Germany is not quite so bad, but the rate of increase between 1870 and 1880 was abnormally high. The population by the latest returns is 46,844,926 as compared with 45,234,061 five years before; giving an annual rate of increase of '71 per cent. per annum in 1880-85, as compared with 1'14 per cent. per annum in the previous five years.

THE Lieutenant-Governor of the Punjab has proposed to the Government of India the establishment of a University at Allahabad, and has furnished a scheme for such an institution in the capital of his province.

AT the afternoon sitting of the Association for the Improvement of Geometrical Teaching, held at University College, on the 14th inst., the President (R. B. Hayward, F.R.S.) in the chair, the Rev. G. Richardson, of Winchester College, read a paper on the teaching of modern geometry, in which he indicated the lines which, in his opinion, a Syllabus on the subject should follow. The draft, which covered an extent of ground too great, we think, for ordinary school-teaching, did not consist of a bare enumeration of the subjects of sections and chapters, but was rendered very interesting by the quaint humour which lightened up and pervaded the whole. The Rev. J. J. Milne read a short note on a part of the above subject, which had been omitted by the previous speaker, viz. the modern treatment of maxima and minima; his strong point was the light to be derived from symmetry in the search for cases of maximum and minimum. Mr. G. A. Storey, A.R.A., read a paper on "Geometry from the Artist's Point of View." In this the writer introduced Euclid and Apelles in converse, and showed the agreement which exists between the purely geometrical method and perspective. The paper was illustrated by numerous drawings of triangles, squares, and cubes. A brief discussion of the several papers followed, and then Mr. E. M. Langley communicated a very simple proof of Feuerbach's theorem (that the nine-point circle touches the in- and ex-circles of the triangle). We may return to the consideration of one or more of the above papers when they have been printed in the Association's Report. Upwards of twenty new members were elected.

WE have received a hand-book entitled "Through the British Empire in Ten Minutes with C. E. Howard Vincent, Esq., C.B., M.P." It is intended to accompany a wall-map on which Mr. Vincent has brought together a large amount of useful information about the British Possessions. In his hand-book he glances at the leading characteristics of each of the great groups into which the Empire beyond the seas is divided.

A STATE weather-service for Pennyslvania is to be formed at Philadelphia by the Franklin Institute. The State Legislature will be petitioned for an appropriation of 3000 dollars for instruments and publications, and it seems to be assumed that so reasonable a request will be readily granted.

THE Americans also have a Society for Psychical Research. The Society proposes to issue the next number of its Proceedings as soon as sufficient material can be collected. Apparently it is not quite so easy to get startling evidence of the "psychical" kind in the New World as in the Old.

DESCRIBING in an American medical journal the influence of the recent earthquake shocks in Charleston upon the health of the inhabitants, Dr. F. Peyre Porcher, of that city, says that many persons experienced decidedly electrical disturbances, which were repeated upon the successive recurrence of the shocks. These disturbances were generally accompanied by tingling, pricking sensations, like "needles and pins," affecting the lower extremities. One gentleman was completely relieved of his rheumatism; another, who for months was nervous, depressed, and entirely unable to attend to business, regained his former activity and energy.

AN interesting sketch of the great Serpent Mound in Ohio is given in *Science* by Mr. W. H. Holmes. It is in the northern part of Adams County, somewhat remote from frequented routes of travel. The entire body of the serpent and the peculiar features of the enlarged portion are all distinctly traceable, and leave no doubt in the mind, Mr. Holmes thinks, as to their artificial character. He is decidedly of opinion that the work should be classed among the products of the religion of the aboriginal races.

MR. J. H. STEWART LOCKHART, of Hong Kong, has addressed, on behalf of the Folk-Lore Society of England, an appeal in the English and Chinese languages, through the press, to students throughout China to co-operate in investigating the folk-lore of that country. He points out that no attempt has been made to deal with this subject as a whole, the work done so far being for the most part of a local character. He now proposes to obtain collections of the lore peculiar to different parts of the empire and its dependencies. Each collection, he goes on, while in itself highly instructive, will be chiefly important as forming a link in the chain of facts from which a general account of the folk-lore of China may be deduced. The Chinese version of the appeal is intended for circulation amongst natives, who, "experience shows, evince a great interest in the subject when once they comprehend its aims and objects." Competent scholars are scattered over the greater part of China, and, as

Mr. Lockhart says: "If willing helpers can be found to assist in the work of collection, the success of the scheme is assured. Failure can only result from want of co-operation and support."

In a paper entitled "Thirty-six Hours' Hunting among the Lepidoptera and Hymenoptera of Middlesex," reprinted from the *Journal of Microscopy and Natural Science*, Mr. Sydney T. Klein has some interesting notes on the best methods of capturing Lepidoptera. He has found it very useful to take advantage of "the attractiveness of the ladies among the Lepidoptera gentry." To those who have not had experience, or have not persevered in, this art, he says, the result is truly marvellous, and will sound very much like a fairy tale. The good taste possessed by the males of Lepidoptera is shown to the greatest perfection among the Bombycidæ. On several occasions, when on botanical excursions in Hertfordshire, Mr. Klein has taken with him a female of *Bombyx quercus*, or other Bombycidæ, fresh from the pupa; and, in a wooded country, provided the sun was hot and a gentle breeze blowing, he was certain of having, within ten minutes, a dozen of the opposite sex flying round him, and from time to time even settling on his shoulders or hands. On one occasion, after remaining, as an experiment, for some time on the same spot, he counted over forty of these large moths within fifty yards.

Negotiations are being carried on in Denmark for the holding of a Fisheries Exhibition in Copenhagen next year.

An enthusiastic fish-culturist is trying to introduce scaleless fishes into English fresh waters. In a lecture on Fish, lately delivered at Worcester, and now published, Dr. Francis Day, C.I.E., expresses his belief that they will prove worthless for sport, almost, if not entirely, useless as food, and dangerous to handle on account of the spines with which they are protected. These fishes delight to eat other forms of fish-life. "I obtained," says Dr. Day, "a specimen of a common Indian catfish at Madras, which I placed in an aquarium that contained some carp. It rushed at one of my poor little fishes, and, before I could interfere, seized it by the middle of its back and shook it until it was dead, as a dog kills a rat."

At the monthly meeting of the Council of the Sanitary Assurance Association on January 10, the Sanitary Registration of Buildings Bill was re-considered. A report on the draft Bill was submitted, with several clauses re-drawn. The Bill was further amended, and ordered to be printed for final consideration at the next meeting of the Council. It is proposed that the new Bill shall be compulsory with regard to schools, hotels, asylums, hospitals, and lodging-houses, and Clause 6 has been made much more stringent in the matter of qualification of persons entitled to give sanitary certificates.

Baron von Mueller, who retains the office of Government Botanist to the colony of Victoria, is about to issue a series of plates with descriptions of the acacias (wattles) of Australia. The work will be similar to the "Eucalyptographia," probably the best and most useful of his publications. For diagnostic purposes he makes use of two characters hitherto overlooked, viz. the number of divisions in the pollen-mass and the position of the seed. The retirement of Baron von Mueller from the direction of the Botanic Garden, some few years since, has enabled him to devote more attention to scientific botany and its applications to practical purposes.

Dr. Giles, who was attached as scientific member to the Chitral-Kafirstan Mission, is now stated to be in Calcutta, engaged in writing a report on the geology of that region.

Capt. Peacocke, R.E., is said to be preparing a report, with sketches, of his experiences with the Afghan Boundary Commission.

On Thursday evening last the Society of Telegraph-Engineers and Electricians held the first general meeting of the session of 1887. Sir Charles T. Bright, the new President, delivered an address on the history of the electric telegraph. Speaking of the progress which has been made since the property of the Telegraph Companies was bought by the State, he said that in 1870, when the transfer was completed, there were 48,378 miles of land wires, and 1622 miles of cable wires (irrespective of railway wires), connecting together 2488 telegraph stations. Now the Post Office has 153,153 miles of wire (including submarine wires) in communication with 5097 offices. In addition, the railway companies have 70,000 miles of wire, making a total of 223,153 miles.

The additions to the Zoological Society's Gardens during the past week include a Red-fronted Lemur (*Lemur rufifrons* ♂) from Madagascar, a Vervet Monkey (*Cercopithecus lalandii* ♂) from West Africa, presented by Mrs. Pawelzig; a Patas Monkey (*Cercopithecus patas* ♀) from West Africa, presented by Mr. George Ellis; a Common Otter (*Lutra vulgaris*), British, purchased.

OUR ASTRONOMICAL COLUMN

New Variables in Cygnus.—A new variable of the Algol type (D.M. + 34°, No. 4181, R.A., 1887·0, 20h. 47m. 32·58s., Decl. 34° 13′ 59″·5 N.), has been discovered by Dr. Gould. Its period is about three days in length, and it varies from 7·1 mag. to 7·9 mag. A minimum occurred at about 10h. 19m. G.M.T. on January 17. This discovery raises the number of stars of the type to eight, the other seven being Algol, period 2·49d.; λ Tauri, 3·95d.; S Cancri, 9·48[illegible]; δ Libræ, 2·32d.; U Coronæ, 3·45d.; U Cephei (D.M. [illegible], No. 25), 2·49d.; and U Ophiuchi (DM + 1°, No. 3408), 0·839d.

Mr. S. C. Chandler, Jun., in a note in Gould's *Astronomical Journal*, No. 148, calls attention to a new short-period variable very close to the above. This star (Lalande 40283, R.A., 1875·0, 20h. 38m. 30·2s.; Decl. 35° 8′ 24″·6 N.) varies from 6·3 m. to 7·6 m. in a little over fourteen days, the increase occupying about four days, the decrease ten days, with a halt in the latter about midway of its course. Mr. Chandler gives for first elements of the star, 1886 October 3·60 G.M.T. + 14d·04 E.

New Minor Planet.—Prof. C. H. F. Peters, at Clinton, discovered a new minor planet on December 22. This will be No. 264, and the forty-sixth discovered by Prof. Peters.

A New Method for the Determination of the Constant of Aberration.—In the *Comptes rendus*, tome civ. No. 1, M. Loewy explains how the principle of his method of determining the amount of astronomical refraction (Nature, vol. xxxiii. p. 303) can be applied to the determination of aberration also. By means of the two reflecting surfaces forming the double mirror placed in front of the object-glass of an equatorial, the images of two stars situated in different parts of the sky appear, in the field of view, side by side; their angular distance is then to be measured in a known direction. To obtain the amount of aberration it is, of course, necessary to measure a properly chosen pair of stars at successive epochs. The first observation is to be made when the stars are at the same height above the horizon, and the second, after a certain interval, under similar conditions. The comparison of the two measures will give a multiple value of the aberration which is independent of instrumental errors. By a proper choice of the angle of the double mirror employed, of pairs of stars selected for measurement, and of the circumstances of observation, M. Lœwy contends that, by attention to the details which he specifies, a more accurate value of the constant of aberration can be obtained by his method in an interval of three months than could be deduced by the methods hitherto in vogue, liable as these are to systematic error.

The Madras Observatory.—In his Report for the year 1885, Mr. Pogson states that the volume of telegraphic longitude determinations in India, and the two volumes of hourly magnetical observations made at Singapore between 1841 and 1845, and at Madras between 1851 and 1855, which were men-

tioned as ready for issue in the last Report, were distributed in 1885. Mr. Pogson's attention was chiefly directed, during the year, to the necessary preliminary investigations for the publication of the meridian-circle observations from 1862 to the present time. The formation of the star ledgers and the deduced catalogues of mean positions for each year were completed for the years 1862, 1863, and partly for 1864, which will form the first of the eight volumes about to be published. The star ledgers for the next three years—1865-67—are also in progress, for the second volume of the series. Except for time observations and determinations of positions of a few comparison stars for equatorial observations, the meridian-circle will be little used until the publication of its past results is accomplished. Only 352 complete positions of stars were determined in 1885, making 52,074 during the past twenty-four years. A few observations of minor planets were made with the equatorials during the year. We are glad to find that there is at length a prospect of the publication of the Madras meridian observations, the long delay in which has been a serious blot on the fair fame of the Observatory.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1887 JANUARY 23-29

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on January 23

Sun rises, 7h. 54m.; souths, 12h. 12m. 4·4s.; sets, 16h. 30m.; decl. on meridian, 19° 27′ S.: Sidereal Time at Sunset, 0h. 41m.

Moon (New, January 24) rises, 7h. 14m.; souths, 11h. 40m.; sets, 16h. 9m.; decl. on meridian, 18° 13′ S.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury ...	7 38 ...	11 34 ...	15 30 ...	23 0 S.
Venus	8 34 ...	13 4 ...	17 34 ...	17 34 S.
Mars	8 49 ...	13 36 ...	18 23 ...	14 36 S.
Jupiter... ...	1 0 ...	6 2 ...	11 4 ...	11 54 S.
Saturn... ...	14 59 ...	23 6 ...	7 13* ...	22 6 N.

* Indicates that the setting is that of the following morning.

Occultations of Stars by the Moon (visible at Greenwich)

Jan.	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image ° °
28	4 Ceti	6 ...	19 16 ...	20 13 ...	179 296
28	5 Ceti	6 ...	19 42 ...	20 26 ...	196 281

Variable Stars

Star	R.A. h. m.	Decl. ° ′		h. m.	
U Cephei	0 52·3 ...	81 16 N. ...	Jan. 26,	22 21	*m*
λ Tauri	3 54·4 ...	12 10 N. ...	,, 24,	20 33	*m*
			,, 28,	19 25	*m*
ζ Geminorum ...	6 57·4 ...	20 44 N. ...	,, 29,	0 0	*m*
S Cancri	8 37·5 ..	19 26 N. ...	,, 24,	0 55	*m*
R Virginis	12 32·8 ...	7 37 N. ...	,, 26,		*M*
V Virginis	13 22·0 ...	2 35 S. ...	,, 23,		*M*
δ Libræ	14 54·9 ...	8 4 S. ...	,, 24,	18 23	*m*
			,, 27,	2 15	*m*
U Coronæ	15 13·6 ...	32 4 N. ...	,, 27,	19 21	*m*
U Ophiuchi... ...	17 10·8 ...	1 20 N. ...	,, 25,	3 30	*m*
		and at intervals of		20 8	
R Scuti	18 41·4 ...	5 50 S. ...	Jan. 27,		*m*
β Lyræ... ...	18 45·9 ...	33 14 N. ...	,, 26,	3 0	*M*
δ Cephei ...	22 25·0 ...	57 50 N. ...	,, 28,	1 0	*m*

M signifies maximum; *m* minimum.

Meteor-Showers

On January 28 a radiant near δ Coronæ Borealis is in evidence. The meteors from this radiant are very swift, R.A. 236°, Decl. 25° N. Another radiant giving very swift meteors lies near σ Leonis, R.A. 168°, Decl. 7° N.

GEOGRAPHICAL NOTES

IT is all but certain that Mr. Stanley will lead the Emin Pasha Relief Exploration by the Congo route. He will certainly go to Zanzibar, prepared to follow whatever route circumstances may indicate as likely to prove the most successful. At Port Said he will meet with Dr. Junker, who may give him information of critical importance. At all events, Mr. Stanley and his staff and the whole of the baggage will proceed, in the first instance, to Zanzibar. If a steamer is handy, the Expedition, after recruiting a caravan and laying in a store of suitable goods for trade by the way, will sail round the Cape to the Congo; that at least is Mr. Stanley's present intention. All the available steamers belonging to the King of the Belgians will be placed at his disposal, and probably by the beginning of May he will be at the limit of navigation and ready for his land journey eastwards to Lake Albert Nyanza; if, indeed, he does not give the lake a wide berth westwards and go direct to Wadelai. A camp as a base of operations will be established, as far as safe from the Congo, and left in charge of a trustworthy member of the staff. About fifty donkeys will be taken to carry the heavy baggage, and the caravan will consist of about 100 men, with a few Egyptian soldiers to maintain discipline. The staff consists of half-a-dozen carefully selected men, among whom are two able engineer officers, under whose care the interests of science will be attended to. Four or five carefully rated chronometers and other instruments are being taken, so that we may expect some good results. It is probable that Mr. Stanley will endeavour to solve the Albert Nyanza and the Wellé-Mobangi problem, as well as other obscure points in African hydrography, on his return journey. It is to be hoped that Emin Pasha will not think of coming away, as Dr. Junker states he wishes to do; but if he does, then no doubt Mr. Stanley will be able to make arrangements to carry on the work which Emin has begun so well. Mr. Stanley leaves England to-morrow, and the good wishes of all will go with him. He is confident of being able to reach Emin Pasha by July 1, and possibly may be back in Europe about Christmas; in that case, we fear, he could not do much exploring work.

DR. LENZ has at last arrived at Zanzibar, having taken less than eighteen months to cross the African continent from the mouth of the Congo. A fortnight ago we gave some account of his journey up the Congo from Stanley Falls to Nyangwe and Kasonge; it will be interesting to know what route he followed after leaving the Upper Congo. It will be remembered that Dr. Lenz went out eighteen months ago for the purpose, if possible, of reaching Emin Pasha and Dr. Junker. From Zanzibar the late Dr. Fischer started through Masai Land on a similar errand. In both cases the object has not been accomplished, and no wonder, now that we know the real facts. Much good work, however, has been done by both men. Dr. Lenz is a man of scientific training and experience in African travelling, and there can be no doubt that the results of his just completed journey will be a gain to science. It is possible that Mr. Stanley may meet with Dr. Lenz on his way to Zanzibar; and if so may obtain some information that will be of service on his great expedition.

THE Rev. Thomas Brydges, a missionary in Tierra del Fuego, in the large island of Onisin, among the Ona and the Yaghons, mentions a curious circumstance with reference to the people, illustrating the influence of environment on the acquirement of habits. Between men and women there is a fair subdivision of labour. Among other things, the men make and fit up the canoes, but the women are the rowers. The result is that the women are good swimmers, but the men cannot swim at all. The reason is that often on the coast there is not a single tree to which to fasten the canoes. The women, therefore, after landing their husbands, have to row the canoes to a spot where sea-weed has been massed together, in order to moor the canoes thereon; after which operation they are compelled to swim back. So, also, when the canoe is wanted, the woman has to swim out for it and row back for her husband.

THE current number of the *Mittheilungen* of the Geographical Society of Vienna (Band xxix. No. 10) has a large map of the route from Ango-Ango to Leopoldville, made by Herr Baumann, of the Austrian Congo Expedition, with accompanying remarks, and a comparison with other recent maps of the same part of the river. There is an interesting note by Herr Baumann on the numerical systems of the Why or Wai Negroes and of the Mandingoes. The former, although they have a writing of their own—the Mandingoes use Arab letters—have no expression in their language for 100, and use the English, while the Mandingoes, Bantus, and other tribes can count with ease up to 1000. Herr Baumann also writes on the region around Stanley Falls,

and its inhabitants. The two remaining papers are mainly geological, one being on the geography of Persia, by Dr. Tietze, the other the conclusion of Dr. Diener's paper on the hypsometry of Central Syria.

EXPERIMENTAL SCIENCE IN SCHOOLS AND UNIVERSITIES

PROF. G. F. FITZGERALD, as Vice-President of the Dublin University Experimental Science Association, delivered an address at the opening meeting, held on November 23 in the Museum Buildings of Trinity College, under the presidency of the Rev. the Provost, on "Experimental Science in Schools and Universities."

Prof. Fitzgerald, at the outset of his address, dealt with the history of Universities, and showed how they gave such preponderance to book as against experimental knowledge. That had led, the Professor continued, to a dual system of education —the professional and the commercial. That gap between the classes was much to be lamented, and necessitated, from a political point of view, the desirability of having all classes educated in the same institutions. The commercial classes would not, however, enter the Universities at present, because they required to be taught useful subjects, and they would not learn the Latin and Greek now required in our Universities. From the political side of the question, he thought, they had got these results—that they must be content to have useful subjects taught in their schools and Universities if the schools and Universities were to be used by the large body in the country who were willing and able to pay for it. What they must have, if possible, was a single school and college system for all classes of the community who were able to spend the first twenty years or so of their life in education, and they ought to have a system that was complete, a training which gave both those who could not afford to go on the whole length up to twenty years, and which ought to be able to train those who desired to go on for the higher culture. Returning to the education side of the question, he insisted that almost the whole importance was as to how the subject was taught. He thought the use of the Latin Grammar had been reduced to a very good system, but he thought it was perfectly evident from the course that things were taking and the reasonableness of things, that they must teach their youth some knowledge of science. People who felt responsibility in the matter were being more and more convinced that it was not right for them to allow their children to grow up ignorant of the laws of the world in which they live. Others made answer to that that they left those laws of the world to the doctors. But how were they to know under what circumstances it was well to consult a specialist? It was very necessary for us to have a knowledge when we required to consult a doctor. Hundreds of people were killed by ignorance of the fact that dirt was the cause of disease. That was a very elementary subject. Nevertheless, people were dying every day from ignorance of that very fact; and, unless they were taught to believe in the fact that there were laws of Nature, they would not believe that dirt was the cause of disease, because they saw some people living in dirt and yet not the victims of disease. He thought that time for teaching science must be found for these two reasons—it was necessary that our youth should learn the laws of the world in which they live, and that they also should learn how to discover those laws. Unless our people were taught the laws under which plants and animals were best grown, the people of other countries would rival them in the manufacture of butter and beef, and the result would be that our people must starve. Another advantage of such training was to prevent superstition such as that of the people of Spain, who preferred the use of charms as a safeguard against cholera to the cleansing of their wells. All the classes of the country required this training—they would die without it, so they must have it.

Having shown that the cultivation of Latin and Greek was originally with the view of acquiring the information contained in the ancient books in those languages, the Professor combated the five reasons formulated by the German professoriate as to why they thought that the cultivation of Latin and Greek was so important, observing, with regard to the fourth reason—that these languages were the best varied exercise in thinking—that if the connection between words and ideas was a thing that must be taught in every system of education, his impression was that that would be a great deal better attained by describing accurately and thinking out the consequences of physical experiment. In choosing the sciences that they should teach, there were three conditions that should be fulfilled. First of all, the sciences chosen ought to be within the grasp of children, because it was highly important that the science begun with childhood should be continued on in the University days; secondly, it ought not to require any expensive apparatus, because schools and people who trained children could not be expected to buy elaborate apparatus, and children could not be expected to work with them satisfactorily; and, thirdly, he thought the sciences should be chosen so as to be concerned with a large number of the laws of the world in which we live. There were two large branches of science which included nearly all the laws of the world, namely, the physical and the biological; and, therefore, he thought it would be desirable to choose two sciences—one on the physical and one on the biological side, so that children might learn something about the laws of living things, and something about the laws of physical things. He therefore suggested chemistry and botany, and he thought the whole weight of their efforts should be devoted to trying to get the children in schools to learn the elements of chemistry and the elements of botany, for there were no other two sciences the elements of which were almost similar, and at the same time there were no other two sciences that led up to a greater number of the laws of life, nor that gave a wider and more extended view of the laws of the world in which we live. The objections to the present system of teaching a knowledge of experimental science was that it almost entirely concentrated the person's attention upon phenomena instead of upon reasoning. Therefore, in choosing their system of teaching, all their weight ought to be thrown into making sure that their plan had the effect of making the child learn to think a good deal. Another thing they had to consider was the enormous time that children were made to remain in school without being engaged in anything except mischief. He thought a child should not spend more than four hours a day at literary work. Well, that occupied but a small part of a child's day; and one of the great advantages of having experimental subjects introduced into school teaching would be that they were subjects at which a child could work without experiencing very much fatigue. He could not help calling attention to the flagrant abuse of the teaching of experimental science in Irish schools. Experimental science in Irish schools was very nearly the same as snakes in Iceland. Having pointed out the fallacy of an examination—as exemplified in the Intermediate Education system—that was satisfied with a reading of the musical signs unwedded to a knowledge of the sounds they represented, the Professor said it would be an enormous advantage if the Intermediate Commissioners could be induced to keep up a peripatetic system of periodical examinations that would insist upon practical knowledge. That, however, should not interfere with the giving of papers also. After observing that it was at the present time impossible to carry out a proper examination in laboratory work, and stating that he considered it would be very desirable that the actual work in the laboratory and analyses in practical subjects should count towards the University prizes, Mr. Fitzgerald said he considered that the present system of analysis was not very satisfactory, and he urged the introduction of a system that would teach chemistry practically. Though that might be harder to teach than Latin and Greek, it would not be so if they had a system worked out and teachers to promote it, and it would have the inestimable advantage that, in addition to training the child to think—which he thought it would do equally well with Latin and Greek—it would teach him the laws of things, and how to see and learn the laws of things. It would also teach the child to use language to express real ideas, and not merely phrases. They would also learn a good deal more of the laws of language from a modern language that they learned with the grain than they would by learning an ancient language against the grain. He thought that literature and history were co-ordinate with science, and they certainly ought to be a large part of education. Literature and history were grievously neglected in the present day—practically they had no place, and that was substantially because Latin and Greek were supposed to be a literary education. One of the reasons was that those subjects were hard to examine in, but there was an easy way out of that difficulty in Universities. They need not examine, but they could require attendance at lectures—attendance on good lecturers; and the student would pick up more

culture and would be obtaining a better literary education from hearing a good lecturer and being inspired by his enthusiasm than he would get by learning off one of Shakespeare's plays, and answering it at an examination. Those two aspects of education, the literary and scientific, were often put in opposition, just as the freedom of the individual and the power of the State to control the individual were very often set up in opposition to one another; but he did not think any one would believe that that opposition really arose, for the freest States were those in which the power of the State was the strongest. In conclusion, he would say that we must equip our youth for the battle of life physically and ethically. The present is a great crisis in Irish education. There is danger of science schools starting, and all the evils of dual education. There are a large body who like Latin and Greek, because they exclude literature and history. These are to be fought tooth and nail. There are those who would sacrifice the rising generation on an altar of so-called culture to starve and die, with their only comfort that they can describe their agony in well-expressed phrases. There are those who would grind all soul out of mankind in a mill of manual labour, constructed on scientific principles. All those are to be guarded against. We must have literature and history. We must have knowledge of the laws of the world in which we have to work. We can have both if we will but work out a reasonable system of education, instead of pretending that the lop-sided corpse that occupies our schools and Universities is a well-developed, symmetrical giant.

ABORIGINAL ART IN CALIFORNIA AND QUEEN CHARLOTTE'S ISLAND

In the fourth volume, recently issued, of the Proceedings of the Davenport Academy of Natural Sciences there is a valuable [illegible] by Dr. W. J. Hoffman on "Aboriginal Art in California and Queen Charlotte's Island." In the summer of 1884 Dr. Hoffman visited the Pacific coast for the purpose of continuing his researches on primitive art, and he was fortunate enough to find a number of localities in which there are painted and "etched" records, of considerable interest, made by Indians belonging to tribes now unknown. These records occur in groups. One group, the first described by Dr. Hoffman, is in the neighbourhood of Santa Barbara. The best preserved paintings in this series are in a cavity which measures about twenty feet wide and eight feet high. The rock consists of gray sandstone, but the ceiling and back portion of the cave have a yellowish appearance. The colours employed were red ochre, white, and bluish black. Some of the paintings Dr. Hoffman takes to be representations of gaudily-coloured blankets. In several instances a grotesque human figure is drawn over or in front of what seems to be a blanket, as if the latter were intended as a body blanket or serape. In the Azuza cañon, about thirty miles north-east of Los Angeles, Dr. Hoffman examined a second series of painted records. Rudely sketched human figures are represented as pointing in certain directions, and the intention evidently was that they should serve as guides to travelling parties. For instance, the left arm of a figure on a white granitic boulder points towards the north-east. The precipitous walls of the cañon make egress in that direction impossible, but two hundred yards further on the cañon makes a sharp turn towards the north-east, and in rounding the point of land to the right the traveller comes to another boulder, on which are numerous faint drawings of various kinds. This boulder is on the line of an old trail leading from the country of the Chemehuevi, on the north of the mountains, down to the valley settlements of San Gabriel and Los Angeles. A third series of records was found in the southern part of Owens Valley, California, between the White Mountains on the east and the Benton Range on the west. They are "etched," not painted. The most common characters in this group are circles, either plain, nucleated, bisected, concentric, or spectacle-shaped, by pairs or threes, with various forms of interior ornamentation. This group resembles etchings in the Canary Islands so closely that the illustrations given by Dr. Hoffman serve for both localities. On one of his plates he presents a number of circles with ornamented interiors, from a simple bisection to the stellate and cruciform varieties. Similar circles bearing cross-lines occur at Grevinge, Zeeland; and other forms resembling some at Owens Valley are found at Slieve-na-Calliagh, Grange, and Dowth, in Ireland. The spectacle-shaped variety resembles the mysterious symbol on some Scottish monuments which has given rise to so much vague speculation. The reversed Z, however, is wanting in the Californian examples. Of the various outlines of the human form presented by Mr. Wallace from Brazil, and referred to more recently by Prof. Richard Andree in "Ethnographische Parallelen und Vergleiche," a considerable number are almost identical with etchings in the Owens Valley series. Many of the characters in these three Californian groups are similar to, and some are indistinguishable from, those made by the Moki and other tribes of the Shoshonian linguistic stock. Further research on the same lines may, therefore, enable anthropologists to determine the former geographical area of the Shoshonian family, as has already been done in the case of the Algonkian tribes.

In the neighbourhood of Los Angeles Dr. Hoffman obtained a portion of an old Indian gravestone. On this slab there are incised characters which seem to represent a whale-hunt, and no doubt they were intended to denote the occupation of the person to whose memory the tablet was erected. Honour is done to the dead in a similar manner by the Innuit of Alaska and by the Ojibwa. Among the Innuit, the posts erected for men usually bear rude drawings of weapons and animals; those for women have representations of household utensils and implements. On Ojibwa gravestones, as Mr. Schoolcraft has noted, the totem of the deceased is drawn in an inverted position.

Dr. Hoffman offers some interesting remarks on the subject of tattooing. In former times, in the vicinity of Los Angeles, every chief caused the tattooed marks upon his face to be reproduced upon trees or poles which indicated the boundaries of his land; and as these marks were well known to neighbouring chiefs, they were a sufficient warning that trespassers would be punished. A custom akin to this prevails in Australia, where the tattooed designs upon the face of a native are often engraved upon the bark of trees near his grave. Among many of the tribes west of the Mississippi there are still numbers of persons who bear tattoo marks upon the chin, the cheeks, and even upon other parts of the body, but the marks seldom occur in any forms other than narrow lines, except among the Haida Indians of Queen Charlotte's Island, where the art of tattooing has reached a higher degree of development than on the mainland. The Haidas tattoo upon the back, breast, fore-arms, thighs, and the legs below the knees; and women submit to the operation as well as men. The characters are totemic, and represent either animate or mythologic beings. They are usually drawn in outline, with interior decorative lines, red being sometimes introduced to form what is supposed to be a pleasant contrast. The ceremonies at which the tattooing is done are held in the autumn, and extend over a period of several weeks. Among the figures generally adopted are the thunder-bird raven, bear, skulpin, and squid. A former Factor of the Hudson's Bay Company told Dr. Hoffman that when he first went to the country occupied by the Haida Indians he saw no tattooing upon the bodies of the older members of the tribe; and he contends that they have learned the art from natives of some of the South Pacific Islands, which they occasionally visit as traders.

The Haidas display considerable skill as carvers in wood and slate. Totem posts are often placed before the council-houses, and more frequently before private dwellings. When the posts are the property of some individual, the personal totemic sign is carved at the top. Other animate and grotesque figures follow in rapid succession down to the base, so that unless one is familiar with the mythology and folk-lore of the tribe the subject would be utterly unintelligible. On one post to which Dr. Hoffman refers there are only seven pronounced carvings, but they relate to three distinct myths. On household vessels, the handles of wooden spoons, and other objects, the Haidas often carve the head of a human being in the act of eating a toad. Sometimes the toad is placed at a short distance below the mouth. The idea is that in the wooded country there is an evil spirit who has great power of committing evil by means of poison extracted from the toad. The Indians are not willing to acknowledge the common belief in this mystic being, even when they are aware that the inquirer is in possession of the main facts.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

OXFORD.—The long-expected reform of the examination system which makes it unnecessary for men reading mathematics and natural science to pass any examinations of a non-scientific

character after coming into residence has at last been accomplished. The arrangement, which comes into force with the beginning of this year, is that candidates for degrees in mathematics and natural science take up responsions (or some equivalent examination at school) like other people, but by passing in one extra subject they are excused the second classical examination, in preparing for which they used to waste a good part of their first year of residence. The extra subjects from which candidates may choose include Greek, Latin, French, and German authors, Bacon's "Novum Organum," and the elements of logic. This alteration will be an undoubted benefit to science men, for, as the new examination involves no preliminary residence and occurs four times a year, they can proceed at once to take up the subject which they have chosen for their final schools.

The following courses of lectures and practical classes are announced for this term:—

Prof. Pritchard is to lecture at the Observatory on "Planetary Theory" and on "Astronomical Instruments and Methods," and offers practical instruction. Prof. Bartholomew Price lectures at the Museum on "Optics."

At the Clarendon Laboratory Prof. Clifton continues his course on "Electricity," and Mr. Walker lectures on "Double Refraction treated Mathematically." The practical work remains in the hands of the Professor, Mr. Walker, and Mr. Selby. Sir John Conroy, who has undertaken Mr. H. B. Dixon's work at Balliol and Trinity, lectures on "Elementary Electricity."

In the Chemical department Prof. Odling will lecture on the "Benzoic Compounds"; Mr. Fischer and Mr. Watts continue their systematic courses on "Inorganic" and "Organic Chemistry" respectively. Mr. C. I. Baker and Mr. Marsh assist in the laboratory teaching. In Mr. Vernon Harcourt's laboratory at Christ Church and in the Balliol Laboratory the usual work is to be carried on.

The arrangements in the department of Morphology have been somewhat disturbed by the appointment of Mr. Baldwin Spencer to the Biology Professorship at Melbourne. Prof. Moseley is to lecture on the "Comparative Anatomy of the Vertebrata," and is to have Mr. G. C. Bourne as Assistant Lecturer and Demonstrator. Mr. Barclay Thompson lectures on the "Osteology and Distribution of the Ichthyopsida."

In the new Physiological Laboratory, Prof. Burdon Sanderson lectures on the "Physiology of the Nervous System," Mr. Dixey on "Histology," and Mr. Buckmaster gives an elementary course of Physiology for the newly-organised preliminary examination. Practical instruction is given in Physiology by Mr. Gotch, in Histology by Mr. Dixey, and in Physiological Chemistry by Mr. Haldane.

Quite a number of men are beginning to read for the new Medical School. The dissecting-room is under the charge of Mr. Arthur Thomson, who lectures on the "Digestive System."

Prof. Prestwich is to lecture chiefly on "Ternary and Quaternary Geology," including the Glacial period and questions relating to the antiquity of man. Prof. Westwood lectures on the "Arthropoda."

At the Botanic Garden, Prof. Bayley Balfour lectures on "Vegetable Morphology and Physiology," and has both elementary and advanced instruction in practical Botany.

The Pitt-Rivers Anthropological Collection is now so far arranged that the formal opening will probably take place this term. All the cases on the ground floor of the new building have been arranged by Mr. Balfour. Dr. Tylor is to lecture on the "Development of Arts" as illustrated by the collection.

Next week the annual examination for a Radcliffe Travelling Fellowship begins.

SCIENTIFIC SERIALS

Bulletins de la Société d'Anthropologie de Paris, tome 9ème, 3ème fascic. 1886.—On the relations between the organs of touch and smell, by Dr. Fauvelle. In this paper the author considers the proposition advanced by M. Pozzi that the attitude of an animal is always in accord with the exercise of its predominant organ of sense. On this assumption the biped station would be the consequence of the predominance of vision over smell, and the attitude of quadrupeds the result of the relatively higher development of their sense of smell. In refutation of this view the writer argues that the relations between the organs of sight and smell in bipeds and quadrupeds are the result, rather than the cause, of their different stations, while he shows that wherever in the animal series the organs of sight would seem to have lost their importance in proportion to the development of the sense of smell the latter is aided by delicate organs of touch situated on those parts of the body which form its anterior side when moving forward. Thus in the vertebrates all the organs of the senses are situated at the cephalic extremity of the body.—On a woman with a tail. The case, reported by M. Melikoff, was observed by Dr. Eliséeff, of St. Petersburg, author of an interesting work on men with tails. According to the statement of the woman, who suffered great pain from her caudal appendage, a similar abnormality had been observed in several female members of her family, in all of whom it had appeared between the ages of 12 and 17 years. Dr. Eliséeff refers this formation to embryogenic causes, such as an arrest of development in the fœtus, and observes that such cases are more frequent in males than in females, the latter, according to him, presenting a much more advanced corporeal development than men.—A case of double uterus, by Dr. Landowski.—On short-tailed dogs, by M. Duval.—Observations on the cranium of several insane subjects, by M. Manouvrier.—On the weight of Gambetta's brain, by M. Duval. This paper, and the discussion to which it gave rise, are especially interesting from the new light which they throw on the assumed relations between the large volume of the brain and intellectual capacity, the weight of Gambetta's being only 1160 grammes, or, according to M. Duval, 1246 after making all possible allowance for accidental diminution by faulty methods of preparation, while the mean for persons not gifted with more than ordinary intelligence is 1360 grammes.—On a new variation of the ossa wormiana, by M. Manouvrier.—A case of pilosity in a young Laotian girl, by Dr. Fauvelle.—On acclimatisation in reference to French colonisation, by Dr. Fauvelle.—On the anthropological characteristics of the Indo-Chinese peoples, by Dr. Maurel.—On the origin of the bronze and tin of prehistoric times, by Mme. Clémence Royer. The writer believes that Europe supplied the sources whence bronze implements were fabricated by early [illegible] while M. Mortillet considers that both the material and production of the weapons, ornaments, and other objects of this kind which belong to prehistoric times must be referred to India and the Far East.—Enumeration of the megalithic remains of Nièvre, by Dr. Jacquinot. The number of such remains in the whole of France, as certified by official inquiry, amounts to 6310, of which thirty-five belong to Nièvre. Among these special interest attaches to the horizontal slabs of Saint Agnan, which Dr. Jacquinot considers to have been altars for human sacrifices.—Summary of the answers given by New Caledonians to the interrogatories of the Society of Sociology and Ethnography, by M. Moncelon. These answers supply interesting materials for the ethnographic study of these races, and show the importance of following a definite plan in pursuing such inquiries.—Anthropological observations of the Khmer tribes of Cambodia, by Dr. Maurel. The writer, who supplies numerous anthropometric measurements, believes that these peoples belong to the Mongolian group.

Rendiconti del Reale Istituto Lombardo, November 11, 1886.—Meteorological observations made at the Brera Observatory, Milan, during the months of August and September.

November 25.—Results of the experiments carried out at the experimental farm of the Royal Milanese School of Agriculture against the mildew of the grape-vine, by Prof. Gaetano Cantoni. Of the various methods of treatment here described, the preparation of a sulphate of copper dissolved in water in the proportion of three per thousand is shown to be the most efficacious. The analysis of the wines obtained from crops so treated shows that they usually contain a scarcely appreciable quantity of the copper.

Bulletin de l'Academie des Sciences de St. Petersbourg, tome xxi. No. 2.—Report on a memoir by M. Harzer on a special case of the problem of the three bodies, by O. Backlund. It is considered a most valuable work, being the first attempt to apply the method of Prof. Gyldén.—New transcription of the Castren's Koibal dictionary and Koibal poetry, made by M. Katanoff (who is himself of Sagai origin), from the Abakan, with a preface by W. Radloff.—Photometric researches on the diffusion of light, by O. Chwolson, being numerical data of new experiments mathematically treated.—Hydrological researches, xlv. to xlvii., by C. Schmidt.—Chemical analyses of water from lakes in North-west Mongolia and in North Tibet.—On a differential equation, by B. Ichmenetzky.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, November 25, 1886.—"On the Dynamical Theory of the Tides of Long Period." By G. H. Darwin, LL.D., F.R.S., Fellow of Trinity College, and Plumian Professor in the University of Cambridge.

Laplace sought to show that, as regards the oscillations of long period, called by him "of the first species," friction would suffice to make the ocean assume at each instant its form of equilibrium. His conclusion is no doubt true, but the question remains as to what amount of friction is to be regarded as sufficing to produce the result, and whether oceanic tidal friction can be great enough to have the effect which he supposes it to have.

In oscillations of the class under consideration, the water moves for half a period north, and then for half a period south. Now in systems where the resistances are proportional to velocity, it is usual to specify the resistance by a modulus of decay, namely, that period in which a velocity is reduced by friction to $1 \div 2{\cdot}783$ of its initial value; and the friction contemplated by Laplace is such that the modulus of decay is short compared with the semi-period of oscillation.

The quickest of the tides of long period is the fortnightly tide, hence, for the applicability of Laplace's conclusion, the modulus of decay must be short compared with a week. Now it seems practically certain that the friction of the ocean bed would not much affect the velocity of a slow ocean current in a day or two. Hence we cannot accept Laplace's hypothesis as to the effect of friction.

This paper then gives a solution of the equation of motion when friction is entirely neglected. The method is indicated in a footnote to a paper by Sir William Thomson (*Philosophical Magazine*, 1875, vol. 50, p. 280), but has never been worked out before.

It appears in the result that with an ocean 1200 fathoms deep covering the whole globe, the fortnightly tide has about 1/7th of its equilibrium value at the pole, and nearly a half at the equator. If the ocean be four times as deep we get analogous results, and it appears that with such oceans as we have to deal with the tide of long period is certainly less than half its equilibrium result.

In Thomson and Tait's "Natural Philosophy" (edition of 1883) a comparison is made of the observed tides of long period with the equilibrium theory.

This investigation was undertaken in the belief of the correctness of Laplace's view as to the tides of long period, and was intended to evaluate the effective rigidity of the earth's mass.

The present result shows that it is not possible to attain any estimate of the earth's rigidity in this way, but as the tides of long period are distinctly sensible, we may accept the investigation in the "Natural Philosophy" as generally confirmatory of Thomson's view as to the great effective rigidity of the whole earth's mass.

There is one tide, however, of long period of which Laplace's argument from friction must hold true. In consequence of the regression of the nodes of the moon's orbit there is a minute tide with a period of nearly nineteen years, and in this case friction must be far more important than inertia. Unfortunately this tide is very minute, and as is shown in a Report for 1886 to the British Association on the tides, it is entirely masked by oscillations of sea-level produced by meteorological or other causes.

Thus it does not seem likely that it will ever be possible to evaluate the effective rigidity of the earth's mass by means of tidal observations.

December 9.—"Note on a New Form of Direct-Vision Spectroscope." By G. D. Liveing, M.A., F.R.S., Professor of Chemistry, and J. Dewar, M.A., F.R.S., University of Cambridge.

December 16, 1886.—"Preliminary Account of the Observations of the Eclipse of the Sun at Grenada in August 1886." By Captain Darwin, R.E. Communicated by Lord Rayleigh, Sec. R.S.

The instruments allotted to me consisted of the coronagraph and the prismatic camera; the two instruments being mounted on the same equatorial stand.

The photograph obtained with the prismatic camera shows several images of the prominences, and it therefore gives every promise of yielding good results when measured and examined.

The five- and ten-second photographs of the corona show signs of a slight vibration, but they will be useful for the inner part of the corona. As my main object was to obtain instantaneous photographs, these long-exposure plates had to be obtained by working the automatic shutter by hand; it was this probably that caused the vibration.

The instantaneous photographs of the corona when developed were complete blanks, proving that the exposure was too short. It should, however, be observed that this does not prove that the light of the corona was insufficient to cause an appreciable effect on the plate if combined with other light. More light energy is necessary to start photographic action than is required to produce a visible difference of shade when once the action is started.

Many of the photographs taken during partial eclipse show what may be described as a false corona, that is, an increase of density near the sun and between the cusps, or *in front of* the moon. In none of them can the moon be seen eclipsing the corona.

The results, therefore, are adverse to the possibility of obtaining photographs of the corona in sunlight; it is, however, I consider, by no means proved that the method is impossible. But at present I am inclined to consider that the result tends to show that a *practical* method of obtaining photographic records of the corona during sunlight is not likely to be obtained. The trial was not conclusive because the conditions were very unfavourable. In order to reduce the air-glare to a minimum, so that the light of the corona shall not be overpowered, the following points must be observed:—

(1) The air should be clear and dry.

(2) The sun should be near the zenith.

(3) The station should be at a considerable elevation above the sea.

(4) The corona, if it does vary in intensity, should be at its maximum brightness.

Now every one of these conditions was unfavourable. The air was saturated with moisture, the sky was of a hazy blue, the sun was low, the station was near the sea-level, and the corona, according to the general impression, was not so bright as on other occasions.

I hope, however, to deal more fully with these considerations on another occasion.

Mathematical Society, January 13.—Sir J. Cockle, F.R.S., President, in the chair.—Prof. G. B. Mathews was elected a Member.—The following communications were made:—Conjugate "Tucket" circles, by R. Tucker.—On the incorrectness of the rules for contracting the processes of finding the square and cube roots of a number, by Prof. M. J. M. Hill.—On the complex angle, by J. J. Walker, F.R.S.—Shorter communications were also made by Messrs. Heppel, Macmahon, and S. Roberts, F.R.S., in the discussion of which several members took part.

Victoria Institute, Jan. 3.—Dr. Wright read a paper describing the Hittite monuments which he had examined in the East, and giving an account of the present position of the question as to the age and extent of the country of the Hittites. Many afterwards joined in the discussion. Thirty members and associates were elected, and it was announced that 100 had joined during the past year, making 1200 members the Institute's strength.

EDINBURGH

Mathematical Society, January 14.—Mr. W. J. Macdonald, Vice-President, in the chair.—Prof. Chrystal gave a paper on the generation of any curve as a roulette; and Mr. William Renton contributed some mnemonics for plane and spherical trigonometry.

PARIS

Academy of Sciences, January 10.—M. Gosselin in the chair.—Note on the works of the late M. Oppolzer, Corresponding Member of the Section for Astronomy, by M. Tisserand. In this obituary notice reference is made more especially to the eminent astronomer's "Traité des Orbites," his determination of the orbits of the planets and many comets, and his theory of the movement of the moon.—On various phenomena presented by the artesian wells recently sunk in Algeria, by M. de Lesseps. The results are described of unusually successful operations undertaken in 1885 and last year in the region of the Shotts, where one well, yielding as much as 8000 litres per

minute of pure water at a temperature of 25° C., has already developed a considerable lake 10 metres deep, by means of which from 500 to 600 hectares of waste land have been reclaimed. Similar results elsewhere give hope that large tracts now uninhabited, but which supported a numerous population in the time of the Romans, will soon be again brought under cultivation.—On the theory of algebraic forms with p variables, by M. R. Perrin.—On the action of the chloride of carbon on the anhydrous oxides, by M. Eug. Demarçay. Schützenberger having shown that the tetrachloride of carbon reacts readily on the sulphuric anhydride, forming phosgene and chloride of pyrosulphuryl, the author here describes some experiments he has carried out for the purpose of ascertaining whether the same substance reacts on the oxides, and whether this reaction might not be utilised in the laboratory for facilitating the preparation of the anhydrous chlorides.—On erythrite, by M. Albert Colson. This substance should yield successively by oxidation a monobasic and a bibasic acid, the latter being tartaric acid, according to Henninger's formula. But no monobasic acid derived from erythrite has yet been described, nor has the transformation of this alcohol into tartaric acid ever given satisfactory results. The author here accordingly resumes the study of its oxidation, testing by the thermo-chemical process the formulas hitherto accepted for erythrite and tartaric acid. He also treats erythrite with the perbromide of phosphorus, obtaining a bromhydrine, $C_4H_6Br_4$, fusible at 112° C., and identical with the tetrabromide of crotonylene, described by Henninger.—On the glycerinate of potassa, by M. de Forcrand. Having already determined the heat of formation of the glycerinate of soda, and of its ethylic combination, and the conditions under which these compounds have their origin, the author here subjects the glycerinate of potassa to a similar process with analogous results.—On the substances derived from erythrene, by MM. E. Grimaux and Ch. Cloez. The object of the experiments here described is to ascertain whether erythrene and the carburet of gas oils are really identical, as supposed by Henninger. The result so far shows that the erythrene derived from the oils of compressed gas unites readily with hypochlorous acid, the product of the reaction being soluble in ether, alcohol, and water.—On the artificial production of zincite and willemite, by M. Alex. Gorgeu. The methods by which the author reproduces zincite are based on the decomposition of several salts of zinc by heat alone, or aided by the vapour of water. It is merely an application of the process by which M. Debray has obtained crystals of glucine, magnesia, &c. Willemite, $SiO_2,2ZnO$, he produces by a method based on the action of silica on a mixture of alkaline sulphate and sulphate of zinc.—Observations on fishes inhabiting very deep waters (second communication), by M. Léon Vaillant. The really characteristic types of this class of deep-sea fauna are referred to the sub-order of the Anacanthini, which yields a considerable number of species, living at great depths. There is almost a total absence of Pleuronectes, the solitary exception being *P. megastoma*, Donov., fished up from a depth of 560 metres. A striking feature of this ichthyological fauna is its great uniformity, the same genera and even closely-allied species constantly reappearing and being evidently diffused over the widest ranges.—Researches on the mechanism of respiration in the Myriapods, by M. J. Chalande. Most zoologists suppose that the breathing process is the same in the Myriapods as in insects; but the author's researches show conclusively that this hypothesis is absolutely erroneous. In them respiration is effected by the rhythmical movements of the dorsal vessel, the air also penetrating by diffusion to the most delicate tracheæ.—On the age of the Bauxite formation in the south-east of France, by M. L. Collot. This formation, which in the Ariège district occurs between the Coralline and Urgonian deposits, is referred to the successive geological epochs between the Lower Lias and the Urgonian.—On the partial results of the first two experiments made to determine the direction of the North Atlantic currents, by Prince Albert of Monaco. Of the 169 floats cast overboard 300 miles north-west of the Azores in 1885, fourteen have been recovered, showing a general south-easterly direction and a mean velocity of 3·83 miles per twenty-four hours. Of the 510 floated in 1886 much nearer to the French coast, nine have reappeared, showing nearly the same direction, with velocities of from 5·80 to 6·45 miles.—Coincidence of certain solar phenomena with the perturbations of terrestrial magnetism, by M. E. Marchand. A comparative study of the solar observations made at the Lyons Observatory in 1885-86 with the curves of the Mascart magnetic recorder shows that there exists a direct relation between the terrestrial magnetic disturbances and the displacements of certain solar elements accompanying the spots and the faculæ.—On the actual value of the magnetic elements at the Parc Saint-Maur Observatory, by M. Th. Moureaux.—Note on the recent minimum of the solar spots, by M. A. Ricco. This minimum, which occurred between October and December, 1886, was specially remarkable for its intensity, no spots or pores being at all visible twice for eleven days and once for eight days during that period.—Remarks on the geological chart of Lake Baikal and the surrounding district, by M. Venukoff. A careful study of this map, drawn to a scale of 1 : 420,000, shows that the Baikal basin is not a *crevasse* in the Jurassic beds, as had been supposed, nor a subsidence due to plutonic or volcanic causes, but that its formation dates from pre-Silurian times and is still in progress.

BOOKS AND PAMPHLETS RECEIVED

Practical Zoology: Marshall and Hurst (Smith, Elder).—The Garner, vol. i. (Bowers, Walworth).—Massachusetts Institute of Technology—Twenty-second Annual Catalogue of Officers and Students, and President's Report (Boston).—Folk-Lore and Provincial Names of British Birds: Rev. C. Swainson (Stock).—Flora of Leicestershire (Williams and Norgate).—Journal of the Franklin Institute, January.—Transactions of the Yorkshire Naturalists' Union, Parts 7, 8, 9 (Taylor, Leeds).—Precious Stones in Nature, Art, and Literature: S. M. Burnham (Trübner).—Health at Schools: Dr. C. Dukes (Cassell).—Deviation of the Compass in Iron Ships: W. H. Rosser (Imray).—Sonnets on Nature and Science: S. Jefferson (Unwin).—Logia of the Lord; Historical Jesus; Paul the Gnostic Opponent of Peter; Devil of Darkness: G. Massey.—Report of Kew Observatory Committee for the Year ending December 31, 1886 (Harrison).—Explication des Taches du Soleil: M. Delauney (Paris).—Elementary Ideas, Definitions, and Laws in Dynamics: E. H. Hall (Cambridge, Mass.).—Studien über das Molekular-volumen einiger Körper: G. A. Hagemann (Friedländer, Berlin).

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THURSDAY, FEBRUARY 10, 1887

THE HISTORY OF HOWIETOUN

The History of Howietoun. Part I. By Sir J. Ramsay Gibson Maitland, Bart. (Stirling, N.B.: J. R. Guy, Secretary Howietoun Fishery, 1887.)

PROBABLY every one at all interested in fish-breeding has heard the name of Howietoun, and a great many people, especially in Scotland, have some knowledge of the character of the establishment and the operations there carried on. Occasional paragraphs in scientific periodicals, as well as in daily papers, announce some experiment in the artificial stocking of home waters with some kinds of trout or with salmon fry, or some successful exportation of salmonoid ova to America or to the colonies at the Antipodes. The name of Sir James Maitland or of Howietoun very often occurs in such announcements. Those who have given attention to the subject will find much to interest them in the account of the development of his fish-farm, and in the description of its present condition, which Sir James Maitland is now placing before the public. At present we have only the first part of the work, in which the history is brought down to the spring of 1879. A note on the fly-leaf informs us that the remaining part will be issued shortly. The present volume is of large quarto size, printed in large type, and liberally illustrated with excellent woodcuts.

The author states in the preface that the culture of Salmonidæ is now an achieved success, and he describes the gradual progress of the efforts which have culminated in this result at Howietoun, with the hope that his experience may prove of use to those who are working on the still larger question of our sea-fisheries. The first seven chapters contain a general description of the regular operations which are now carried on after thirteen years of practice and experimental ingenuity at the Howietoun farm. Sir James Maitland asserts emphatically that Great Britain is pre-eminent among all nations in matters pertaining to fisheries. He does not argue at any length in support of this patriotic claim, which he seems to found chiefly on the perfection of the Howietoun establishment, and the success of the system of Government supervision under which the Scottish herring trade is carried on. His eulogy of these two institutions is quite justified by facts, and there can be little doubt that the value of the fisheries of Great Britain, in proportion to the total population and total wealth, is greater than in many other countries. But there are other matters pertaining to fisheries in which the pre-eminence of Great Britain may well be disputed, and has been disputed very frequently of late years. The scientific study of the sea-fisheries, and the application of the results of such study, have undoubtedly been carried out to an enormously greater extent in other countries than with us. The reproduction of the cod was first investigated in Norway; oyster-culture as understood in Holland and in France is still unknown in Britain; and the organised scientific investigation of fishery matters, which has been commenced by the Scottish Fishery Board and is about to be instituted by the Marine Biological Association in England, has been, as it were, forced upon us by the example of the United States. Perhaps no American salmon-hatchery is quite as efficient as the Howietoun farm, but the extent of piscicultural operations applied to Salmonidæ in the United States is certainly greater on the whole than in Britain. This is not the occasion, however, for a complete comparison of Great Britain with other countries with regard to pisciculture. The history of Howietoun shows how greatly Sir James Maitland, by his individual energy and enterprise, has advanced the art of breeding Salmonidæ, and we have to notice shortly some of the most interesting parts of his book.

Before considering particular points, we may remark that the "History of Howietoun" is a book that can not only be referred to with profit, but read with pleasure. The author's genial individuality has an interest of its own, and his pages are full of suggestions of healthy, cheerful, energetic out-door life which make them picturesque and refreshing. The use of the plural "ova" as a singular seems to be common among pisciculturists, and it is a pity that this small blemish was not remedied in the proofs.

The greater number of the ova hatched at Howietoun are from Loch Leven trout kept in ponds at the farm. Ova are collected from wild *Salmo salar* taken from differen Scottish rivers, and small numbers of ova of *S. fario* and *S. fontinalis* are dealt with, but the greatest amount of space and attention seems to be devoted to *S. levenensis*. In the account of the "egg harvest" some interesting discoveries are mentioned which show a constant relation between feeding and breeding. If the fish are highly fed at an early date in the year, they begin to spawn earlier; the food used for this purpose is Pecten, and if this is given early in February, maturity is reached early in November. To obtain the eggs for the hatchery the females are stripped over large earthenware milk-plates, into which the ova fall. About 10,000 ova are stripped into one pan, and these can usually be impregnated by the milt of one male. After the milt has been added, only a tumblerful of water is poured into the pan; the eggs are then left to impregnate for 30 to 45 minutes. The ova, when first shed, are soft to the touch and inclined to adhere together; after impregnation they feel hard, and separate easily. The next process is to pour the ova into large pails full of water, which are held immersed in one of the inlets to the ponds, so that the milt is washed away; the ova are then carried in the pails to the hatching-house.

Collecting ova from fish in the wild state is a much more laborious process than from the fish in the ponds, and Sir James advocates strongly the advisability of Fishery Boards building proper ponds in which to retain the gravid fish until ripe. At Howietoun 20,000,000 trout (presumably *levenensis*) ova can be produced at a cost of little over 1000*l.* a year.

The account of work in the hatching-house would naturally follow that of the egg-harvest, but the chapter on packing has been inserted between them. The work in the hatchery is described in detail. The eggs are poured with a glass measure over the centres of the glass tubes forming the *grilles*, and afterwards dressed into regular rows by "feathering," an operation performed by girls, as the eggs at this stage are easily killed by too

much handling, and a trained girl can give the slight motion which is required to the eggs without actually touching them with the feather at all. Each box is entered by a number in a book, and a record of the number of dead eggs daily taken from it is kept on a printed form, and afterwards entered in the same book. Two girls only are employed in attending to all the hatcheries at Howietoun. The stage in the development of the ova between the formation of the blastoderm and the appearance of the eyes is called the "spectacle" stage, and the health of the embryo can be estimated by certain signs at this period; but the description given of these signs is not easy to follow. Up to the eye stage the ova are very delicate, but as soon as the eyes appear the eggs can be handled, and this is the best age for packing for the Antipodes. Eggs for America or Europe are packed at a later period, when red blood has appeared. When the eggs are ready to hatch, the *grilles* are taken out, the boxes cleaned, and the eggs are emptied off the *grilles* on to the bottom of the box. The depth of water in the boxes containing the alevins is only 3 inches. The alevins congregate in dense masses in the corners and against the sides of the hatching-box, and the motion of the pectoral fins causes a continuous current to descend downwards through the mass. When the yolk-sac is nearly absorbed, the fry are fed with food prepared from fillet of beef or of horse, and yolks of hard-boiled eggs. The food is made into paste in a mortar, and rubbed through "feeding-spoons" of perforated zinc into the hatching-box.

Next follows an account of the method of despatching living fry. These cannot travel for more than twenty-four hours, and they are sent in tanks quite full of water, as motion of the water exhausts the fish at this stage. The greater number of the fry, after a short time in the hatching-house, are placed in ponds constructed of wood, 100 feet in length, where they remain throughout the summer, and where they are fed daily by hand for the whole time. It is stated that 100,000 trout eleven months old would consume between two and three horses a week.

A considerable amount of stocking is effected with yearling trout, which are carried in conical tanks. The fish must be starved some days before being despatched, as, if placed in travelling-tanks when fully fed, they rapidly make the water foul. In the bottom of the lid of the tank is an inverted cone perforated with holes and filled with ice; this keeps a constant temperature, and promotes aëration of the water. Two-year-old, and even larger, trout are also sent out; these are placed in larger tanks, provided with small wheels, but constructed on the same principle.

In Chapter III. an elaborate account is given of the methods of packing ova. The first operation is to transfer the ova which are to be packed from the *grilles* to peach netting stretched on square wooden frames. This step is carried out in a specially constructed sink, through which water is kept running. The ova are emptied from the *grille* into a wooden box, from which they pass into a leaden basin with a narrow bottom. One of the frames is then floated in the sink, and a glass measure containing 1100 eggs is used to measure the eggs from the basin on to the frame. The frames are placed in the packing-room in piles, one pile for each box. Next morning the frames are examined, so that any egg with an ill-developed embryo may be picked out. Then, a square of swan's-down, contained in a special tray, is placed over the eggs on the frame, and, the two being suddenly reversed, the eggs rest on the swan's-down without altering their relative position; thus each egg lies separately on the swan's-down. The frame is removed, and the square of swan's-down with its burden placed in one of the travelling-trays. Above the eggs is next placed a square of felted moss (*Sphagnum*). Above the moss is placed another layer of swan's-down carrying a layer of eggs, and then another layer of moss, and so on, till the travelling-tray is filled. The bottom of the travelling-tray is made of perforated zinc, and before any eggs are placed in it, the bottom is covered with a thin layer of moss. The eggs thus rest on swan's-down, and are covered with felted moss, a layer of which also forms the lowest and uppermost layer of the tray when full. For journeys to the Continent or America, unbleached lino is substituted for the swan's-down, because swan's-down retains so much carbonic acid that advanced embryos are asphyxiated. For the Antipodes, an extra precaution has to be taken: a thin layer of moss is inserted between the layer of unbleached lino and the eggs, so that the latter are in contact with the moss above and below. The travelling-tray is 10 inches square and 2½ inches deep. The trays are packed in an inner box only ⅜ inch larger than themselves, and this is placed in an outer box 4 inches deeper and 3 inches wider than the inner. Between the two is a layer of sawdust. The outer box or case measures 1 foot 4 inches square, by 1 foot 10 inches deep. This is the method of packing for short journeys within the United Kingdom. The boxes for foreign consignments are larger, and oblong in shape; there is a sawdust space as in the boxes already described, but the trays are separated by means of charred fillets, so that an air-space surrounds each tray: above the pile of trays is a large ice-tray, which occupies the whole of the top of the box. Ova can be safely kept in one of these boxes during a period of sixty days.

In the chapter on "breeders" we have an account of the most unique feature of the Howietoun establishment,—the feature which entitles the place to be called a fish-*farm*, and not merely a hatchery. Salmon and trout eggs have been artificially fertilised and kept in hatching-houses by a great many pisciculturists, but never before the institution of the Howietoun system has a species of Salmo been treated after the same method which is applied by agriculturists to domestic cattle. Sir James Maitland may be said to have domesticated the Loch Leven trout. He keeps them in a system of ponds, where they are placed under more favourable conditions than they meet with in the wild state, where they are supplied with a constant abundance of food, and are protected from enemies. The Howietoun trout have been rescued from the battle of life and subjected to the influences of cultivation and artificial selection. A flow of 5,000,000 gallons of water per diem is made to support a stock which produces 20,000,000 ova annually. The original stock of breeding-fish was raised from eggs taken at Loch Leven in 1874. As the fish grew older the size of their eggs increased, the fry from these ova were bigger and stronger each season, and it became evident that the ova of old trout were much the most valuable.

Time has not yet shown whether the new generation of breeders raised from selected ova of the largest trout, in their turn produce still finer ova and fry, but there can be little doubt that this will be the case.

The history of the gradual improvement of the pisciCultural apparatus given in Chapters VIII. to XVII. is extremely interesting. A detailed account is contained in these chapters of the increasing amount of stock, and of the hatching operations in succeeding seasons. But enough has been said to show the character and value of the first part of the work. The second part will contain descriptions of the experiments which have been made at Howietoun since the establishment reached its present complete and efficient condition. J. T. C.

HARMONY AND COUNTERPOINT

Elements of Harmony and Counterpoint. By F. Davenport, Professor of Harmony, &c., Royal Academy of Music. (London: Longmans, 1887.)

YEARS ago, when the laws of musical sounds, like the laws of Nature before Newton, lay hid in night, it was not unusual for clever and ingenious writers on music to invent what they called "systems of harmony." They found certain combinations and progressions in use by by the best composers, and they conceived it to be their [illegible] to explain, or account for, or justify these by some [illegible]d of imaginary natural principles, more or less fanciful, which they conjured up out of their inner consciousness, to fit the case. But, unfortunately, these writers widely disagreed among themselves as to the principles on which their theories should be based, and the result was such a mass of contradiction and confusion that the very name of theoretical harmony became a by-word and a scandal, until the Newton of musical acoustics, Helmholtz, arose, and, by explaining the real nature of musical sensations, swept away these fanciful inventions into deserved oblivion.

Among these systems, however, was one, published in 1845, by a Dr. Alfred Day, which had the great good luck to be admired and patronised by no less a personage than Sir George Macfarren, the Principal of the Royal Academy of Music. So far as we know, this admiration has not been widely shared by musicians in general; but it would be idle to ignore the great weight that such an opinion must carry, and it is this, no doubt, that has preserved for Dr. Day's work an existence which might otherwise have terminated long ago.

It is natural that Prof. Macfarren should wish this system followed at the famed institution over which he presides, and the little book before us appears to be intended as a cheap manual for the purpose. No one need object to this, for, when it comes to the practical teaching of harmony, it matters little whose system is followed so that the orthodox forms of writing are taught and recommended. That system is the best which renders this knowledge easiest to acquire. It is a feature of Dr. Day's book, that he lays down strict laws, pretty copiously and peremptorily, as to what ought or ought not to be done, and Mr. Davenport has conscientiously carried out this plan. His work bristles throughout with such rules, and we may safely say that if any student can succeed, either with or without the professor's help, in mastering them, he ought to be competent to write very good harmony. If he is of an inquiring mind, and wants to know *why* he is strictly enjoined to do so and so, or strictly forbidden to do so and so, he should postpone his curiosity till he has finished his academical course, and in the meantime be content with the Dicta of Doctor Day.

We must do Mr. Davenport the justice to remark that he has added to the work an original feature of his own which is worthy of all praise, namely, the combination of *counterpoint* with harmony-teaching. It is the general custom to give the harmony examples in the form of pianoforte chords, and this produces the anomaly that when rules have to be stated affecting the motion of certain notes, an idea of part-writing must enter which is somewhat foreign to the general system. Our author has taken the bull by the horns, by requiring the student *ab initio* to write his harmony in separate parts, putting each part on a separate line with its proper clefs. This is an excellent idea. Counterpoint is the highest and most perfect style of musical writing, but it has been much neglected in late days, and Mr. Davenport has hit upon a happy mode of encouraging its cultivation, which cannot fail to benefit his pupils.

PEARLS AND PEARLING LIFE

Pearls and Pearling Life. By Edwin W. Streeter, F.R.G.S. (London: George Bell and Sons, 1886.)

THE book before us, according to the preface, and as far as we are aware, is the only work in the English language which is entirely devoted to the history of pearls. The introductory chapter is immediately followed by one which gives a brief historical account of pearls in connection with India, China, Persia, Palestine, Egypt, Ancient Greece and Italy, and Europe in the Middle Ages. This is succeeded by a *résumé* of the ancient ideas respecting the origin and supposed medicinal qualities of pearls, and by a few words on "breeding" pearls. The next chapter treats of the different kinds of pearl-forming mollusks, both marine and fluviatile. The writer then gives an account of the true mother-of-pearl shell, describing its geographical distribution, the different varieties, its structure, the parasites found within the shells, and their external enemies, their method of getting rid of extraneous substances (stones, small shells, &c.) accidentally introduced within the valves of the shell, and the uses to which the mother-of-pearl is put. The sixth chapter, although headed "The Origin and Formation of Pearls," also refers to the different kinds, such as *bouton* pearls, *baroque* pearls, and *coq de perle*, the mode of life of the oyster, the positions in which pearls are found, &c. It also treats of the qualities which regulate the value of pearls. The next chapter gives a short account of the Sooloo Archipelago, the natives as pearl-divers, and their method of dredging. Then follows a good description of the fisheries of North-West Australia and Torres Strait, and this is succeeded by an interesting chapter entitled "Pearling Life at the Present Day," which is practically descriptive of pearling expeditions made by Mr. Streeter's vessel, the *Sree Pas Sair*, from Singapore

to the North-West Australian coast and the Sooloo Archipelago.

Chapter XI. is devoted to a condensed account of the pearl-fisheries of Ceylon and Southern India, and this is followed by a *résumé* of what is known respecting the fisheries in the Persian Gulf, the Red Sea, on the west coast of North America, and at the West Indies. Pearls produced by shells which inhabit the rivers and lakes of Great Britain and foreign countries are described in Chapter XIV., and the artificial production of pearls by the Chinese is also here referred to. The different kinds of coloured pearls, and the mollusks which produce them, are then treated of. In the succeeding chapter the most famous pearls of both ancient and modern times are recounted, and the immense sums at which some of them were valued are stated. Chapter XVII. gives the history of the remarkable cluster of pearls known as "the great Southern Cross pearl," which was exhibited in the West Australian Court of the Colonial and Indian Exhibition, and valued by the owners at 10,000*l*. The next and concluding chapter is devoted to the value of pearls, and shows how their worth has varied in this country at different periods from 1671 to the present time.

A map is then introduced showing the principal pearling regions. In an appendix, the works bearing on the subject which have been consulted by the author are enumerated, and a full index completes the volume.

Mr. Streeter has brought together a large amount of information which will be of interest to the general reader, for whom especially, and not for the scientific, the work has been written. The most original material is comprised in the part extending from the seventh to the tenth chapter. The chapter devoted to the Sooloo Archipelago contains some details which, although interesting in themselves, are rather foreign to the subject of the work. The same observation applies to the account of the constellation *Crux Australis*, or Southern Cross, introduced in the seventeenth chapter.

As far as we have noticed, the various opinions and statements set forth in the work are mostly accurate. It may, however, be questioned whether "there is perhaps no instinct implanted in the human breast more powerful than the love of admiration," for is not that of self-preservation supposed to reign supreme? We would point out that the term *Lamellibranchiata* is now superseded by that of *Pelecypoda*, and with good and sufficient reasons is adopted in the latest and best manuals on conchology. The bathymetrical range of bivalves far exceeds the stated limit—200 fathoms—specimens having been obtained by the *Challenger* and other deep-sea exploring expeditions in depths ranging as low down as 2900 fathoms.

The book is printed in good legible type upon toned paper, but the pictorial portion mars the rest. The plates illustrating the *Malleus*, the *Meleagrina*, the *Unio*, the *Pinna*, the *Strombus*, and the *Turbinella* are simply execrable. They are printed upon a fearful black ground (one almost expects to see "Sacred to the memory of," &c.), inclosed by a thin white line with ornamental corners, and seem to us to have a most common appearance. We cannot see one redeeming feature in them, the drawing and colouring of the shells being equally bad. If another edition is called for, fresh and accurate illustrations should be provided. E. A. S.

OUR BOOK SHELF

The Definitions of Euclid, with Explanations and Exercises, and an Appendix of Exercises on the First Book. By R. Webb, M.A. Pp. 48. (London: G. Bell and Sons, 1886.)

THERE are some good points in this little book which will make it a useful help in many cases, especially with backward and dull pupils. The explanations are clear and precise; the exercises are very simple, and aim chiefly at insuring that the pupil really masters the idea involved in the definition illustrated; and good diagrams are supplied. We are sceptical, however, as to the advisability of representing "each of two or more lines which are parallel to one another by two straight lines close together." This is put forward as an assistance to the memory, but the assistance, such as it is, may be too dearly purchased.

The deductions at the end of the volume—three or four on each proposition of Euclid, Book I.—are nearly all very easy; they do not require any knowledge of propositions subsequent to the ones to which they are attached.

Berättelse om en Resa til Grönland. ("Narrative of an Expedition to Greenland.") By Nils O. Holst. (Stockholm: Norstedt und Söner, 1886.)

DR. HOLST'S object in visiting Greenland was to investigate the phenomena of glacial action as they are manifested in the varied geological formations of the Arctic regions, and to secure materials which might help to elucidate many of the questions still needing solution in regard to the Ice Age in Europe.

Having obtained permission from the Swedish King to absent himself from his labours in connection with the Swedish Geological Surveys, and having been allowed by the Royal Danish Greenland Trading Company—generally very chary of granting similar favours—to make the voyage in one of their ships, he embarked at Copenhagen on April 8, 1881, in the *Peru*, which after thirty-nine days sighted the west coast of Greenland. Here he found himself suddenly brought into immediate contact with the ice-formations which he had come so far to study, for the pack-ice, which is annually brought by the Arctic current to the coasts of Greenland between the months of March and September, was so unusually dense in that year that it required ten days' cautious navigation to penetrate the ice—which, with a depth of 10 feet and more, was in many parts from 8 to 10 miles in width—and to reach safe anchoring-ground. This was at length found at Smalle, in 61° 32′ N. lat., far to the north-west of Julianehâb, for which the *Peru* was bound, and there Dr. Holst left the ship and engaged a native boat to carry him to the mouth of Arsukfjord, and to the settlement of Tigssaluk, where he had the opportunity of examining several of the "horse-shoe" moraines described by Hornerup, and comparing the land and water ice-sheets with their respective crevasses, glaciers, packs, and floes, besides making as complete a geological survey of the coast which he visited as time and circumstances permitted. In the course of these expeditions he ascended several of the characteristic so-called "*nunatackor*," or bare fjeld-tops, some of which are between 3000 and 4000 feet in height. On these isolated hill-tops were found, amongst other plants, various Cladonias, Silenes, Cetrarias, and Luzulas, besides *Rhododendron lapponicum*, *Nephroma arcticum*, &c.

Dr. Holst was disappointed in his expectation of examining the kryolite mines of Ivigtut, orders having been received from headquarters in Copenhagen that strangers should not be allowed to see the works, but he was able to determine the geological character of the district, and the conditions under which the mineral is found. According to him, the predominant rock is a grey, finely-

granulated gneiss, in some places impacted together with green sandstone into a tolerably dense granitic breccia. At some points the kryolite is found in direct contact with the granite, at others pegmatite is interposed between the two, while here and there this mineral is embedded in a granitic ivigtite.

Great interest attaches to Dr. Holst's observations on the nature and appearance of the so-called "kryokonite," in regard to whose origin the most opposite views have been maintained. According to the writer, who mainly agrees with the opinions held by Danish geologists, this substance is nothing more nor less than moraine mud; in support of which view he gives the result of the careful analyses made, independently of one another, by Profs. Lasaulx, Zirkel, and Svedmark, who agree in maintaining that kryokonite contains nothing but the ordinary constituents of the native rocks. The evidence supplied by these and other carefully-conducted microscopical investigations is, it would appear, so conclusive as to the true constituents of all kryokonites, that it has considerably modified the views once held by Baron Nordenskjöld and others, who at one time maintained the cosmic origin of these bodies. In point of fact, Dr. Holst's observations of this substance, of which he collected various specimens between Kipissako, in 61° N. lat., and Illuliakik, 65° 25′ N. lat., seem to show that the kryokonite of Greenland differs in no way in its nature from the loess of Europe, of which it may be considered as the Arctic analogue.

During his four months' stay in Greenland Dr. Holst visited various native settlements, and his descriptions of the numerous difficulties he encountered in securing boats and guides in the face of the Greenlander's habitual slowness and vacillation are not without interest, but the great value of his narrative depends upon the care and clearness with which he has recorded the results of his scientific investigations. In these particulars, indeed, geologists will find that he has ably fulfilled the purposes of his expedition, and there can be no doubt that the results of his diligent study of the various processes by which glacial action is manifested, and the effects which it produces, will prove of the greatest use in contributing new materials towards the interpretation of various problems connected with the Ice Age in Europe.

A chart of South Greenland, drawn by C. J. Kjellström, on which the inland ice-beds are marked in green and the habitable land in white, enables the reader to follow the track of coast explored by the writer between Holstenborg, in 66° 50′, and Kipissako, in 61° N. lat.

The Handy Natural History. By J. G. Wood, Author of "Homes without Hands." With 226 Engravings. (London: Religious Tract Society, 1886.)

MR. Wood is so well and so widely known for his many popular books on natural history, that the present one is sure to be welcomed by a large number of readers. The illustrations as a rule are most excellent, and care has been taken to make the text as simple as possible for even juvenile readers. The chapter on the monkey tribe is one of the longest and most interesting in the book. Mr. Wood is very careful to state in his first page that between the lower animals and man there is a great gulf fixed which neither can pass. Mr. Wood does not seem to see that the question which has been widely ventilated of late years is not whether there is a great gulf now, but whether there was originally any gulf at all. It is not necessary that this question should be discussed in a book intended chiefly for juvenile readers; but in the absence of a discussion, the statement to which we refer is one which had better not have been made.

There is no index to the book, but at the beginning of it an alphabetical list of animals mentioned is given, which practically serves the purpose of an index. The number of animals mentioned may be gathered from the fact that the list occupies seven pages of closely-printed type in three columns.

Hand-book of the British Flora. By George Bentham, F.R.S. Fifth Edition. Revised by Sir J. D. Hooker, F.R.S. (London: L. Reeve and Co., 1887.)

IN the preface to the first edition of this book the author explained that he had often been asked to recommend a work which should enable persons having no previous knowledge of botany to name the wild flowers they might gather in their country rambles. His object in writing his "Hand-book" was simply to meet this demand, and experience has shown that it is well adapted for its purpose. Sir Joseph Hooker, we need hardly say, has revised his late friend's work with perfect tact and judgment, adding considerably to its value by bringing it into accordance with the latest knowledge, without making any essential changes. Mr. Bentham held that previous writers on our indigenous flora had exaggerated the number of distinct species. His opinions on this subject, Sir Joseph Hooker thinks, should not be dismissed hastily, since they were the views "of a great master of systematic and descriptive botany who had collected and studied a large proportion of the prevalent forms of British plants in a living state, not only in our three kingdoms, but in France, Scandinavia, Russia, Germany, Switzerland, and Turkey."

The Zoological Record for 1885. Being Vol. XXII. of the Record of Zoological Literature. Edited by Jeffrey Bell, M.A., &c. (London: John Van Voorst, 1886.)

BEFORE the close of 1886 the record of zoological literature for the year 1885 was in the hands of those interested in zoology, and the editor is to be warmly congratulated on this result. The difficulties in the way of such a result are very great; on the present occasion they have been overcome, and we confidently trust the same may be the case for the future. The recorders have accomplished much, but they would be able to do more if the writers of scientific memoirs would assist in so desirable a cause and promptly send to the editor copies of their writings when first issued from the press. All of the recorders seem to have done their share of the work with care and discretion, though to some the lion's share has fallen; the largest contributor being Dr. Sharp, who records all the Insecta with the exception of the Neuroptera and the Orthoptera, which latter groups are recorded by Mr. McLachlan. The large group for so many years recorded by Dr. von Martens is now divided between Prof. W. A. Herdman and Messrs. W. E. Hoyle and G. R. Vine. Dr. P. Bertkau records the Arachnida, including the new species and genera for 1883 and 1884. Numerous corrections and additions have been made in the list of works consulted, and this list now forms a very useful work of reference to the scientific publications of the world. To the records of the Mammalia and the Birds short introductory paragraphs are added, a practice which we would suggest to the other recorders. It is very expedient that they should follow this example, for, short though these paragraphs are, yet in them the reader gets some hint of what has been done in the group for the year. The Zoological Record Association is again able to record grants of 100*l.* each from the Government Grant Fund and the British Association, and one of 10*l.* from the Royal Irish Academy. Although these money grants are extremely well disposed of, we very much regret that so valuable and essential a publication should be to a large extent dependent upon them, and we would fain hope to see the list of subscribers greatly increased.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Lightning-Flashes

THE brief note (NATURE, vol. xxxv. p. 85) giving the results of the observations of Herr Leyst, of the Pawlowsk Observatory, on the anomalous forms of lightning-flashes, suggests several considerations relating to this class of phenomena.

Leaving out of view the exceptional and anomalous phenomena of slow-moving (ball or globular) lightning—which are very difficult to correlate with any purely electrical manifestation—it is questionable whether it is possible for the observer to determine the direction in which the electrical current moves. In ordinary cases the velocity of the electrical discharge is so great, and the duration of the luminous flash is so brief, that it is impossible for the unassisted eye to determine the direction of motion.

According to the experiments of Prof. Rood (*American Journal of Science*, third series, vol. i. p. 15, 1871; also *idem*, vol. v. p. 163, 1873), the duration of lightning-flashes varies from 1/1600 to 1/20 of a second. Even the maximum duration of 1/20 of a second is probably too small to be recognised by the unaided human eye. Hence simple observation by means of the eye cannot determine the direction in which the electrical current moves.

It is nevertheless true that the eye seems to perceive the direction of motion of the luminous tract from one point of the cloud-covered sky to another. But this seeming recognition of direction must be an illusion of judgment based upon our interpretation of the phenomena presented to the sight. In these cases, our judgment of direction of motion seems to be dependent upon two considerations:—

(1) When the flash bifurcates or forks, we imagine (probably from the analogy of a ruptured projectile) that the electrical discharge passes in the direction of the diverging branches.

(2) But the more common cause of illusion of judgment in relation to the apparent direction of motion of the electrical discharge arises from the difference of brightness of different portions of the luminous path; this gives rise to a difference of duration of the lingering visual impression on the retina. Thus, in the case of a flash several kilometres in length, one extremity will probably be much nearer to the observer than the other; and hence the light emanating from one end will traverse a greater thickness of absorbing atmosphere than that emanating from the other end. This would necessarily render one extremity of the luminous path brighter than the other; and consequently the duration of the impression on the retina would be greater for one end than for the other: hence the flash would seem to reach the end where the visual effect lingered longer at a later period than the other extremity. In other terms, the light produced in the luminous path is really generated sensibly at the same instant of time along its entire length, and the apparent direction of discharge is an illusion of judgment arising from the varying duration of the visual impression, due to differences of brightness in different portions of the flash. It is evident that the refinements of modern methods of measuring indefinitely small intervals of time might render the actual direction of motion of the electrical discharge appreciable to our senses.

With regard to the zigzag and irregular branching forms of lightning-flashes, these are the natural results of electrical discharges through an interrupted and non-homogeneous medium. The enormous length of some flashes (eight or ten kilometres) indicates that the intervening non homogeneous dielectric acts as an interrupted conductor. In such a medium the path of electrical discharge is along the line of least resistance, which is the line of best induction, which is likewise the line of best conduction. In the atmosphere these lines are irregular and are perpetually shifting, hence the path of discharge may be nearly rectilinear at one time, branching at another time, and even quadrilateral at another time.

JOHN LE CONTE

Berkeley, California

THE quotation from M. Hirn in your issue of January 27 (p. 303) suggests a few remarks. What may be the greatest length of a flash of lightning? In the year 1843 I attempted to answer this question by the following observations.

My Inarya hut had far-projecting eaves supported by rough posts, some black, others white, and thus easy to distinguish. On the first appearance of a storm in a brick-red cloud I took my seat near the fire-hold, leaning my head against the door-post, and holding to my ear a pocket-chronometer. Among several flashes I noticed one nearly horizontal. It travelled northwards, and its thunder followed 54·4 seconds later. The thermometer being then at 19° C., I took that degree of heat, from want of better information, as mean heat of the whole trajectory, and got thus 343·7 metres for the velocity of a sound per second. This gave a distance of 18·7 kilometres for the commencement of the flash. It had begun before post A and ended beyond post D. As they were near me, I took care not to move my head before measuring with a small sextant the horizontal angle between A and D. I found it = 20° 30′, and obtained thus 6760 metres for the length of flash, supposing it horizontal and perpendicular to my line of sight. This result was a minimum, because the angle was evidently too small, and because moreover the flash, not quite horizontal, had travelled obliquely towards me. I drew the latter conclusion also from what appeared to me a fact on this and on other occasions, viz. my ear referred the thunder successively to different parts of the preceding flash. If an amanuensis had been at hand, I could have dictated to him at what beats of the watch the sound came from the direction of each post. It would then have been easy to get at least a rough estimate of the azimuth in which the flash travelled, and consequently its real length. In a similar way I measured on another day a flash more than ten times longer. I have not put down its particulars, because such an enormous result made me fear some mistake in time or angle. On my return to Europe, I mentioned these observations to the late F. Petit, then astronomer at Toulouse. He subsequently informed me that he had measured two flashes of lightning, one 13 and another 17 kilometres long. Should you publish the foregoing note you may induce other observers to follow this line of inquiry with improved appliances.

ANTOINE D'ABBADIE

Abbadia, Hendaye, February 2

Dr. Modigliani's Exploration of Nias

YOU have on two occasions given news of Dr. Elio Modigliani's recent exploration of this remarkable and interesting island. I believe it will therefore interest your readers if I endeavour to complete such information. Dr. Modigliani returned to Florence from Nias a short time ago, and at the last meeting of our Anthropological Society gave an able and graphic account of his visit to the island, and especially of his experience of the people; he illustrated his communication with an exhibition of the rich and very complete ethnological and anthropological collections he has made.

The natives of Pulo Nias are evidently Malesoid, judging from the numerous interesting photographs taken by Dr. Modigliani, and yet they have peculiarities of their own; and looking at the fine series of crania exhibited, one would say that on a Malayan face a Papuan skull had been fastened. Dr. Modigliani found also some resemblance between the Nias people and some of the hill tribes of Southern India. No traces of stone or shell implements are found in use at Nias. The natives get their iron, brass, and gold from traders, principally Chinese, but work the metals themselves with a primitive forge, making axes (hafted in wooden, club-like handles, as those of some African tribes), lance-heads, and swords: the former, usually barbed, recall the Celebean ones; the latter are very like the *parangs* of the Bornean Dyaks. Their shields are often heavy and cumbrous, coated with buffalo-hide, very Bornean in shape; they make besides curious iron helmets of a common Asiatic pattern. The swords are sheathed in wood, and have in front a globular wicker or rotang basket, the size of a big orange, which contains curious and very various amulets, with which they never part willingly; the handle is often carved so as to represent a grotesque human face. The Nias people are inveterate head-hunters, and Dr. Modigliani showed one of their ghastly trophies procured whilst he was there, and preserved in spirits. The head is buried, and when the flesh has fallen off, the skull is hung up under the council-house. Every young fellow to be considered a man must have cut off at least one head—no distinction is made of sex

or age; after that, he wears as special badge a collar made of a polished section of the cocoa-nut palm stem with ends of brass.

The women go about with a curious staff ornamented with brass; the usual ornaments are armlets of brass wire, bracelets cut out of Tridacna-shell, and ear-rings of the same material or of metal, and beads. The clothes used to be, and in the southern districts are still, entirely made of beaten bark.

Their idols are roughly carved wooden figures, and both they and the still more primitive carvings representing dead relations vividly recall the idols and the *Karwars* of the Western Papuans. Each village has its chief, and usually war to the knife is waging between one village and the other. This renders a thorough exploration of Nias far from easy.

Dr. Modigliani certainly lost no time, and did his very best; and although quite new to such explorations, in a very short time, with rare energy and perseverance, surmounting many difficulties and not slight dangers, he has succeeded in bringing home most interesting and ample information on the people, extensive ethnological and anthropological collections, important zoological series, and a most interesting sample of the local flora, amongst which are some new species of the singular ant-plants (*Myrmecodia*) now being illustrated by Dr. Beccari.

I must say in conclusion that I do not know of any traveller so young and inexperienced who in so short a time (Dr. Modigliani was absent from Florence altogether just eleven months) has succeeded in doing so much and so well.

HENRY H. GIGLIOLI

Royal Museum, Florence, January 22

"Lepidosiren paradoxa"

ZOOLOGISTS will be interested to hear of the capture of a fine specimen of this the rarest of the Dipnoi. Only a few weeks ago I received from my friend Dr. J. Barbosa Rodriguez, the learned and energetic Director of the Museu Botanico do Amazonas, at Manaós, a very fine specimen of the *Lepidosiren*, captured some time last August in that neighbourhood. This specimen is well preserved in alcohol; it measures 85 centimetres in length, with a girth behind the pectorals of 28 centimetres. On opening it I found that it is a female, the ovaries being well laden with well-developed ova; unfortunately the alcohol had not been let into the visceral cavity, and none of the internal organs were in a condition to be successfully investigated. I found the pericardium singularly large and thick. The body is cylindrical, but quite flat along the abdominal surface, where the scales are also bigger, thicker, and of a lighter colour. The short caudal region is much compressed. There are no true median fins except the irregularly rounded caudal, which extends merely as a slightly marked keel to about the middle of the back. The fin-rays on the caudal portion are close together, cartilaginous, and quite hidden by the skin; pectorals and ventrals without traces of membranous edging and rays; the former are slender and compressed, the latter conical and considerably stouter. The entire body, except the head in front of the eyes and the paired fins, is covered with moderate cycloid scales—thicker, as I observed, on the *abdominal cuirasse*, extending from the chin to the anus and composed of about ten longitudinal rows of scales. Except along this ventral stripe, which is of a whitish colour, the animal is generally of a dark brownish purple, with darker indistinct blotches. The double lateral line is dark; it reticulates on the cheeks and around the eyes. These are quite rudimentary, and show under the skin as a whitish spot; they remind me of the eyes of the two *Gymnotus* which I saw alive in the Insect House at the London Zoological Gardens last October. The branchial openings are very narrow, protected by a thick fleshy flap: there are no traces of external branchial appendages, indeed, even the internal branchiæ cannot be seen through the deep, narrow, branchial slit. The mouth is terminal, with well-developed fleshy lips; there are two small conical vomerine teeth; the maxillary and mandibular dental plates are very similar in size and shape; fleshy pads fit into the spaces between the dental ridges. The tongue is thick, smooth, and fleshy, with a rounded point. Four branchial clefts can be made out on each side in the pharynx, the fourth is much reduced; the three free branchial arches are fringed with conical papillæ. The palate and mucous membrane of the mouth is white and quite smooth; the pads along the dental plates are papillous. The anus is exactly 10 millimetres on the left of the mesial line; it is 8 millimetres in diameter, and surrounded with a border in deep folds. I had forgotten to mention the nostrils: both pairs are *inside* the mouth; the anterior ones, just within the upper lip, are ovoid, transverse, without flap or valve; the posterior pair are situated just outside the hinder ridge of the maxillary dental plate, they are ovoid and longitudinal.

I need hardly insist on the importance of the capture of this new specimen of *Lepidosiren*. As far as I am aware, this is the *fourth* known; there are, besides, Natterer's two preserved at Vienna, and Castelnau's one in the Paris Museum. More recent explorers have utterly failed to find any, although an active search was made by several. Only recently I heard from a high authority the expression of a doubt as to the existence of such a creature as the South American *Lepidosiren*!

I may finally state that, evidently prompted by his friendship for me, Dr. Barbosa Rodriguez, seeing, as he believed, distinctions in his specimen, sent a brief description to a Rio scientific periodical, naming it *Lepidosiren gigliolina*; this before forwarding the specimen to me. I have not yet seen his description, nor am I in a position to decide as to any distinction existing between this and the other three existing specimens. I can only say that I consider such a difference very unlikely. I suppose that, like *Ceratodus*, *Lepidosiren* is liable to considerable individual variation. Lastly, I believe it not unlikely that *Lepidosiren* may be on the verge of extinction; that would account for its rarity.

HENRY H. GIGLIOLI

Royal Museum, Florence, January 22

The Coal-Dust Theory

SOME of the facts elicited at the adjourned inquest on the bodies of the twenty-eight persons who lost their lives in an explosion at Elemore pit on December 2 last, appear to have a direct bearing upon the coal-dust theory, and are therefore worthy of being recorded. It will be remembered that the inquest was adjourned until January 18, when it was re-opened; it was concluded on the following day. The verdict of the jury was as follows:—

"That Ralph Fishburn and others met their deaths by an explosion in the George Low Main seam, Elemore Colliery, on the morning of December 2, 1886; that the said explosion occurred between the Daleway end and the greaser; but what caused the ignition there is not sufficient evidence to show."

One of the victims, named Luke, who afterwards died from his injuries, made a statement to the effect that a shot was fired in one of the main intake airways not far from the bottom of the down-cast shaft, at the instant the explosion took place. The person who, according to Luke's statement, ignited the shot, still survives, and denies having done so, although he admits having fired a shot near the same place a short time previously. Some of the experts, including the two inspectors of mines, came to the conclusion that Luke's statement was the more probable; others were unable to concur with them in this. The evidences of violence point to the place indicated by Luke as having been the origin of the explosion. A good deal of discussion took place between some of the examining counsel and solicitors and some of the witnesses, as to whether coal-dust alone in the absence of fire-damp could originate and carry on an explosion, but nothing new was elicited in this respect. All agreed that there could not have been any gas present at the point where the shot was said to have been fired. Mr. G. Baker Foster was "quite of opinion that there had been no gas; . . . he could not imagine that in such an intake, with such ventilation, and such a position, gas could accumulate for a minute." Mr. Bell, the Inspector of Mines for the district, said:—"The ventilation throughout the pit was good. It was a well-managed pit, and the last in which he would have expected an explosion to take place." Mr. W. M. Atkinson, the Assistant-Inspector, said:—"The explosion was confined to those parts of the pit least likely to contain gas, and where there was the most coal-dust. It was highly improbable that there was any fire-damp where the explosion originated. He once examined the place when the barometer was as low as 27·5 inches, and no trace of fire-damp could be detected." (The barometer stood at 29·55 inches at 1 a.m., two hours before the explosion.) "He believed the explosion was entirely due to the combustion of coal-dust in pure air, and that its ignition was caused by a shot fired by Johnson. A blown-out shot would not be necessary. Wherever there had been coal-dust in the mine the explosion had gone; but wherever there was an absence of coal-dust,

there the explosion ceased." The last statement was not called in question by anyone, and stands unimpeached.

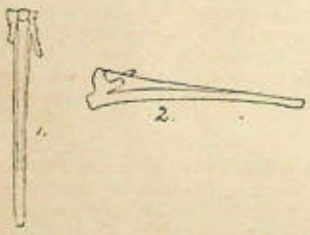
Those witnesses who would not go the length of saying that coal-dust alone in the absence of fire-damp had caused the explosion, had no explanation of their own to offer. The "outburst of gas," the cry which used to be so often adopted in similar cases, was not entertained by anyone in this case. Some of the witnesses were unable to accept the coal-dust theory on account of preconceived notions regarding it; others had read in books and papers certain statements which prevented them from adopting it; and one (Mr. Lishman, the manager of Elemore Colliery) had made experiments, with an apparatus similar to one of mine, which did not lead to conclusive results. With these conflicting opinions before them, the jury arrived at the conclusion that the men had been killed by *an explosion*, but, with the characteristic caution of men of the North, they refrained from stating what it was that had exploded.

Cardiff, February 3 W. GALLOWAY

Abnormality in the Urostyle of the Common Frog

ATTENTION has recently been drawn to abnormalities in the vertebral column of Rana. (See Bourne, *Quarterly Journal of Microscopical Science*, January 1884; Howes, *Anatomischer Anzeiger*, 1 Jahrgang, 1886, Nr. 11; Lloyd Morgan, NATURE, November 1886.) One form of such abnormality is the addition of a supernumerary (tenth) vertebra.

I wish here to record the occurrence, in the skeleton of a large *Rana temporaria*, of an abnormal urostyle, bearing at its anterior end a larger (right) and a smaller (left) transverse process. These are shown in the accompanying figures. Fig. 2 shows a tendency,



in the dorsal moiety, towards a segmentation of the urostyle and and the separation of a supernumerary vertebra. The coccygeal foramina lie just behind the transverse processes.

This case is interesting as showing an incompletely separated tenth vertebra, and as bringing an abnormal Rana into relation with a normal Discoglossus.

C. LLOYD MORGAN

University College, Bristol

The Cambridge Cholera Fungus

I HAVE read with much interest the correspondence on the above subject in your issue of January 27 (p. 295). In the new edition of my work on bacteriology, to be issued, I hope, before many days, will be found the following statement:—

"At a meeting of the Physiological Society, held May 15, 1886, at Cambridge, a preliminary communication was made upon the investigations in Spain, referred to in the first edition of this work. The observations made by Roy, Brown, and Sherrington rather tend, in the opinion of the author, to confirm Koch's views. Comma-bacilli were found to be present in some cases in enormous numbers, and the frequency of their occurrence led these observers to believe that they must bear some relation to the disease. At the same time, as they failed to find them in all cases, they regarded the existence of a causal relation as not proven. They failed to find the Naples bacterium or the small straight bacillus noted by Klein, but they drew attention to certain peculiar mycelium-like threads in the mucous membrane of the intestines. These organisms, however, judging from a preparation stained with methylene-blue which was exhibited at the meeting, appeared to the author to much more closely resemble some of the involution-forms of comma-bacilli, *filaments à masses globuleuses*, figured by Van Ermengem, than anything else he had seen. Yet assuming these peculiar structures to belong, as described, to some species of Chytridiaceæ, it is very doubtful whether they can be considered to be of any significance. Methylene-blue has been employed by Koch and others, including the author, for staining sections of the intestine from cholera cases, and had they been constantly present, it is hardly possible that such striking objects could have been overlooked. Again, we must bear in mind that hyphomycetous fungi have been found occasionally to occur saprophytically in the intestinal canal, as well as in the lungs, external auditory meatus, and elsewhere. We must, however, wait before expressing a more definite opinion, until the Report of these observers is published in full."

This, I think, may explain Mr. Gardiner's difficulty. Very probably the same preparation was shown to him, as his second opinion coincides with the conclusion I arrived at last May. I have now before me the Proceedings of the Royal Society, No. 247, and I am greatly puzzled by the illustrations, for they certainly appear to represent a branching mycelium, and do not in the least recall to my mind the preparation which I had opportunity of examining.

EDGAR CROOKSHANK

Eastbourne, January 31

Low Barometric Readings

IN a Note in NATURE of December 16 (p. 157) you observe that the barometric reading of 27·333 inches (reduced to sea-level) recorded at Ochtertyre, Perthshire, on January 26, 1884, is the lowest observed by man anywhere on the land surface of the globe. This, however, is not the case. The cyclone which on the morning of September 22, 1885, swept over False Point, on the coast of Orissa, gave the lower readings 27·135 at the beginning of the central calm, and 27·154 half an hour later (both readings reduced to 32° and sea-level). These readings are perfectly authentic, the instrument being a Casella's observatory standard (on Fortin's principle) that has been verified with the Calcutta standard and is corrected to that standard, which is 0·011" higher than the Kew standard. Its elevation above the sea, 20·6 feet, has been determined by spirit-level; and the observer, Mr. Workman, is one of the best of those who keep a regular meteorological register for this department. The above are the lowest of a series of readings, taken at intervals throughout the storm, which was then travelling at the rate of thirteen miles an hour.

The storm will be long remembered as that in which the settlement of Hookeytollah, six miles to the north of False Point lighthouse, together with its inhabitants, was swept away by the storm-wave accompanying the cyclone. At False Point station the water rose 22 feet above mean sea-level directly after the passage of the storm centre. The country inundated lay to the north of the lighthouse, and is a low-lying alluvial tract from 4 to 5 feet above mean sea-level, intersected by a network of salt-water tidal creeks.

The destruction that ensued was very great. Including the small settlement of Hookeytollah, some two thousand households were swept away, representing a loss of from six to ten thousand souls. Crops valued at ten lakhs of rupees (100,000*l.*) were irretrievably damaged and lost; the wells and tanks of drinking-water were rendered unfit for use; and about 60,000 acres of land rendered unfit for cultivation for two or three years to come. But even this is very small in comparison with the destructive effects of the Calcutta cyclone of October 5, 1864, and those of the Backerganj cyclone of November 1, 1876.

HENRY F. BLANFORD

Indian Meteorological Office, Calcutta, January 6

Magnetic Theory

MR. WATSON asks, What is the physical evidence in favour of the existence of A, B, C, and α, β, γ? With regard to the former the evidence, derived from the permanence of the magnetisation in a small piece of a hard steel magnet, seems to me almost conclusive; while the following consideration tells very strongly in favour of α, β, γ.

To determine the mechanical force and couple acting on a magnetic element placed in a magnetic field in air, we treat it as consisting of two equal and opposite poles very near together, and find the resultant of the forces on these two poles. It may be proved without difficulty that the same process may be used to find the mechanical force and couple, arising from magnetic causes, acting on an element within the mass of a magnet. In the first case we may, of course, employ either α, β, γ, or a, b, c, as the forces acting on a unit pole. But in the second case we

must employ α, β, γ, as defined in Mr. Watson's letter in your issue of January 27 (p. 296). These mechanical forces cannot, I believe, be expressed in terms of the values of a, b, c, u, v, w, and their differential coefficients at the point. This is a definite physical argument in favour of the existence of α, β, γ, within a magnet.

St. Moritz, Engadine JAMES C. MCCONNEL

"Phantasms of the Living"

NOTHING in your last week's notice of "Phantasms of the Living" gratified me more than the attention paid to our experimental results. The grounds of our own confidence in them are (1) that the conditions were in many cases such as completely to exclude unconscious physical signs, and (2) that, if the success was due to fraud, it was not fraud which the investigators failed to detect, but fraud in which they must actively have shared. But, where the scientific presumption against new phenomena is so strong, it is best to recognise that no line can be drawn at which the evidence for them *ought* to be found convincing, and that, till it actually *is* found convincing, it is incomplete. Meanwhile it *ought* to be scepticaly approached—not with the impatient scepticism which denies that such facts can ever be proved, but with the cautious scepticism which perceives that they require a very great deal of proving. The object of this letter, then, is to urge the paramount importance of extending the area of experiment. This cannot be done without an amount of public spirit which it is very hard to evoke. The "percipient" faculty, even though possessed in a high degree, is very unlikely to reveal itself spontaneously: our only hope of discovering it is that trials in thought-transference shall be very widely made—which means that a large number of persons shall spend some time and trouble in a manner which will often appear to have been fruitless. It is difficult to press this on anyone as a duty; but it is at any rate worth while to point out how simple and [illegible]d the process of experimentation may be made. Especially [illegible]us am I that a great many pairs of persons should carry out [illegible]eriments of the very simple type described in "Phantasms," vol. i. pp. 32, 33. If any of your readers are willing to do this, will they kindly, *before beginning*, send me their names and the number of the trials that they propose to make, to guard against any *selection* of results? EDMUND GURNEY

14 Dean's Yard, S.W., February 3

University College, Bristol

MY attention has been called to a paragraph in your issue of the 3rd inst. (p. 326), referring to this College. Will you kindly grant me space to correct the statement made therein, which is inaccurate in some important points, and is calculated, as it stands, to injure our reputation?

No general reduction of the salaries of the Professors has been made, nor is it contemplated. Notice to terminate our engagement with two Professors has been given them, as it was believed that more advantageous arrangements could be made in their departments without affecting the quality of the instruction given. It is too true that the College greatly needs more liberal pecuniary support than it has hitherto received, but efforts are being made to procure it; and as yet the Council have no intention of limiting the subjects hitherto taught, or of requiring a lower standard of attainment than that which has distinguished so many of their Professors. ALBERT FRY,

Chairman of the Council

University College, Bristol, February 7

A Rule for escaping a Danger

SUPPOSE a weir, AB, across a river, and first let it be at right angles to the direction of the current. Suppose a man in the stream above the weir, nearer to B than to A. Let O be his position, and OX a perpendicular on AB. Then he cannot escape, if his velocity, v, is $< \frac{BX}{OB} . u$, where u is that of the stream. If his full speed has this critical value, or if there is any uncertainty about his safety, he must swim at right angles to OB.

The rule is obviously correct, for to escape he must clear the nearer end of the weir, and must therefore exert his strength in the direction mentioned. Geometry puts it clearly: Reduce the stream to rest so that the weir is advancing on the man with velocity u. Let P be the point at which the man is overtaken, then, if PN be perpendicular to AB,

$$\frac{OP}{v} = \frac{PN}{u},$$

so that P is on a conic for any given velocity. Varying v, he will escape if the conic reaches the bank. The first to do so touches at the end C of the minor axis, and since CB is a tangent, the angle COB is right. Also now

$$v : u = OC : CB = BX : OB.$$

If the weir slants across the river, the direction of safety is still at right angles to the line joining O to A or B. The swimmer must decide, by looking in both directions, to which bank to direct his efforts. The locus of points for which both directions give the same distance is, to axes through the middle of the weir up and at right angles to the current, of the form

$$(y^2x - 2aby + b^2x)(y^2a - 2bxy + ab^2) = by(x^2 - a^2)^2,$$

a quintic having cusps at A, B.

The rule fails if the change of velocity as one approaches the bank be considerable. One would then strike more across.

If one were being charged by any insensate object, the rule would of course apply. FRANK MORLEY

Bath College

Abnormal Cats' Paws

IN reference to the recent articles in NATURE on six-toed cats, allow me to remark that the experiment about to be tried on one of the small islands off the English coast has *apparently* been anticipated at the village of Morriches Centre, on Long Island, where nearly all the cats have at least one supernumerary digit on all feet, and are currently called, in the place, "double-footed." I have a specimen showing the abnormality distinctly. I say "apparently," because there can be little doubt that at some time a single individual was introduced, which has become the ancestor of all the "six-toed" cats in the village.

E. W. CLAYPOLE

ABNORMITIES in cats' paws occur rather frequently in Massachusetts. They are called mitten cats, and are much in demand because they are considered to be good mousers. The first I ever saw was a male yellow tiger, whose four paws had two extra toes strongly developed. A little stray female kitten which was brought up at my house had two abnormal fore-paws with four extra toes on each. As there are no male cats in our neighbourhood with any abnormity I was very anxious to see whether her young ones would inherit the shape of their paws from the father or mother cat, and whether some abnormity would also appear in the hind-paws. She had eight, and only one of them with four normal paws; all the others inherited from the mother the abnormal fore-paws, some even having five to seven extra toes, with perfectly developed claws and pads. I did not pay attention to the sex, but brought one up on account of its strong build, which turned out to be a male, and another for its beautiful stripes, which was a female. The old cat rested nearly a year, and then again had eight three times in succession, in April, June, and October, and every time only one with normal paws. The mother is a pale grey tiger, and each one of the young ones was differently spotted, and, as I believe, had a different father, as I recognised the marked resemblance to the various visitors to our garden. I paid no attention to the sex, but brought up from the last litter the strongest looking, which turned out to be a male, and two others—the one selected by a child, the other because it had seven extra toes. Both these were females.

H. A. HAGEN

Harvard University, Cambridge, Massachusetts, January 5

The Cross as a Sun Symbol

THE use of the cross as a sacred symbol dates from the earliest times, and is almost universal. It occurs upon the monuments and utensils of every primitive people from China to Yucatan. In many, perhaps in a majority of, instances it is used as a symbol of the sun. One of the oldest and most widely occurring forms is the cross with *crampons* turned to the right or left, the *svastika* and *sauvastika* of India, the "Thor's hammer" of Western Europe. Prof. Max Müller thinks that the *svastika* represents the vernal sun, and is hence an emblem of life,

health, and creative energy (Schliemann's "Ilios," p. 348). Mr. Edward Thomas (*ibid.*) believes it to have arisen from the conception of the sun as a rolling wheel. The Chaldean sun symbol was first a circle, then a circle with an inscribed cross. The symbol of the sun-god at Sippara is a small circle with four triangular rays, the four angles between being occupied by radiating lines, and the whole circumscribed by a larger circle. The same symbol occurs repeatedly upon the shell gorgets of the mound-builders (Second Annual Report of the U.S. Bureau of Ethnology, plates liii., lviii., and lix.). The peculiar figure repeated upon the *façade* of the "House of the Nuns" at Uxmal seems to be a conventionalised circle and cross with rays. The Moqui symbol for the sun is a Greek cross with a small circle at the centre, in which are three marks to indicate the eyes and mouth of a face (First Annual Report of the U.S. Bureau of Ethnology, p. 371). It is needless to multiply examples: the important question is, How has the cross come to be a symbol of the sun? If anyone will observe carefully a lamp, or other bright light, with partially closed eyes, the answer will be obvious. The rays which appear to proceed from the luminous point always form a cross of some kind. A little experimenting will show that this appearance is due to reflection from the eyelashes and edges of the eyelids. The same experiment may be tried with the sun itself: if observed when considerably above the horizon, squinting will be unavoidable. If the head is erect, the downward arm of the cross will be much the strongest, and the upward arm may be obsolete; but if the head is thrown back, the arms will be nearly equal. The evolution of the sun symbol seems to have been as follows: He was first represented by a circle or disk as he appears when near the horizon; observations made when he was shining brightly revealed the crossed rays. This led to a combination of the circle and cross. If this hypothesis be correct, the *svastika* was originally neither a rolling wheel, nor, as Burnouf supposes, the crossed sticks from which our ancestors elicited fire; but it is a modification of the circle and inscribed cross.

It is not claimed that the cross has in every case originated in this way; but since sun-worship is known to have been an almost universal form of primitive religion, and since the unscientific observer would be sure to regard the crossed rays as an essential part of the sun, this hypothesis furnishes a reasonable explanation of the universality of the symbol. Anything bearing the cross would be regarded as sacred; hence the Egyptian worship of the scarab, as noticed by Mr. R. G. Haliburton (NATURE, vol. xxxiv. p. 610), and the spider-gorgets of the mound-builders (Second Annual Report of the U.S. Bureau of Ethnology, plate lxi.). Not the least remarkable feature of the subject is the fact that the most ancient and universal symbol of the physical sun should, for entirely independent reasons, continue in use as the sign of "the Sun of righteousness" and "the Light of the world."

CHARLES R. DRYER

Fort Wayne, Ind., U.S.A., January 12

Clausius's Formula

IN the report of our preliminary communication to the Royal Society, reported in your issue of the 13th inst. (p. 262), we give Clausius's formula intended to express the relation between the gaseous and liquid states of matter as

$$p = \frac{RT}{v-\alpha} - \frac{c}{T(v+\beta)^2}.$$

We should have mentioned that this formula has been amended by Clausius to

$$p = \frac{RT}{v-\alpha} - \frac{c}{\Theta(v+\beta)^2},$$

where $\Theta = \alpha T^{-b}$. As Θ is a function of T, it is evident that this latest form also is not in agreement with the simple relation pointed out by us for ethyl ether,

$$p = bT - a.$$

WILLIAM RAMSAY
SYDNEY YOUNG

January 20

Notes on Certain Traits of Infant Navajos

As we know, the Navajos are an American tribe of Indians, scattered for the most part over the Territories of New Mexico and Arizona. Quite a number of them live with their families, in the curious little habitations they erect, about the frontier military station of Fort Wingate, New Mexico. It is in this latter place that I have had the opportunity, for over two years past, of studying many of their ways and customs. And it was here, too, that, a few days ago, I went out among them with a photographic camera, armed with an English instantaneous shutter, with the view of taking a few pictures of them while they were actively engaged in some of their very interesting games.

After having obtained four or five more or less satisfactory plates, the Indians became quite restive, as they rather object to that sort of a thing; and, as if by common consent, they gradually disappeared, a few at a time making for one of their low, conical-shaped mud huts, where they entered through the single small door at its side. In less than half an hour there were none of them to be seen outside at all, and, knowing [illegible] well that they would not appear again so long as I remained upon the ground, I shouldered my instrument and prepared to come away. At the time, I was standing between two of their huts, situated some three hundred yards apart, with a well-beaten, though narrow footpath passing from one to the other. There were no trees within a quarter of a mile, the plain being sparsely covered with sage-brush, the plants being from 2 to 3 feet high. Just then one of their babies toddled out of the doorway of the upper hut; the child could not have been over ten months old, and wore only a very dirty little shirt, which came about half way down to its knees. It looked more like an infant Eskimo than any child, not white, that I know anything about; and it started right down the path with a very unsteady baby-waddle, making for the lower hut, where I imagine its mother had taken refuge from my merciless camera. I had often longed for a good picture of a Navajo baby in its native plains, and here was an opportunity not to be lost. So, stepping a few feet out of the way, in an instant I had my instrument in position, focused on the path, and, with instantaneous snap ready, I stood quietly for my subject to pass. On he toddled, until he came within about 30 feet of me, where he suddenly stopped, and, to my surprise, seemed to fully take in the situation.

At this stage, I feel quite sure that one of our babies, especially at this tender age, would have begun to cry, and more than likely retraced its steps to the hut from whence it had issued. Not so, however, this infant Navajo; and, mark the difference. He steadily watched my every movement, and was evidently determined to reach the lower hut. Very cautiously leaving the path on the side furthest from me, he was, in the next instant, behind one of the sage-brushes, which was something over a foot taller than the baby. From this position he peered through the leafless twigs at me, to see what I would do about it. A little annoyed at this turn in affairs, I threw the focusing-cloth over my head, and turned the instrument on him. Taking advantage of this temporary concealment of my head, he ran, thoroughly baby-fashion, to the next *lower* brush, a distance of some 10 feet, where, hiding as before, he crouched down, and stared at me like a young lynx through the twigs. He now looked, for all the world, the young Indian cub at bay, with all the native instincts of his ancestors on the alert, and making use of all the strategy his baby mind could muster. It was a wonderfully interesting picture to study; but, fearing that I would lose a permanent memento of it, I turned to lift the instrument, with the view of taking a much nearer position, when, again facing the brush where I had last seen the baby, it was, to my great surprise, not there, but had scampered to the next lower one, in the direction of the hut for which it was bound. A full-grown buck of the tribe could not have possibly managed this last movement any better. As it ran to the still next lower brush, I was astonished beyond measure (for, I take it, I am a good stalker myself) how it took advantage of everything that lay in the short intervening distance, and how, after it arrived at the brush, it immediately took a position on the opposite side of it, from where it could make another quick start, and yet not lose sight of my movements. And, mind you, all this from a baby only ten months old at the most. As it was rapidly gaining its point and approaching the lower hut, in sheer desperation I ran up on its last place of concealment, holding my camera in such a way that I could immediately place the tripod in position, which I succeeded in doing, with the lens levelled directly at its head, and not 3 feet from it. It now stood up to the full extent of its baby height, and, giving vent to a genuine infantile bawl, it made a break for the final point of its destination, for there

was nothing else left for it to do. It is almost needless to add that, before I could focus and insert a plate, my Navajo baby was out of range. And, fearing that its angered mother might appear at any point, at the cry of alarm of her child, I immediately forsook the ground.

My object in making a record of such an interesting case as this is to simply draw attention to the fact that the native instincts of these American Indians are exhibited in their young at a wonderfully tender age; and in this particular they differ vastly from our own children at a corresponding time of life, and reared, as they have been for ages, in a civilised environment.

R. W. SHUFELDT

Fort Wingate, New Mexico, January 11

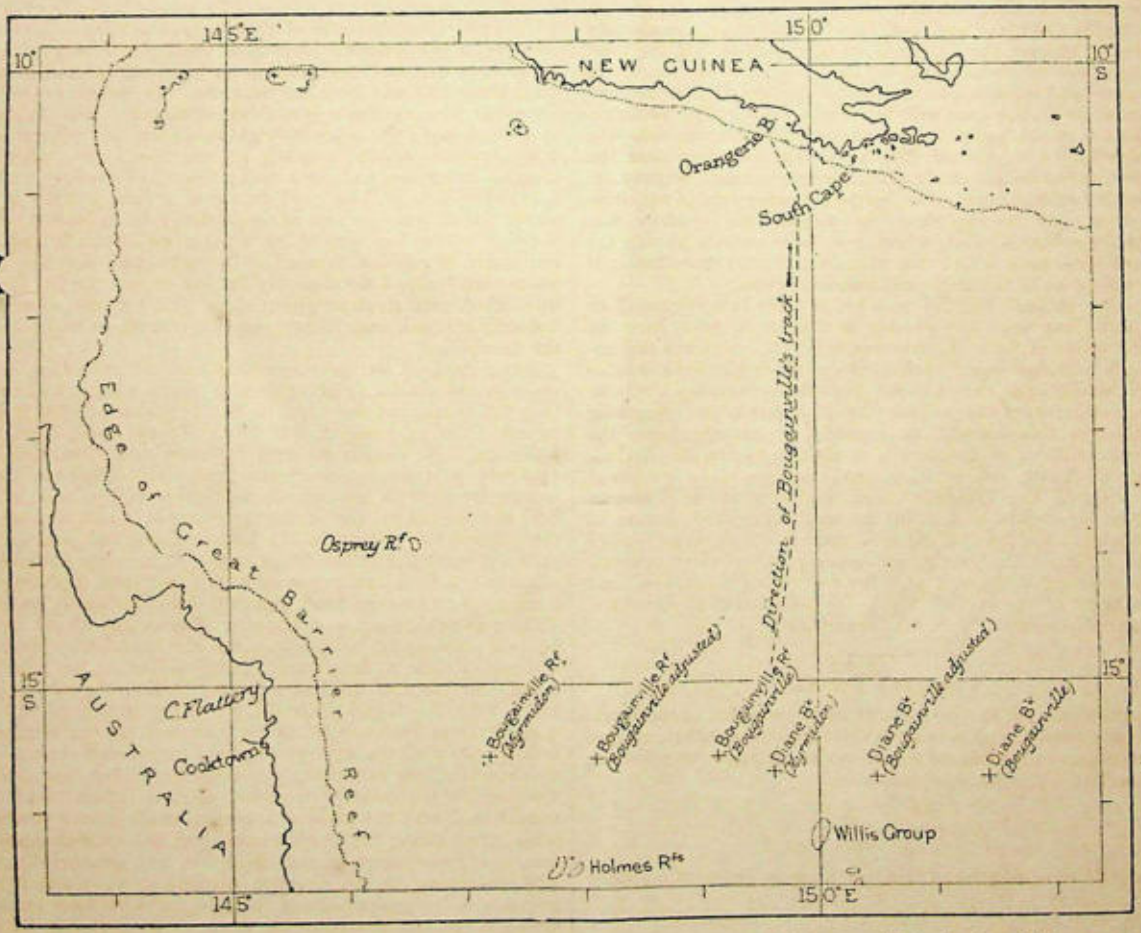
LONG-LOST REEFS

A REMARKABLE instance of the manner in which small reefs in the ocean may elude search has recently been brought to light, and may be of interest to some readers of NATURE.

In June 1768 M. de Bougainville, in the frigate *La Boudeuse*, having left Espiritu Santo, in the New Hebrides, was sailing west over the Coral Sea, south of New Guinea, near the parallel of 15° S. At midnight of the 4th he sighted a sand-bank, and waited till daylight to examine it, when it proved to be a very small patch of sand only just out of water, with apparently no reef around it. This he called Bâture de Diane.

Resuming his course west, he, on the 6th, having run by his reckoning 137 miles from the sand-bank, sighted a reef on which the sea broke heavily, and closing it, at noon obtained its position. After a zig-zag course of five hours, another reef was seen ahead, and as this might be but the prelude to more, the project of exploring further westward was given up, and *La Boudeuse* steered northward, making New Guinea at a bay to which the name of Cul de Sac de l'Orangerie was given. Bougainville thus lost the honour of discovering the eastern coast of Australia, which the celebrated Cook explored two years later. On the last reefs seen no name was bestowed, but they have always been known as the Bougainville Reefs.

Time passed, but these dangers were not again seen.



The subject of their existence was much discussed, and on the longitude of Espiritu Santo being revised, it was recognised that M. de Bougainville's discoveries should be also moved to the westward about sixty miles—the amount of error in longitude of Espiritu Santo in his time. The Diane was therefore placed in longitude 150° 28′ E., and the reefs in 148° 6′. In this position they were searched for by Capt. Denham in H.M.S. *Herald*, who spent fifteen days in traversing in every direction an area of forty miles radius round each danger, but without success. As a result of this search, seeing that Bougainville's description was so circumstantial that the existence of the dangers could scarcely be doubted, they were removed back to their original positions on the charts. These positions, though manifestly too near to Espiritu Santo, agreed better with the land-fall made in New Guinea by *La Boudeuse* after leaving the last reef, as it seemed impossible that the bay generally supposed to be the Cul de Sac de l'Orangerie could have been reached on the course steered by M. de Bougainville from any position westward of longitude 149° 8′ E., Bougainville's own position of the reef.

Many ships passed in fear and trembling over the long line in which it was thought these dangers might yet

exist, and the records are full of remarks as to their non-existence, especially with regard to the Diane, which lay near the main track to Torres Strait from Sydney. They were, however, retained on the charts, with notations as to the doubt in their positions.

At length, in 1884, two reports were made by small trading-vessels from Queensland to New Guinea, one of a small bank in lat. 15° 41′, and long. 149° 43′, the other of a submerged reef in lat. 15° 28′, long. 147° 6′. It was at once observed that the latitudes of these, and their distance apart, agreed with those of Bougainville's discoveries, though they were far to the westward, and it seemed as if the long-lost reefs were at length again found, since it was not at all improbable that the westerly current had caused the reckoning in longitude, uncorrected by chronometers, to be over-run by *La Boudeuse*. Capt. Denham's searches, minute and painstaking, and apparently sufficiently extended as they had been, just fell short of the positions of these new reports, the limit of his examinations passing within ten miles of both of them.

One link, however, was missing to insure certainty in the identification, viz. the second reef of Bougainville.

During the past year H.M.S. *Myrmidon* has been scouring the Coral Sea, and in the course of her cruise made this one object of search. It was, however, unavailing; clear sea was alone seen in the direction of the second reef. But her description both of sand-bank and reef reported in 1884 tallied precisely with Bougainville's detailed accounts. More accurate observations, moreover, showed that the latitudes were in each case almost exactly identical with his, and that the distances apart, as before stated, agreed.

But what of the reef still missing?

A closer examination of Bougainville's journal revealed that the second reef was sighted from aloft at 5.30 p.m., at an estimated distance of five miles. The sun set at 5.35, behind the reef; twilight is short in those latitudes, and it seems improbable that *La Boudeuse* could have been near enough to see the reef clearly before night closed in. It is therefore believed that the delusive appearance of reflection misled the voyagers, and that Bougainville, so accurate in his other reports, was in this instance mistaken.

A further difficulty remains. How could *La Boudeuse* steering the course reported have made the land 100 miles to windward of her direct track? Here, again, the explanation seems to be that later voyagers re-bestowed the name of Orangerie on that one of the numerous bays on the New Guinea coast which corresponded to Bougainville's longitude. These are assumptions; but the other evidence is so complete that it is believed that the mystery of 120 years is cleared up, and that the dangers which have so long been a source of anxiety to the navigator have at length found their true places on the charts.

The three positions these reefs have occupied are as follows:—

	By Bougainville		Bougainville corrected for the position of Espiritu Santo		By *Myrmidon*	
	S.	E.	S.	E.	S.	E.
Diane ...	15° 46′	151° 26′ ...	15° 46′	150° 28′ ...	15° 43′	149° 37′
Bougainville Reefs	15° 35′	149° 8′ ...	15° 35′	148° 6′ ...	15° 33′	147° 12′

W. J. L. WHARTON

THE CROCUS[1]

MANY splendidly printed and illustrated monographs of special genera of flowering plants have been published, but few surpass in merit or interest Mr. Maw's monograph of the species of the genus Crocus. This work, the author tells us, has pleasantly occupied his spare hours for the last eight years. In collecting the material for it, he has travelled far and wide over the crocus region; he has enlisted the services of a whole host of friends, who, on the borders of the Mediterranean, of the great Basin of the Black Sea, and along the shores of the Caspian, have collected the species peculiar to these localities, and forwarded them for culture and description to Mr. Maw. Perhaps never before has a monograph been written so entirely from the study of living plants. At the same time, no information that was to be gleaned from the dried specimens in herbaria has been neglected.

The monograph opens with a chapter on the life-history and physiology of the forms belonging to the genus. The minute structure of the various parts of the plant has not been made a special study by the author, this portion of the subject leaves a good deal to be done by future workers. The strange phenomenon of dissepiments on the pollen-tube is figured as existing, on the authority of Prof. Martin Duncan. In the chapter on classification and sequence, we find that the author adopts the division of the species indicated by Dean Herbert, into those with, and those without, a basal spathe. These larger divisions are, again, subdivided into sections, characterised by the form assumed by the bundle tissue or the corm tissues, and these, again, into groups arranged according to the period of flowering. The third chapter is a most interesting one, on the geographical distribution of the species. Confined to the Old World, the species of crocus are therein only to be met with in the northern hemisphere, where they reach a northern limit at about 50° N. latitude. Westwards, they reach their limit at the coast of Portugal; southwards the limit extends to Morocco, though no species appear to be endemic to Africa, and none have been found in the region between Tetuan and the Nile Delta. In Asia, on the borders of Syria, *Crocus hyemalis* has the most southern range of all the species. The eastern limit of the species is at present uncertain, for it seems pretty certain that one or more species have been found in Afghan Turkestan. Of the sixty-nine known species, thirty occur in 40° N. latitude, which is far in advance of any other district as a line of growth, but the metropolis of the genus is a district including Greece, the Greek Archipelago, and Asia Minor, for in these regions it forms a more important feature in the flora than in the outlying countries to which it extends. The genus is also remarkable for the wide range in altitude of the majority of the species, those that are essentially alpine or lowland being comparatively few in number; and Mr. Maw does not know of a single species which is not perfectly hardy, that is to say, capable of enduring any of the extremes of cold or heat to be met with in our climate. There do not appear to be distinct areas for the spring and autumn flowering forms, and Mr. Maw has been unable to detect any instances of wild hybrid forms, notwithstanding the close relationship of some of the species, and the fact that their areas of distribution constantly overlap.

In a fourth chapter the history and literature of the genus are treated of. Two centuries before the days of Linnæus the crocus was known in England as a garden plant, and in Gerarde's "Herball" (1597) eleven forms are figured and described. Most of the famous pre-Linnean writers on plants have added to our knowledge of the species, such as Parkinson in his "Paradisus" (1629), and Ewart in his "Florilegium" (1612); but Linnæus contented himself with making but two species, one *C. vernus*, and the other *C. (Bulbocodium) bulbocodium*. The first important attempt to classify the genus was made by A. H. Haworth in 1809, followed by Goldbach's monograph in 1817, Gay's in 1827, and Sabine's in 1830. Dean Herbert in 1847 and Baker in 1873 added much to our scientific knowledge of the group, and now in this beautiful monograph

[1] "A Monograph of the Genus Crocus." By George Maw, F.L.S., &c. With an Appendix on the etymology of the words "Crocus" and "Saffron," by C. C. Lacaita, M.A., M.P., F.L.S. (London: Dulau and Co., 1886.)

we have the history of the genus, written in a manner that, except for the anatomical student, will not for very long indeed be surpassed.

Hints on cultivation and on species not yet introduced to cultivation, and remarks on saffron, its cultivation and uses, form Chapters V. and VI. Saffron would appear to have been cultivated in England prior to 1582, and from its importance as an article of commerce gave its name to Saffron Walden. It is very strange that after having been grown as an economic plant in England for three or four centuries its production has died out, and that it is an extremely difficult thing to get the saffron crocus to flower in this country. The author says that saffron was used as a royal dye in the olden time in Ireland, but this is a very doubtful statement.

Into the descriptive portion of this work it is needless that we should enter in detail. All the species and their chief varieties are most carefully described, full synonymic lists are given, and ample details as to the geographical distribution of each and its period of flowering. The description of each species is accompanied by a plate illustrating the corm, flower, leaves, fruit, and structural details; and, as if to add to the attractiveness of this splendid volume, there is a series of very exquisite woodcuts, introduced as head-pieces, of some of the more remarkable districts where the rarer species are found. Some of these are from original sketches, by Mr. Danford, of the remote mountain region of the Taurus and of other parts of Asia Minor, where, with Mrs. Danford, journeys were made in quest of crocuses. The volume is dedicated to Mr. and Mrs. Danford.

The appendix, by Mr. Lacaita, on the etymology of the words crocus and saffron, is of great interest, and tells of the almost world-wide use of the terms.

NOTES

LAST week, Sir William Armstrong paid to the bankers of the Royal Society a cheque for 7800*l.* for the Scientific Relief Fund.

THE Council of the Geological Society have awarded the medals to be given at the anniversary meeting of the Society on February 18, as follows:—The Wollaston Gold Medal to Mr. J. W. Hulke, F.R.S., the Murchison Medal to the Rev. P. B. Brodie, the Lyell Medal to Mr. S. Allport, and the Bigsby Gold Medal to Prof. C. Lapworth. The balances of the Funds at the disposal of the Society are awarded as follows:—The Wollaston Fund to Mr. B. N. Peach, the Murchison Fund to Mr. R. Kidston, and the Lyell Fund to the Rev. Osmond Fisher. We believe that the President's address at the anniversary meeting will deal mainly with the relations between geology and the mineralogical sciences.

THE Geographical Society of Australasia has been authorised by the Queen to prefix the word "Royal" to its title.

THE recent death of General Hazen, the chief of the Army Signal Service in the United States, which is responsible for the meteorology of that country, has raised the question whether or not meteorology should be dealt with by a civil rather than a military bureau. It will be remembered that when the present meteorological system was established in the United States it was connected with the Signal Service, in order to utilise the time of the officers and men during peace. There is no doubt that the work done by the American Signal Service has been done with a thoroughness and vigour which have not been equalled elsewhere; and the eminent men of science who have been associated with the Chief Signal Officer have taken care that the mere forwarding of weather information should not be the whole of their duties. A Committee of the National Academy of Science has already been appointed to consider the matter, and has recommended separation of the work from the War Office. Whatever decision is arrived at, it is to be hoped that the service in its new form (if it is to have one) may not be less efficient than it has been in the past. This question is of course part of the general question now being seriously discussed in the United States, as to whether a purely scientific service should be controlled and directed by scientific men. In the abstract there can be of course but one answer to this question, but it must at the same time be pointed out that to make a man of science responsible for large administrative and executive work is to destroy him utterly as a man of science. This is a good reason for having some one other than a man of science for the carrying out of such work. It is, however, no argument for placing the man of science in a subordinate position to any mere administrator, and it would perhaps be best to intrust such inquiries on a very large scale to a small Committee, one of whom should be the man responsible for the science and the other the man responsible for the administration.

VERY enlightened ideas prevail among the influential classes of India with regard to the manner in which the Queen's Jubilee should be celebrated. On the motion of Dr. Hunter, the Vice-Chancellor of Calcutta University, the Jubilee Committee at Calcutta decided some days ago that the fund which is to be raised in India for a permanent memorial, shall be devoted partly to the Imperial Institute in London, partly to a scheme for the placing of technical education in India on a sound and lasting basis. It is said that the provincial cities are resolved not to be outstripped by the capital. The people of Patna propose to found an industrial school, and the Calcutta Correspondent of the *Times* says their example is likely to be followed in many places. The native princes have also begun to see the importance of technical education, and the Maharajah of Mysore has determined not only to contribute largely to the Imperial Institute in London, but to form an Institute of a similar kind in his own dominions. All this promises well for the material progress of our great dependency, and it should tend to strengthen the movement among ourselves for the establishment of closer relations between science and industry.

NEARLY four years ago we were able to announce that a vote had been passed at Oxford authorising the Curators of the University Chest to spend a sum of 7500*l.* in building an annex to the east side of the University Museum, to contain the splendid anthropological collection which General Pitt-Rivers had most munificently offered to the University, and in providing the requisite cases and fittings. The collection has now been partially arranged in the hall built for it, and is thrown open to visitors. It has been enriched by objects transferred from other University Museums, such as the Ashmolean, and by numerous donations from other sources. The opening of the collection ought to mark an epoch in the history of anthropological study at Oxford. Its importance arises less from the value of the objects (although that, of course, is very great) than from the manner in which they are grouped. The arrangement brings out with astonishing clearness the working of the law of evolution in the development of all kinds of implements and weapons.

IT is proposed that a Medical School shall be formed in connection with University College, Dundee. There can be little doubt that the scheme will be successful, for not only has Dundee an important hospital, but medical students at the new school would have the advantage of being able to take the degrees of the University of St. Andrews. Some time ago Mr. T. H. Cox offered 12,000*l.* as an endowment for a Chair of Anatomy, and now the sons and daughters of the late Mr. J. F. White, of Balruddery, have given 6000*l.* to found a Lectureship or Chair to be associated with their father's name.

About 2000 delegates, including about 300 from Europe, are expected to be present at the ninth triennial meeting of the International Medical Congress at Washington in September next. An effort is being made to secure the hall of the House of Representatives for the opening meeting. After this meeting the Congress will be divided into seventeen sections, assembling in the different halls of the city.

Mr. G. T. Ryves, F.R.Met.Soc., wrote the other day to the *Times*, from Stoke-on-Trent, presenting the results of an independent comparison of the daily forecast issued by the Meteorological Office for the Midland District with the actual weather experienced in 1886. The number of forecasts sent out by the Office during the year was 310. Of these, 309 were tested, and Mr. Ryves found that there were 247 absolute successes, 26 absolute failures, and 36 partial or doubtful successes. That is to say, omitting small fractions, there were 80 per cent. of successes, 8½ per cent. of failures, and 11½ per cent. of doubtful cases. Mr. Ryves understands that a similar result has been arrived at in other places where the forecasts have been submitted to an examination extending over a period of sufficient length to make it possible to strike a fair average.

The French Minister for Public Instruction has nominated a Commission, under the presidency of M. Bertrand, the Secretary of the Académie des Sciences, which will award a prize of 50,000 francs (2000*l.*) to the inventor of a cheap method for the application of electricity to the purposes either of heating and lighting, chemical or mechanical force, telegraphy, or the treatment of the sick.

The Royal Scientific Society of Göttingen offers a prize of 500 marks (25*l.*), in 1889, for a complete review of the literature of the Arabs and the Arabian-speaking tribes of the Islam and Christian kingdoms up to the time of the conquest of Egypt by Turkey. Further particulars can be obtained of the Society.

Mr. Maclean, the official assistant to the Professor of Natural Philosophy in the University of Glasgow, has just published a little book containing examples of exercises given in the natural philosophy class during recent years, with indications how to answer them. The exercises deal largely with dynamics and properties of matter, and include sound, light, magnetism, electricity, and heat. The exercises, especially those on dynamics, are very interesting, and indicate distinctly the thoroughness of the instruction given. Several of the hints for solution will be found also of great value to students.

We have frequently had to refer to the scientific *renaissance* now going on in Italy. Another indication of this has just reached us, in the shape of a volume of some 500 pages, on "Geological Evolution: Inorganic, Animal, and Human," by Signor Enrico del Pozzo di Mombello. The book is published by Sgariglia, of Foligno. It exhibits a wide philosophical grasp of the subject. The first chapter is almost confined to an analysis of Herbert Spencer's "Principles of Evolution." The writer then discusses the nebular hypothesis, and the new views as to the inorganic evolution now going on in the sun. Geological climates, with full references to the works of Lyell and Croll, follow; and after a chapter on vulcanism are chapters on practical geology. The rest of the work deals with life, including a full statement of Darwinism and human evolution, while the last chapters are devoted to prehistoric man. Such a book as this will be of the greatest service to science in Italy.

We have received the fifth edition of "Celestial Motions," a handy book of astronomy, by Mr. W. T. Lynn, formerly of the Royal Observatory, Greenwich. In this last edition a chapter has been added on the refraction, propagation, and aberration of light. The treatment, however, is necessarily so limited, that the chapter is practically useless for educational purposes.

We have received also the fifth edition of Prof. Bentley's "Manual of Botany." The physiological part of the subject has been largely revised, with the assistance of Mr. J. D. Groves, Demonstrator of Practical Biology at King's College, London. Many alterations have been made in the part treating of the properties and uses of plants; but the most marked change is in those chapters relating to the classification of plants. The book is now adapted in all essentials to the arrangement adopted in the "Genera Plantarum."

A strong shock of earthquake was felt in Venice on the night of January 24. No damage seems to have been done. At Aquila, in Lower Italy, seven shocks of earthquake were noticed on January 26, three of which were rather strong. They occurred between 2.30 p.m. and 7.45 a.m. of the next day.

On the night of January 31 a shock of earthquake was felt in Zurich and the neighbourhood, and in the cantons of Zug and Schwyz. The district affected was about 80 kilometres in diameter.

Under the auspices of the Geological and Natural History Survey of Canada, Prof. J. Macoun, of Ottawa, has now completed the first volume of his "Catalogue of Canadian Plants." The third part, just published, comprises the Apetalæ, Coniferæ, and a long list of additions and corrections to parts 1 and 2, carrying the work down to the end of Exogens.

A consignment of German carp has been forwarded to Portugal by the National Fish-Culture Association, for the purpose of acclimatisation in the waters of that country. The experiment is being made by Messrs. Broughton and Frietas, who have also made arrangements to import a quantity of salmon and trout ova, and hatch them out for a similar purpose. The National Fish-Culture Association have intimated their intention of supplying Salmonidæ fry this year gratuitously to public bodies desirous of repopulating depleted waters. One million and a half of whitefish ova (*Coregonus albus*) arrived from the American Government at the hatchery of the Association on January 31.

The National Fish-Culture Association have just issued the first number of their quarterly Journal, edited by Mr. J. W. Willis-Bund. The objects of this publication are not only to chronicle the operations of the Association, but to collect information concerning the fish, fish culture, and fisheries both of the United Kingdom and abroad. The present number includes articles by Dr. Francis Day, Mr. J. W. Willis-Bund, Mr. W. Oldham Chambers, and Mr. Anderson Smith.

Herr Richard Andree, of Leipzig, who has for some years past made a special study of cannibalism and its prevalence in ancient and modern times, has recently published (Beit: Leipzig) a pamphlet on the subject, which is full of interest to others besides the ethnologists for whom it is, of course, mainly intended. He treats first of the practice of anthropophagy in prehistoric times, discussing traces of it in popular tales, legends, and superstitions. To this section also belong the investigations into the remains found in caves and ancient burial-places in Europe, which Herr Andree thinks prove beyond doubt that cannibalism existed at this remote epoch in countries which are now the most highly civilised on the globe. The next part deals with the geographical distribution of the practice at the present day. The mass of information brought together is drawn from the literature of many countries, ancient and modern, and is enormous in amount. The writer attributes the origin of cannibalism to hunger and want in the first instance, until it developed into a settled practice, from which the step to human sacrifice, whether of single individuals, such as prisoners, or of holocausts of victims, as in ancient Mexico, is not a long one.

The death is announced of Dr. Philip Fischer, the well-known mathematician and Professor at the Polytechnic Institution at Darmstadt. He died on January 22.

IN a recent issue, *Science* comments on the fact that the number of lectures delivered by professors at Oxford and Cambridge falls considerably below that which it is usual for a professor to give in the United States. *Science* is by no means of opinion that the American plan is best. American professors are, it says, compelled to teach and lecture so much that few of them have an opportunity of doing justice to their abilities as investigators and writers. Our American contemporary counsels governing Boards in the United States to take this fact into serious consideration. "They value a professor according to the number of lectures he delivers and the number of students he attracts. They fail to perceive that scientific research is the peculiar duty, and should be the peculiar privilege, of the University professor. Oxford and Cambridge professors do more original work than our professors, simply because they are given the time for it."

CAPT. DUTTON, of the U.S. Geological Survey, is making rapid progress with the preparations for his Report on the Charleston earthquake. With regard to the velocity of the propagation of the earth-wave, the final computations have not yet been made, but the evidence is said to indicate with certainty a velocity somewhat in excess of three miles per second.

WE have received the new number of the *Annuaire* of the Royal Observatory of Brussels, by M. Folie, Director of the Observatory. This periodical has appeared every year without interruption since 1834. The present number, like its predecessors, contains much useful astronomical information. The section on physical units and constants has been enlarged, and there are valuable notes on the geography and statistics of Belgium.

MESSRS. RIVINGTON will shortly have ready a "Text-book on Animal Biology," by Prof. C. Lloyd Morgan, of University College, Bristol. The first part of the volume deals with the anatomy and physiology of vertebrates, as exemplified by the frog, the pigeon and fowl, and the rabbit. In this part there are special chapters on histology, embryology, the genesis of tissues and organs, and animal metabolism. The second part is occupied with the structure and life-history of some invertebrate types, viz. the crayfish, cockroach, earthworm, liver-fluke and tapeworm, snail, freshwater mussel, hydra, vorticella, and amœba. Numerous outline woodcuts have been drawn specially for this work. It aims at satisfying the requirements of those who are preparing for the immediate science and preliminary scientific examinations of the London University, and for the Oxford and Cambridge Local Examinations.

IN a report on the working of his department during the past six years, which has just been laid before Parliament (C—4943), the Controller of the Stationery Office refers to the publication of the Report of the scientific results of the exploring voyage of the *Challenger*. This was much delayed, Mr. Pigott observes, by the long illness and death of Sir Wyville Thomson in 1882, but it now approaches completion. The original estimate of the bulk of the work has already been very largely exceeded, "owing," writes Mr. Murray, the present editor, "to the enormous wealth of the observations and collections made during the expedition not having been at first realised." Twenty-seven quarto volumes, illustrated by about 2000 full-sized lithographic plates (many of them exquisitely finished in colours), by some eighty charts and diagrams, and by many hundred photographs and woodcuts, either already have been, or in the course of a few weeks will be, published. The editor (continues Mr. Pigott) estimates that another seven volumes at least will be required to complete the work, but hopes that with perhaps the exception of the last, in which it is intended to show the bearing of facts stated in the previous volumes on theories hitherto accepted, all will be before the public before the end of the coming financial year (March 31, 1888). The Controller thinks that perhaps it is fortunate for science that the Lords of the Treasury, when considering whether the publication of the results of the voyage should be undertaken at the public expense, were necessarily imperfectly informed of the cost. The amount paid from Stationery Office votes alone has already reached nearly 25,000*l.*, of which about 12,000*l.* only has been recovered by sales. To the balance of this account in calculating the actual cost of the book must be added the sums granted annually by Parliament for the expenses of the commission since the return of the ship —something over 40,000*l.*, making the net cost of the publication up to the present time, roughly, 53,000*l.*—a larger sum perhaps than has ever been spent by any Government on a single work. On the other side, however, Mr. Controller Pigott is good enough to add that the value of the Report can scarcely be exaggerated, and in a few lines he gives his estimate of the work of the expedition.

LIEUTENANT W. H. EMORY, of the U.S. Navy, who commanded the *Bear* in the Greely Relief Expedition, has been ordered to the *Thetis*, and will shortly sail for Alaska. He is to investigate the seal-fisheries, and has received special instructions regarding the boundary-line between Alaska and British territory.

THERE seems to be some need for a scientific examination of medals granted in America for distinguished services. The "fine, large, gold medal," given to General Grant for the part he played in the Mexican war, is now in the National Museum, Washington, and, according to *Science*, it is "bogus," having a specific gravity of only 7 instead of 16.

IN a recent Report, Mr. J. R. Dodge, Statistician of the U.S. Agricultural Department, shows that the amount of beetroot-sugar produced last season exceeded the cane-sugar by 162,000 metric tons. The manufacture of beet-sugar is wholly a European industry, and Mr. Dodge says its success in Europe is largely due to the fact that each shareholder in the stock of a beet-sugar factory is required to furnish so many beets per share. The farmers are in reality the manufacturers, and, since they obtain the profits of the manufacture, it is their interest to raise good beets at a nominal price. Mr. Dodge states that the sugar consumed in the United States amounts to about one-fourth of all the sugar reported from the places of principal production, and that within twenty-five years the country will require as much as the whole of the present supply of the cane-sugar of commerce, and nearly as much as the present production of beet-sugar. Mr. Dodge expresses surprise that Americans "scour the world for food-products costing more than 200,000,000 dollars per annum, the larger portion of which should be produced in the United States." What is needed, he thinks, is "a more skilful, scientific, and inventive agriculture."

THE introduction of the electric light is not always, apparently, an unmixed benefit. Some time ago electric lights were placed in front of the Treasury and other public buildings in Washington, and a fine and striking effect is said to have been produced. Unfortunately, however, spiders discovered that game is plentiful in the vicinity of the new lights, and that they may there ply their craft successfully both day and night. In consequence, as Mr. G. Thompson writes to *Science*, their webs are so thick and numerous that portions of the architectural ornamentation are no longer visible, and when the webs are torn down by the wind, or fall from decay, the refuse gives a dingy and dirty appearance to everything it comes in contact with.

We notice in one of the morning papers that considerable progress is being made at the great Lambeth factory of Messrs. Maudslay, Sons, and Field, with the large compound engines which are being prepared for the new Italian armour-clad *Il Re Umberto*. According to the contract, these engines are to be of 19,500 horse-power, which is about 7500 horse-power more than that of any vessel yet designed for the British Navy. It is stated that they will actually indicate 21,000 horse-power, or 9000 more than any vessel in the British Navy. These engines, completely made of steel, are expected to drive the *Il Re Umberto*, fully equipped, about 20 knots per hour.

Mr. C. C. Lacaita is taking charge of the Sanitary Registration of Buildings Bill in the House of Commons. The Bill as introduced in 1886 consisted of ten sections, and, it will be remembered, made the sanitary registration of all buildings compulsory in towns of 50,000 inhabitants and upwards. The new Bill consists of seventeen sections, and is to apply to all towns or districts of 2000 inhabitants, but it is only to be compulsory in the case of schools, colleges, hospitals, asylums, hotels, and lodging-houses. An important feature of the new Bill is that the local authorities will have to keep a Sanitary Register, in which any building certified in accordance with the proposed Act may be registered, so that a stranger visiting any district would be able to ascertain at the office of the local authority whether any particular house was or was not certified as in a satisfactory sanitary condition. The new Bill will, no doubt, be more acceptable to sanitary experts, seeing that all persons entitled to certify must first obtain a license from the Local Government Board, and provision is made for the appointment of examining Boards. Persons entitled to sign certificates are designated Licentiates in Sanitary Practice.

The town of Baku was recently threatened with destruction by the sudden outburst of a natural naphtha fountain. This was soon followed by a volcanic eruption from Lok Botan, close to the Ponta railway station, and about ten miles from Baku. The eruption began on the night of January 15, when the inhabitants of Baku were alarmed by a shock like that of an explosion, which made all their window-panes tremble violently, while towards the south-west the sky was illuminated by an intense light, as of some terrific conflagration. The following information, furnished by the railway officials of the Ponta station, appeared in a telegram from the St. Petersburg Correspondent of the *Times* on Monday last:—"Quite suddenly, at eleven o'clock at night, the noise of an explosion was heard, and the summit of Lok Botan shot up an enormous column of fire some 350 feet high. The whole country was instantly lit up brighter than day, and the heat could be felt at nearly a mile from the crater. There was scarcely any wind, so that the column continued to ascend quite vertically, carrying with it, as could be seen, large dark substances which appeared to fall again into the volcano. This lasted with short intervals of subsidence all through the night and the following twenty-four hours, but luckily the matters ejected did not reach the railway station." The *Times* Correspondent says that the volume of muddy liquid thrown out is estimated at half a million cubic *sejenes*—the Russian *sejene* equalling 7 feet—and has spread itself over more than a square mile to a depth of from 7 to 14 feet.

On the night of January 26 a brilliant meteor was observed at Holmestrand, on the south-east coast of Norway. It went from south-west to north-east, at a rapid pace, and disappeared below the horizon. The light was an intense white, illuminating for a few seconds the whole town as in broad daylight.

A statue is to be erected at Christiania in honour of the celebrated mathematician Abel, subscriptions being raised towards it from all parts of Europe.

The Council of the Royal Meteorological Society have arranged to hold, at 25 Great George Street, S.W. (by permission of the Council of the Institution of Civil Engineers), on March 15 to 18 next, an Exhibition of Marine Meteorological Instruments and Apparatus. The Exhibition Committee are anxious to obtain as large a collection as possible of such instruments; and they will be glad to show any *new* meteorological instruments or apparatus invented or first constructed since last March, as well as photographs and drawings possessing meteorological interest.

Mr. John Murray, of the *Challenger* Expedition Office, Edinburgh, writes to us that the passage placed within inverted commas in one of our Notes on Jan. 27 was not a quotation from his address to the Royal Society of Edinburgh. We may explain that the passage was quoted from what professes to be "a condensed report of the address" in the January number of the *Scottish Geographical Magazine*. In this "condensed report" Mr. Murray is represented as having said that "money grants of considerable annual value are devoted to the maintenance of learned Societies in London and Dublin." Our only object was to point out that so far as London is concerned this statement is misleading.

The additions to the Zoological Society's Gardens during the past week include a Black-winged Peafowl (*Pavo nigripennis* ♀) from Cochin China, presented by Mr. John Marshall; a Cayenne Lapwing (*Vanellus cayennensis*) from South America, purchased; six Long-fronted Gerbilles (*Gerbillus longifrons*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

Comet Brooks (1887 *b*).—This object was observed at Paris on January 27 as a circular nebulosity of about 1′·5 in diameter, with a small but fairly bright nucleus, almost stellar in appearance, and situated not quite in the centre of the coma. The comet was estimated as of the 12th magnitude.

Dr. Rud. Spitaler, Vienna Observatory, has computed the following elements and ephemeris:—

T = 1887 March 23·01985 Berlin M.T.

π = 89° 26′ 17″
Ω = 283 0 15
i = 102 25 29
Mean Eq. 1887·0
log q = 0·19021

Error of middle place ($O - C$).

$d\lambda \cos\beta = + 9''$, $d\beta = - 5''$.

Ephemeris for Berlin Midnight

1887	R.A. h. m. s.	Decl. ° ′	log Δ	log r	Brightness
Feb. 12	1 59 34	+ 73 5·6	0·07734	0·21040	1·39
16	2 35 23	68 19·5	0·08193	0·20660	1·39
20	2 59 23	63 27·4	0·09016	0·20314	1·36
24	3 16 58	58 41·5	0·10154	0·20007	1·31
28	3 30 42	+ 54 9·1	0·11553	0·19744	1·25

The brightness on January 25 is taken as unity.

Comet Barnard (1887 *c*).—Barnard's comet was observed at Paris on January 26, and seemed to be of much the same brightness and dimensions as Brooks's comet appeared on the following night, but it differed somewhat as to its nucleus, there being a central condensation forming a diffused nucleus about 4″ or 5″ in diameter. The comet is steadily diminishing in brightness. The following elements and ephemeris are by Prof. E. Weiss:—

T = 1886 November 23·6302 Berlin M.T.

π = 284° 27′ 58″
Ω = 257 14 17
i = 85 22 5
Mean Eq. 1887·0
log q = 0·15454

Error of middle places ($O - C$).

$\Delta\lambda \cos\beta$ + 4″ − 3″, $\Delta\beta$ − 1″ − 9′.

Ephemeris for Berlin Midnight

1887	R.A. h m s	Decl. ° ′ ″	log Δ	log r	Brightness
Feb. 12	20 4 1	+ 37 25·2	0·338827	0·26127	0·83
16	20 16 44	39 50·3	0·341157	0·26929	
20	20 29 54	42 12·3	0·345660	0·27733	0·74
24	20 43 32	44 30·2	0·350518	0·28538	
28	20 57 38	+ 46 43·4	0·356038	0·29341	0·66

The brightness on January 24 is taken as unity.

THE ROUSDON OBSERVATORY.—We have received Mr. Peek's report on the astronomical work done at the Rousdon Observatory, Lyme Regis, in 1886. During the year, 146 nights were available for observation, the most cloudy month having been February, and the clearest December. Selected lists of long-period variable stars are under systematic observation with the 6·4-inch equatorial. The following comets have also been observed: 1885 *d* and *e*, 1886 *a*, *b*, *c*, *e*, and *f*. The great nebula in Andromeda is under regular observation. We would suggest to Mr. Peek the propriety of publishing the observations of cometary positions at as early a date as is possible; their value is much increased by speedy publication.

MINOR PLANET No. 264.—This asteroid has been named Libussa by Prof. Peters, of Clinton, U.S.A., the discoverer.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1887 FEBRUARY 13–19

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on February 13

[redacted]ses, 7h. 20m.; souths, 12h. 14m. 25·5s.; sets, 17h. 8m.; decl. on meridian, 13° 21′ S.: Sidereal Time at Sunset, 2h. 42m.

Moon (at Last Quarter February 15) rises, 22h. 48m.*; souths, 4h. 27m.; sets, 9h. 55m.; decl. on meridian, 7° 5′ S.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury ...	7 43	... 12 38	.. 17 33	... 13 7 S.
Venus	8 1	... 13 22	.. 18 43	... 8 28 S.
Mars	7 56	... 13 16	... 18 36	... 8 33 S.
Jupiter... ...	23 43*	... 4 44	... 9 45	... 12 11 S.
Saturn... ...	13 29	... 21 37	... 5 45*	... 22 19 N.

* Indicates that the rising is that of the preceding evening and the setting that of the following morning.

Occultations of Stars by the Moon (visible at Greenwich)

Feb.	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image ° °
13 ...	94 Virginis ...	... 6 ...	5 26 ...	6 22 ...	38 305
14 ...	ξ Libræ	6 ...	1 4 ...	2 6 ...	52 202

Feb. h.
13 ... 12 ... Jupiter in conjunction with and 3° 43′ south of the Moon.

Variable Stars

Star	R.A. h. m.	Decl. ° ′		h m	
U Cephei	0 52·3	81 16 N.	Feb. 15,	20 58	*m*
S Piscium	1 11·7	8 20 N.	,, 18,		*M*
R Arietis	2 9·7	24 32 N.	,, 15,		*M*
Algol	3 0·8	40 31 N.	,, 13,	18 50	*m*
ζ Geminorum ...	6 57·4	20 44 N.	,, 13,	4 0	*M*
R Boötis	14 32·2	27 14 N.	,, 17,		*M*
δ Libræ	14 54·9	8 4 S.	,, 17,	0 57	*m*
U Coronæ	15 13·6	32 4 N.	,, 14,	1 37	*m*
V Coronæ	15 45·5	39 55 N.	,, 14,		*M*
U Ophiuchi... ...	17 10·8	1 20 N.	,, 15,	2 41	*m*
		and at intervals of		20 8	
T Herculis	18 4·8	31 0 N.	Feb. 18,		*M*
β Lyræ...	18 45·9	33 14 N.	,, 20,	22 0	*M*
R Lyræ	18 51·9	43 48 N.	,, 13,		*m*
δ Cephei	22 25·0	57 50 N.	,, 13,	4 0	*m*
R Cassiopeiæ ...	23 52·7	50 46 N.	,, 15,		*M*

M signifies maximum; *m* minimum.

Meteor-Showers

On February 17, a radiant near υ Herculis, R.A. 238°, Decl. 48° N. On February 20, from Coma Berenices, R.A. 180°, Decl. 33° N.; and another from near ρ Herculis, R.A. 263°, Decl. 36° N. Other radiants of the week:—Near λ Draconis, R.A. 165°, Decl. 73° N., and near β Ophiuchi, R.A. 260°, Decl. 0°.

GEOGRAPHICAL NOTES

IN a private letter from Mr. H. M. Stanley, published yesterday, he says that when he reached Cairo he found that all the political authorities and experts there were opposed to the idea of his taking the Congo route. They thought that as the Expedition was to be armed with several hundred Remingtons and a machine-gun of the latest invention it was to be an offensive force, conducted after strict military rules, and that Mr. Stanley would therefore meet with no insuperable difficulties either by the Karagwé or by the Masai route. On this point he undeceived them, and he also showed that if serious fighting were necessary his men would be wholly unable to meet great masses of native warriors. Besides, the probable result of a struggle with Uganda would be that Mr. Mackay, the missionary, and the French Bishop and Père, now in Mwanga's power, would be murdered. The total length of each land journey is given by Mr. Stanley as follows:—Congo route: Matáddi to Stanley Pool, 235 English miles; Stanley Falls to Lake Albert, 360 English miles—total 595 English miles. Karagwé route: Zanzibar to Lake Albert, 950 English miles. Masai route: *viâ* Taveta, Kenia, and Turkan, 925 English miles. Mr. Stanley also calculates the length of the various routes by days, assuming that only an average of six miles could be made daily. Congo route: land journeys, 99 days; Zanzibar to Congo, by steamer, 20 days; Lower Congo, by steamer, 3 days; Upper Congo, by steamer, 35 days. Total, 157 days. Karagwé route: land journey, 156 days. Masai route: land journey, 154 days.

THE most important contribution to the new number of the *Bulletin* of the Paris Geographical Society is the series of maps of the River Ogové in West Africa, by Lieut. Mizon. These maps, which are on the scale of about 1 kilometre to an inch, and refer to the whole course of the river as surveyed by Lieut. Mizon, are executed with much care. In the brief text which accompanies the maps, the author describes his method of observation, and gives the positions of some of the more important points. M Jamkowski contributes an article on Fernando Po, in which he gives some welcome information on the curious people known as Bubis, who inhabit the mountainous districts of the island. Other papers in this number are on the "Ksour" of Bouda (West Sahara), by M. Chatelier; two papers on Tonquin, by Lieut. Gouin; and a paper on the expedition of General de Bussy in the Deccan in the eighteenth century.

IN the Bulletin of the American Geographical Society, No. 2, 1886, Commander H. C. Taylor, U.S.N., describes the various projects which from time to time have been advanced for the construction of a canal across Nicaragua, and attempts to show that this is the most favourable route for a canal between the Atlantic and Pacific. Dr. G. E. Ellis gives an interesting *résumé* of the history of the Hudson's Bay Company, 1670–1870.

LAKE TAHOE, long regarded as the deepest fresh-water lake in the United States, must now take the second place. Capt. C. E. Dutton, of the U.S. Geological Survey, made, in July 1886, a series of soundings at Crater Lake, Oregon, with unexpected results. The mountain wall that surrounds the lake is 900 feet high; the average depth is 1500 feet, and the maximum 1996.

To the January number of *Petermann's Mitteilungen*, Dr. Theobald Fischer contributes the first part of a study of the coasts of North Africa, in which he attempts to account with precision, on geological and meteorological bases, as well as by the action of the sea, for the various features of the North African coast. The present instalment deals mainly with the Algerian and Tunisian coast, and the investigation forms part of a detailed study which Dr. Fischer is making of the whole Mediterranean coasts. The paper is accompanied by maps, while another map illustrates the distribution of languages in Germany and Austria, the accompanying text being by Prof. F. Heid. Dr. Possewitz contributes a paper on the laterite outcrops in the Island of Banka.

THE new number of *Appalachia* contains, among other things, a series of useful data, by Prof. E. C. Pickering, on "The Heights of the White Mountains," and a valuable paper by Prof. W. Morris Davis, on "Mountain Meteorology."

IT may interest both geographers and ethnologists to know that in the current numbers of *Les Missions Catholiques* the Rev. Jules Branetti describes his recent journey up the River Maroni, in French Guiana, giving many details concerning the Negro population which is settled on its banks.

THE Austro-Hungarian Expedition for the investigation of Central Africa, which was organised last year by Count Samuel Teleki, and reached Zanzibar last June, has left for the interior.

A GERMAN Expedition to Brazil sailed from Bremerhafen on January 25. The gentlemen are: Dr. Karl von den Steinen and his cousin Wilhelm, Dr. P. Vogel (Uelfeldt), and Dr. Ehrenreich (Berlin). Both Dr. K. von den Steinen and Dr. Vogel took part in the German Polar Expedition to South Georgia, and the former gentleman and Dr. Clauss were with the celebrated Expedition for the investigation of the Xingu River in Central Brazil, while Dr. Ehrenreich was on a journey in the Amazon district.

THE new number of the *Mittheilungen* of the Vienna Geographical Society contains Dr. Lenz's map of the Congo between Stanley Falls and Kasonge, to the journey up which we referred in a recent number of NATURE. The map gives much information as to the character of the country along the banks of the river, and the people who inhabit them. As it is only six months since Dr. Lenz arrived at Kasonge, one cannot but remark the rapidity with which the journey between the coast and the centre of Africa can now be made. As a matter of fact, the London Missionary Society has a monthly mail between Zanzibar and Lake Tanganyika, and letters from their missionaries on the west shore of that lake reach London in three months.

THE same number contains the conclusion of Herr Baumann's very valuable description of the country and people on the Middle and Lower Congo; a paper on the high lakes of the Eastern Alps, by Dr. August Böhm; and a collection of recent statistics on the population of Bosnia and Herzegovina.

HERR P. LANGHAUS has been endeavouring to form an estimate of the native population in the Cameroons territory recently acquired by Germany. He confines himself to the coast region between the Rio del Rey and the Rio Campo, and gives 480,500 as the population on 26,000 square kilometres, or only 18 per square kilometre. The people mostly belong to the north-west branch of the Bantu stock, and Herr Langhaus gives some useful details as to their distribution and subdivision in the *Deutsche Rundschau* for January.

A NEW exploration of the districts on the Upper Meikong, inhabited by the Laos tribes subject to Siam, has attracted considerable attention in Paris. Towards the end of 1885, the Siamese Government found it necessary to undertake an expedition against these tribes (the principal of them being the Ho). An Italian officer, Capt. Pinson, who was a military instructor in the Siamese service, accompanied the expedition, which ultimately arrived at Muen-Son, fourteen days' march to the north-east of Luang-Prabang, in the centre of a region wholly unknown to Europeans, for these Hos had prevented Dr. Neis from completing his famous exploration of the whole of the Laos States. The expedition, owing to frontier complications with Tonquin, was not a success, and now M. Pinson has determined to explore the country for himself, partly with the object of discovering commercial routes along the Meikong into Yunnan and into Tonquin, both starting from Luang-Prabang, and also for geographical purposes. He has arrived in Paris to lay the project before the President of the Council and the various mercantile bodies. To the former he has presented a memorial asking to be despatched on the mission by the French Government. In this document he describes briefly the divisions of the Siamese Laos, the nature of the soil, the commercial situation of Great Britain in Burmah in regard to the Laos States, the alternative trade routes for Upper Laos—which he describes as by the Meinam to Bangkok (which appears the natural route), by the Ho country into Tonquin, or by the Meikong—and other details. He expresses the determination to return without delay to Luang-Prabang, and, if aided by the French Government, (1) to penetrate into Yunnan in order to study the peoples on the route and their commercial wants, and (2) to explore and study in like manner the two routes from the same town into Tonquin and Annam. The projected exploration, it will be observed, is mainly through unknown territory, Dr. Neis not having been able to penetrate a large part of this region.

IN the last number of *La Gazette Géographique* M. Kaltbrunner publishes an interesting article entitled "L'Indicateur Géographique." He first gives statistics of the various Societies for geography and the allied sciences in the world. According to continents, the number of these is as follows:—Europe 91, Africa 5, America 9, Asia 9, Australia 2, giving a total of 115. France heads the list with 28, then comes Germany with 23, then Italy with 8, Switzerland with 7, Austria with 6, and Great Britain with 4. The total number of periodicals treating of geography as a principal or accessory subject is 263, of which 214 are published in Europe, 14 in Africa, 19 in America, 15 in Asia, and 1 in Australia. France again heads the list with 79, Germany has 42, Great Britain 18, Italy 13, Austria and the United States 11 each. Many other interesting details respecting membership, amount of subscriptions, of Government assistance, &c., are given. In Great Britain, Germany, and France the average subscriptions per member are 30, 30, 35, and 15 francs respectively. The writer complains that, notwithstanding the great number of French Societies and publications, no one publication similar to *Petermann* in Germany and the Proceedings of the Royal Geographical Society in England exists. He proposes, therefore, that a geographical indicator should be published containing the title, place of publication, summary of contents, price, and, where desirable, a critical review of all the geographical journals, as well as of new books, maps, &c. The editor of *La Gazette Géographique* promises to carry out the idea as far as possible by giving these details respecting such of the publications as have reached his hands since the beginning of the New Year.

DR. VON KLÖDEN recently published a list of 374 rivers, with their lengths, and other data, in which he gave the Nile as the longest river, with a length of 6470 kilometres, the Missouri-Mississippi coming second with 5882 kilometres. General von Tillo revises these estimates, and from more exact measurements concludes that the Missouri-Mississippi is the longest river in the world, with 6750 kilometres, the Nile coming next, with 6470 kilometres as in Von Klöden's list. Other rivers given both by Von Klöden and Tillo with the same measurements are the Ta-Kiang, 5083 kilometres; the Amazons, 4929; the Yenisei-Selenga, 4750; the Amur, 4700; the Congo, 4640; and the Mackenzie, 4615. In connection with this subject *Petermann's Mitteilungen* states that a new curvimeter is being practically tested in Perthes's geographical establishment; if the results are satisfactory it will be of great service to those who have much to do with maps.

THE Geographical Society of Mexico is about to resume the publication of its proceedings, which has been interrupted since 1882.

Cosmos announces the forthcoming publication of an important work on the geography of the interior of Madagascar, by a French Jesuit, Père Roblet, who has explored the greater part of the island. It will be accompanied by various topographical maps, especially of the provinces of Imerina and Betsileo.

AT a recent meeting of the Geographical Society of Paris, a note was read from M. Cervera, who is charged by the Madrid Geographical Society with a journey in Eastern Africa, on his itinerary. M. Raffray, the Consul of France at Zanzibar, sent a report on the results of Dr. Junker's last journey. M. Choffanjon, writing from San Fernando, announced his approaching departure for the exploration of the Orinoco; and Dr. Chervin read an interesting paper on the increase of the populations of France and the principal States of Europe during the present century. In France the urban population was only 24 per cent. of the total in 1843, while now it is 35 per cent. The writer referred to the very slow increase of the population in France, although the average mortality is less than in other European countries. In some of the departments the population is even less now than it was in 1801. He thought colonial extension was one of the most efficacious remedies for a state of things which threatened to place France in a position of numerical inferiority towards other States. New colonies, he says, open new fields to future generations. The process suggested, however, appears like that of putting the cart before the horse.

THE INSTITUTION OF MECHANICAL ENGINEERS

THE Institution of Mechanical Engineers held its meeting in the Theatre of the Institution of Civil Engineers on Thursday and Friday of last week. The paper on "Triple Expansion Engines," read at the last meeting, of which we then gave an abstract, was discussed. The remainder of the papers on the programme were read and discussed.

Mr. E. P. Rathbone's paper on "Copper-Mining in the Lake Superior District" comprised a general description of the district, the method pursued in mining, and the system of ore-dressing and machinery employed. The ore employed is what is known mineralogically as "native copper." It does not occur in true fissure veins, but rather in beds, or, as they are not inaptly termed in the district, "belts," dipping at the same inclination as the "country" or rock inclosing them.

From exhaustive scientific investigations into the origin and derivation of the copper in these deposits, it appears probable that it was infiltrated into them in the form of an aqueous solution of copper, which also appears to have had a strong chemical affinity for special constituents of the rocks, thereby giving rise to a series of chemical reactions, whence resulted the precipitation of native copper in a more or less concentrated state, according to the proportion and the even distribution or otherwise of the precipitating or displacing agent present in the original rocks. In the amygdaloidal trap-rocks the displacing agent appears generally to have been less evenly distributed than in the conglomerates; in certain places the concentration of the displacing agent has been so excessive as to give rise to the formation of large masses of copper. Whether or not the precipitating action was connected with some natural process of lixiviation, influenced by terrestrial electrical currents, it is impossible to decide. In the amygdaloidal trap-rocks the vein-stone is frequently composed largely of epidote, a mineral whose presence is regarded as favourable or "kindly" to copper. Other minerals found in association with the hornblendic and augitic porphyries that constitute the veinstone proper, are quartz, calc-spar, and many varieties of the zeolite group. The commercial copper smelted from these ores being entirely free from deleterious matters, such as arsenic, bismuth, antimony, &c., is especially valuable for electrical purposes, as the conductivity of copper is reduced by the presence of foreign matter even in the minutest proportions, a trace of arsenic reducing the conductivity 20 per cent. In the manufacture of brass, again, the presence of antimony is most deleterious: one-tenth of 1 per cent. converts first-rate "best selected" into the worst possible; one-fortieth of 1 per cent. renders it unfit for anything but inferior brass; one-eightieth of 1 per cent. changes "best selected" into "tough ingot"; one-tenth of 1 per cent. of either bismuth, arsenic, phosphorus, nickel, or cobalt, is sufficient to turn "best selected" into tough metal.

There are two methods pursued: "mass mining," where copper is found concentrated into masses varying in weight from a few hundred pounds up to many tons; and "stamp-rock mining," where the copper occurs in a more or less divided state, and usually pretty evenly disseminated throughout the whole veinstone, so that its separation from the matrix or gangue can be economically effected only by stamping and by the subsequent processes ordinarily employed in mechanical ore-dressing. The more evenly the copper is distributed throughout the veinstone, the more valuable is the latter, and hence it is that veinstone producing only 0·75 per cent. can be worked profitably at the present low price of copper.

The object of ore-dressing is to separate as far as possible the small percentage of valuable metal occurring in the ore from the worthless matrix or gangue, and concentrating it to the highest degree of purity practicable. The main feature of the process may be said to consist in applying to copper ore the principles and the machinery already employed elsewhere in the dressing of tin and lead ores.

In the Lake Superior copper-mining the features which appear to the author most worthy of special attention are:—(1) The care with which the exploratory workings are kept in advance of the stoping. (2) The general use of machine drills, which admits of opening up the mines at a rate otherwise impracticable. This is one of the few localities where drills are employed for stoping, and it has been found that two or three times as much rock can be stoped in the same time by drill as by hand. (3) The care bestowed upon the separation of the copper from the gangue by dressing.

M. Marc Berrier-Fontaine's paper was descriptive of his portable hydraulic drilling-machine, by means of which holes are drilled in a single operation through all the superposed thicknesses of metal without stopping the drill, which insures that all the holes are quite true. By its use 25 per cent. more holes are drilled than can be drilled by stationary machines in the shops.

Mr. H. Teague's notes on the pumping-engines at the Lincoln Water-works, which the Institution visited at its summer meeting last year, are mainly of a technical character. It is interesting to learn that when in 1884 still further pumping power was required, the author, from experience gained at Grantham, Maidstone, and other places, decided to revert to the Cornish pumping-engine, as he had been convinced that the cost of coals and repairs had been reduced in some instances to as low as only one-sixth of the annual expenditure pertaining to rotatory pumping-engines previously in use there.

THE SCOTTISH METEOROLOGICAL SOCIETY[1]

THE Journal of the Scottish Meteorological Society, which has recently been published, contains, in addition to copious tables of the meteorology of 1885, several papers of more than usual interest. Prof. Piazzi Smyth leads with a suggestive paper on hygrometric observation, based chiefly on observations made by him in the neighbourhood of Malvern in the summer of 1885, on fifteen successive days, at 9 a.m., in June, at a height of 125 feet; and subsequently for twenty successive days at the same hour but at a height of 350 feet. Scrupulous care was taken to have the dry-bulb surrounded with air as nearly as possible of the same quality as that of the free atmosphere outside, by placing a large and tall black iron chimney on the top of the Stevenson screen, according to Mr. Aitken's idea of promoting a current inside the screen; and to have the wet-bulb as perfect as possible by enveloping it in thin muslin, tightly drawn over its surface, and by securing that it was always thoroughly wet for each observation. The results gave for the lower station a mean depression of 3°·4 of the wet- below the dry-bulb; and 6°·4 for the upper station. It is probable that these results would be found to be higher than what obtained at the three or four stations in Central England nearest to Prof. Smyth's at the same dates; and without a doubt the value of the inquiry would have been enhanced if such comparisons had been made and recorded in the paper.

An important point would be gained if such inquiries led meteorologists more earnestly to consider the necessity of improving the means and methods of observing and reducing the observations of this most important element of the atmosphere, it being by its aqueous vapour that the disturbing influences at work are called into play, giving rise to winds, storms, rain, snow, hail, electric displays, and other atmospheric phenomena.

Mr. Omond, in an interesting paper on the wind and rainfall of Ben Nevis in 1885, based on the hourly observations at the Observatory, shows that the direction of wind with which most rain fell was a little to the north of west, and that the quantity diminishes round the compass in both directions from this until the driest point is reached a little to the south of east: east winds having a very low value. As regards the rate of fall with each wind during the time it lasts, north-westerly winds are the wettest and easterly and south-easterly winds the driest. Since south-easterly winds mostly occur when an anticyclone is moving off and a cyclone approaching, the fact of their dryness at the Observatory, 4406 feet high, is a valuable contribution to our knowledge of storms, since the same winds under the same conditions at lower levels are notoriously wet.

A hopeful inquiry is being carried on at the Ben Nevis Observatory by Mr. Rankin, first assistant, on rainband observations; and from the results already obtained there can be little doubt that when a complete low-level observatory, with hourly observations, has been established at Fort William, much light will be thrown on the vertical distribution of vapour in this part of Great Britain, and its important bearing on forecasting the weather. The observations for seven months are discussed, and the means show that a heavier rainband indicates with steady regularity a larger rainfall as determined by the hourly observations.

But the most important contribution of new facts in the Journal are thirty-nine pages of temperature observations made on the Firth and Lochs of the Clyde from March to November 1886, by

[1] Journal of the Scottish Meteorological Society, Third Series, No. iii. (Edinburgh and London: William Blackwood and Sons.)

the staff of the Scottish Marine Station on board the *Medusa*; the trips having been made in April, June, August, September, and November. The observations were made at all depths of the sea, from the surface to 107 fathoms. The novelty and, in not a few cases, the unexpectedness of the results render it advisable to delay a full discussion till more observations have been made and the densities worked out. In the meantime a provisional report on the results of the April and June trips, by Dr. H. R. Mill, will be read with interest. Among the unexpected results was the discovery in June in Loch Fyne of a lenticular mass of water with temperature below 43° floating between two warmer strata, the cold area being most definite at its upper surface and more diffused below. The greatest thickness of the mass of water colder than 43° was 180 feet, off Inveraray. Its lower bounding plane ran along the bottom from the head of the loch to Dunderave: then where the water deepens it dipped down again at the same angle until off Inveraray, where it bent up again and met the upper bounding surface at Furnace, 120 feet under the surface of the loch.

In a paper by the secretary on the meteorology of Ben Nevis, it is shown from the three years' observations at the low-level station and the high-level observatory that the mean decrease of temperature with height is at the rate of 1° F. for every 270 feet of ascent, the lowest monthly rate being 1° for every 284 feet in winter and the most rapid rate 247 feet in spring. A table of the barometric corrections for height for the different sea-level pressures and air temperatures that occur has also been prepared directly from the observations themselves. The importance of the results of these two inquiries rests on the fact that the Ben Nevis pair of stations alone supply, owing to their great difference in height, close proximity horizontally, and the positions of their thermometers, the physical data of observation which satisfy with sufficient closeness the requirements of these fundamental problems of meteorology. The science has now passed that stage when Great St. Bernard with Geneva, Mount Washington with Portland and Burlington, Hochobir with a station in one of the neighbouring deep valleys, or brief continued observations with balloons or at different heights on the slopes of the Faulhorn, can be accepted as affording the data required for dealing seriously with these questions.

REPORT ON THE BOTANICAL GARDEN, SAHARUNPUR

MR. DUTHIE'S "Report on the Progress and Condition of the Government Botanical Gardens at Saharunpur and Mussoorie for the Year ending March 31, 1886," which has recently reached us, contains, besides the usual routine matter, inseparable from such Reports, on the state of the Garden itself, much that has a wider range of interest. As usual, the cultivation of new plants of economic value appears to have occupied a considerable amount of attention during the year. Where so many useful plants have been introduced and reported upon, it is not an easy matter to select one or two for an example of the work in which Mr. Duthie is engaged. The character of this work is now, however, pretty well known, though the following extracts will show that plants of very varied character and uses are yearly being experimented with in our Indian and colonial botanic gardens.

Under the head of New Zealand spinach, a quantity of the seed of this vegetable is reported to have been received and planted, germinating freely and yielding a continuous crop of leaves, which, when cooked, is said to much resemble in flavour that of English spinach. The plants, Mr. Duthie says, seed freely, and he has no doubt that it will readily acclimatise; though, as he says, the introduction is not one of much importance, except for variety, as it comes into season at the same time as English kinds, and it can hardly compete with them in popular estimation. This so-called New Zealand spinach many of our readers will remember as *Tetragonia expansa*.

The Oca-quina (*Ullucus tuberosus*) is another food-plant upon which experiments in cultivation have been made. It is a native of South America, and the tubers, which are about the size of a walnut, and similar in appearance to a potato, are eaten, when cooked, by the people. Its cultivation in this country as a substitute for the potato was at one time proposed and attempted. Mr. Duthie says that twenty-eight tubers were received by him from the Royal Gardens, Kew, four of which were sent to the Arnigardh Garden, and the remainder were planted at Saharunpur. Up to within a few weeks of the date of the Report, these latter plants had made good growth, but after the commencement of the hot weather they became sickly, so that it is evident it will not suit the plains of India, but may succeed very well in the climate of Arnigardh, where it was intended that the majority of the plants should be sent.

Of the Japanese varnish-tree (*Rhus vernicifera*) the seedlings are stated to be making rapid progress. The growth for the two years after germination did not average more than a foot, which, however, has been doubled since the commencement of the hot season, and there is now no reason to doubt that this useful tree will thrive in the climate of Saharunpur. Mr. Duthie further says a small plantation will be made next rainy season, and it will then be a question of time as to when the plants will be ready for tapping.

Mr. Duthie makes the following interesting report on the subject of spider silk, which had previously attracted [illegible] attention. He says:—"I arrived from British Garwhal [illegible] time to superintend operations at the commencement. The men employed on this work were provided with small sticks about a foot long, and they were told to collect as many clean webs as possible during the day. There was not much to show at the end of the day, as the silk takes up very little space when wound round these sticks, and the weight is inappreciable. The total weight of webs collected during the season did not exceed 10 lbs., the bulk of which was despatched to Mr. Wardle, of Leek. The cost of collecting the above, and the carriage from Bhim Teel to Saharunpur, and from Saharunpur to Bombay, amounted to Rupees 33 - 7 - 0. At this rate the export of spider silk to England would, of course, never pay, but expenses might be reduced very considerably: for instance, this first consignment included the weight of the sticks round which the silk was wound. The silk is removable after immersion in hot water. During my stay at Indalpur, in the Shâhjahânpur district, I saw some fine clean webs of the same kind in a forest about eight miles to the north of Indalpur."

Judging from the remarks of Mr. Duthie, there seems [illegible] little chance of spider silk ever becoming an article of commercial value.

The Report includes some interesting notes on some official tours made by Mr. Duthie during the year, and a valuable list of plants collected, the names of which have been verified at the Royal Gardens, Kew.

SCIENTIFIC SERIALS

Bulletin de l'Académie des Sciences de St. Pétersbourg, tome xxxi. No. 3.—Corrections and additions to the Syrian-German and Votyak-German dictionaries, published in 1880, by F. J. Wiedemann. These emendations are based on the following recent works: "The Land and Language of the Syrians," by Lytkin; the publications on the Votyak language issued by the Kazan Mission; "Votyak Tales and Proverbs," collected by Dr. Aminoff, and published in the works of the recently instituted Finnish-Ugrian Society; Dr. Max Buch's ethnographical sketch of the Votyaks in the "Actæ Societatis Scient. Fennicæ," vol. xii.; and MM. Koshurnikoff and Miropolsky's monographs on the Votyaks.—On the Ornis of the western spurs of the Pamir and Alai, by V. Bianchi—On "Claudii Galeni Pergameni Scripta minora," by L. Nauck.

Nyt Magazin for Naturvidenskaberne, vol. xxx. Nos. 3 and 4, Christiania, 1886.—This number of the Norwegian *New Journal of Sciences* contains:—Continuation of Herr Brögger's paper on the geological history of the Christiania Fjord. According to the writer, it may be assumed that the bed of the fjord has been raised by eruption to the surface of an older bed, which consists of depressed strata of the earth's crust, whose depression had been connected with active processes of dislocation, crumpling, and folding in the post-Silurian period. The evidences of erosion and eruption are considered at length, with special reference to the action of glaciers in the formation of the fjord.—Dr. Lang concludes in an exhaustive paper his contributions to the study of the eruptive rocks of the Silurian beds of Christiania, and thus completes an important chapter in the geological history of South Scandinavia.—Notice of *Regalecus glesne ascanius*, by Herr J. Grieg. This specimen, a female, with well-developed ovarium, is the fourteenth that has been taken off the Norwegian coasts since 1740.—Report of the various attempts made within the last four years to introduce new plants into Iceland, by Dr. Schierbeck. The results of these efforts to

enlarge the meagre flora of the island are scarcely encouraging. Thus, although hopes are entertained that some kinds of maples may thrive in sheltered spots, conifers, from whose introduction great expectations were entertained, have not given promise of success, while poplars, oaks, apple and pear trees have without exception died. Common red- and black-currant bushes thrive so far as to set fruit, but this does not ripen except in the warmer summers. Potatoes, which would be invaluable to the islanders, have not yet been successfully cultivated, but turnips, rhubarb plants, and several of the hardier cabbages, together with lettuce and chamomile, do well. The great question, whether cereals can be cultivated, as would appear to have been the case in the times of the Sagas, does not seem to admit of a satisfactory solution, and, according to the writer, the present regular supply of corn from the mother-country by means of rapid steamers, no longer makes the attempt necessary or desirable from an economic point of view. An interesting list of the various plants introduced, with the times of sprouting, budding, &c., adds to the value of Herr Schierbeck's paper.

Revue d'Anthropologie, troisième série, tome ii., Paris.—Recapitulation, by M. Topinard, of the Society's instructions for noting the colour of the eyes and hair in France, with *fac-similes* of the printed papers distributed to intending observers, and directions how they should be filled up.—On a quinary nomenclature for the nasal index in the living subject, by Dr. Collignon. The writer, who considers a correct and systematically determined nasal index as the most important anthropometric determination, not excepting even the cephalic index, proposes to divide the ordinarily accepted nasal groups into hyper-leptorhinian, leptorhinian, mesorhinian, platyrhinian, and hyper-platyrhinian, including under the platyrhinian section all the black races, under the mesorhinian the yellow races generally, and under the leptorhinian most of the white races. The paper gives a clear and concise description of the instruments in general use, and of those best adapted for making the required measurements, which he regards as of paramount value in determining racial characteristics.—Contributions to the sociology of the Australian races, by Elie Reclus. This paper, which is principally concerned with the system of clanships and cousinships existing among these peoples, has comparatively little interest for English readers, who have long been familiar with the curious questions involved in the principles of inter-tribal relationship. Indeed, M. Reclus has drawn so largely from the writings of Brough-Smyth, Eyre, Howitt, Taplin, Morgan, McLennan, and other British writers, that this first part of his paper is a mere *résumé* of some of the more sensational details of information contained in their several works.—Anthropological observations in Guiana and Venezuela, by Dr. Ten Kate. These observations chiefly refer to the differences between the native Caribs, the so called "wood Negroes," and half-castes. The first of these present two distinct types, reminding the anthropologist of the Red Indians in some respects, and of the Mongolian races in others; the second are a specially vigorous black tribe, the descendants of runaway slaves domiciled in the forests of Surinam. Most of these men are of herculean strength and stature. Numerous anthropometric and other tables illustrate the paper.—On the depopulation of France, by M. de Lapouge. This subject, which has lately been attracting renewed attention through the appearance of the second edition of M. de Nadaillac's interesting pamphlet "On the Decline of the Birth-Rate in France," is considered by the author from an anthropological as well as a social and moral point of view. After drawing attention to the fact that while between 1770 and 1780 there were 380 births for every 10,000 of the population, this number has gradually fallen to 235 for the present decade, and is thus lower than that of Switzerland, which had been assumed to have the lowest birth-rate in Europe, and less than half that of Russia. According to the writer, the population of France has reached a stationary point, its annual increase of 80,000 admitting of no comparison with the hundreds of thousands, and even millions, annually added to the populations of Germany, Russia, the United States, and the British Empire, while, moreover, this slight increase is solely to be referred to the constantly increased immigration into France of foreigners, who now constitute one million of the population, and who predominate so largely at some points as to have reduced the French language to a secondary place in such districts. The writer discusses the various causes, such as the adoption of Malthusian principles, alcoholism, Catholicism, immorality, want of patriotism, self-interest, &c., to which the present low birth-rate has been referred. And rejecting these as inadequate, he insists that the main source of the increasing depopulation in France is the gradual obliteration since the great revolution of the blond dolichocephalic type, to which he considers most of the distinguished Frenchmen of earlier times belonged, while the representatives of the brachycephalic races, who have never distinguished themselves in science, art, or letters, have been able to take the lead through superiority of numbers. By their cupidity, narrow range of interests, and indifference to the traditions of family and national glory, he holds them responsible for the anomalous condition of the country, in which an unprecedented accumulation of wealth and great prosperity are associated with physical degeneration and diminished births. In the re-introduction of the dolichocephalic element through immigration the author sees the surest means of effecting a substitution of national type and the best prospects of securing renewed vitality to the French race.

Rendiconti del Reale Istituto Lombardo, December 1886.—Obituary notice of the late honorary member of the Institute, Signor Marco Minghetti, by the Editor. Reference is made more especially to the illustrious statesman's great merits as a political economist and art critic.—On the liquors employed in the artificial cultivation of Bacteria and other minute organisms, by E. L. Maggi. The various gelatinous, albuminous, and other solutions now in general use are described, with remarks on the best means of preparing and rendering them sterile.—On the geometry of linear spaces in a space of n dimensions, by Prof. E. Bertini. The author's theorem for ordinary space of three dimensions—"A necessary and sufficient condition for three straight lines to exist in a plane is that all straight lines meeting two of them at arbitrary points shall also meet the third"—is here generalised for a linear space S of any number n dimensions.—Meteorological observations made at the Brera Observatory, Milan, during the months of October, November, and December, 1886.

Rivista Scientifico-Industriale, December 1886.—Determination of the weight of the mercury contained in a thermometer, by Dr. G. Gerosa. Clayden having recently determined the volume of the mercury contained in a thermometer (Proceedings of the Physical Society of London, vol. vii. p. 367, 1886), Dr. Gerosa here gives a determination of its weight, which he had already worked out in the Rendiconti of the R. Academia dei Lincei, vol. x., 1881.—On the electric transmission of force, by Dr. Gerosa. The paper gives a critical appreciation of the work done by M. Marcel Deprez at Creil and by M. Fontaine in the Atelier Gramme. He considers the latter experiments the more successful of the two, M. Fontaine showing that with more economic means the same results may be realised as were obtained in the experiments at Creil.—On the development of electricity in the condensation of aqueous vapour, by Dr. Franco Magrini. In reply to Prof. Costantino Rovelli the author again shows that there is no perceptible development of electricity during the condensation of the vapour of water. A description follows of M. A. Nodon's hygrometer, already reported in the *Journal de Physique* for October 1886.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, January 13.—"Supplementary Note on Remains of Polacanthus foxii." By J. W. Hulke, F.R.S.

In a paper published in the Phil. Trans. 1881 the author described some remains of a large Dinosaur, remarkable chiefly for its dermal armour, discovered some fifteen years previously in Brixton Bay by the late Rev. W. Fox, and then in his collection. These have since become national property; and the large shield, which, for facility of transport, had been broken up by its discoverer into innumerable small pieces, having been recently reconstructed in the workshop of the British Museum, the author now describes this singular armature, and also some parts of the pelvis formerly obscured by rock. The pieces, which, in their very fragmentary condition, had been thought scutes, are now seen to be parts of a continuous osseous shield which protected the rump and loins, having its anterior surface ornamented with closely-set tubercles, and in each lateral half four longitudinal rows of keeled eminences. The ischium has its long axis directed transversely to that of the trunk, and not roughly parallel to it as in the Iguanodonts.

January 20.—"A Study of the Thermal Properties of Methyl Alcohol." By William Ramsay, Ph.D., and Sydney Young, D.Sc.

The writers have investigated the properties of the above substance, and obtained numerical values for the expansion of the liquid, the vapour-pressure, and the compressibility of the vapour; and from these results the densities of the saturated vapour and the heats of vaporisation have been deduced. The range of temperature is from − 15° to 240° C., and of pressure from 11 mm. to 60,000 mm. The apparent critical temperature is 240°, and the pressure 59,660 mm. The pressures were corrected by means of Amagat's results, and the temperatures are those of an air thermometer.

January 27.—"On a Perspective Microscope." By G. J. Burch.

In 1874, the author, while trying to devise means whereby the different planes of an object should be visible under the microscope without the adjustment of the focus to each, discovered that, when two lenses are separated by a distance equal to the sum of their focal lengths, the optical conditions are such that the magnitude of the image bears a constant ratio to that of the object, no matter where upon the optic axis it is situated—the ratio being that of the focal lengths of the two lenses; that a given displacement of the object along the axis causes a displacement of the image in the same direction, but in the square of the ratio.

Further, that a picture drawn with the camera lucida under these conditions has the perspective of an object magnified in the square of the ratio, when it is brought within the proper distance of the eye.

The field of view of the perspective microscope is small, but may be increased by using more than two lenses, and the author's researches gave him reason to believe that, with glasses of wide angle specially constructed, a high power, with sufficiently large field, might be obtained. Several uses, other than microscopic, were indicated, to which the instrument can be applied.

The paper was accompanied by diagrams showing, in two different ways, the changes of position of the principal foci and principal points, &c., of a system of two lenses as the distance between them is varied.

A piece of moss was shown under the instrument, in magnified perspective.

"On the Thermo-dynamic Properties of Substances whose Intrinsic Equation is a Linear Function of the Pressure and Temperature." By Geo. Fras. Fitzgerald, F.R.S.

Prof. Ramsay and Mr. Young have found that within wide limits several substances in the liquid and gaseous states have the following relation connecting their pressure (p), temperature (T), and specific volume (v),

$$p = aT + b,$$

where a and b are functions of v only.

Now in this case the following are the forms that the thermodynamic equations assume: T is temperature, and ϕ is entropy, and I is the internal energy.

Then $$I = \gamma + \lambda,$$

where γ is a function of temperature only, and λ a function of volume only.

Also $$\phi = \Gamma + \alpha,$$

where Γ is a function of temperature and α of volume only.

Also, the specific heat at a constant volume is a function of the temperature only.

It would be most important if by some method, König's for instance, or by inserting a small microphone into a tube, the velocity of sound in substances in various states could be accurately determined, as that would enable us to determine separately the specific heats at constant pressure and constant volume.

Linnean Society, January 20.—W. Carruthers, F.R.S., President, in the chair.—Mr. J. Benbow and Mr. F. S. J. Cornwallis were elected Fellows of the Society.—It was announced from the chair that H.R.H. the Prince of Wales had officially entered his name on the roll of the Society.—The President made the presentation of an oil-portrait of Francis Masson, F.L.S., elected 1796.—Prof. Bayley Balfour exhibited specimens and showed the microscopic structure of the "ginger-beer plant." He pointed out that, although well known and used by many people as a means of manufacturing an acid drink out of sugar solution and ginger, yet no scientific account of the organism had appeared except a short note by Worthington Smith in the *Gardener's Chronicle*. It has the appearance of a white No toc, and is composed of a Bacterium (passing through all forms of rods, coils, and filaments), which apparently constitutes its greater part; and associated with this is a sprouting fungus. Judging from descriptions and figures by Kern of the "Kephir," used in the Caucasus to induce fermentation in milk, the ginger-beer plant closely resembles this; but there are many points of difference. The plant is said to have been introduced into Britain by soldiers from the Crimea.—A letter was read from Mr. Benj. Lowne referring to an exhibition by him of photographs from microscopical specimens of the retina of insects. One section represented the retinal layer detached from the opticon; other sections showed the basilar layer: thus practically affording evidence that the nerves terminate in end organs, rods placed in groups beneath the opticon—a view promulgated by Mr. Lowne in his memoir published in the Society's Transactions.—Mr. W. Waller exhibited a block of wood, part of an oak grown in Sussex containing an excavated tunnel and live larva of the longicorn beetle *Prionus coriarius*.—Mr. Thiselton Dyer showed and made remarks on two sheets of Arctic Alpine plants from Corea.—Mr. F. Darwin and Miss A. Bateson read a paper on the effects of stimuli on turgescent vegetable tissues, of which we hope to give an abstract in an early issue.—Mr. J. R. Vaizey read a paper on the morphology of the sporophore in mosses. According to his researches, the seta of mosses consists of an outer sclerenchyma, within which is parenchymatous tissue, and in the middle the "central strand"; this latter being surrounded by a single layer of cells, forming the endoderm, derived from the outer meristem of the growing apex. It consists of two forms of tissue, one being of thin-walled prosenchymatous cells destitute of protoplasm, their function being to conduct water: this the author terms *proxylem*. Surrounding this is a second cylinder of elongated cells with thickened walls, containing granular protoplasm; this tissue he terms *prophloëm*. On tracing the proxylem downwards, it is found that it gradually encroaches on the other tissues by the "foot," until it takes on the character of conducting tissue. The stomata on the theca are confined to the hypophysis: the form of stomata in which the guard-cells communicate is internally typical only of Polytrichaceæ and *Funaria*. In the young sporagonium five distinct meristems occur with different laws of cell-division; one form with an axial solid cylinder he terms "endomeristem." It gives rise to the central strand in the seta, and in the theca to so much of the tissue of the columella as lies within the sporagenous zone, the cells round this being derived from the "epomeristem," whilst the sporagonium layer is itself derived from the endomeristem. The hypophysis is an absorbing and assimilating organ, and performs all the functions of a leaf, and should be classed as a phyllome. The water-conducting tissue of the sporagonium only differs from the xylem of Vasculares in the absence of spiral thickening and lignification of the cells. The prophloëm differs even less from the phloëm of some Vasculares, and though no sieve-like tubes have been made out, yet they are wanting also in some Vasculares, *e.g. Selaginella*. The author compares the development of the sporagonium in some respects to certain parasitic plants; and he draws the conclusion that the Muscineæ are descended from an ancestor common to them and Vasculars, similar to the Anthoceratheæ, finally hoping in a future paper to deal with their phylogeny, specially referring to the vascular system and its homologue, the central strand of the Musci.

Anthropological Institute, January 25.—Anniversary Meeting.—Mr. Francis Galton, F.R.S., President, in the chair.—The following were elected Officers and Council for the ensuing year:—President: Francis Galton, F.R.S. Vice-Presidents: Hyde Clarke, J. G. Garson, M.D., Prof. A. H. Keane. Secretary: F. W. Rudler. Treasurer: A. L. Lewis. Council: G. M. Atkinson, Sir W. Bowman, Bart., E. W. Brabrook, Sir George Campbell, M.P., C. H. E. Carmichael, A. W. Franks, F.R.S., Lieut.-Colonel H. H. Godwin-Austen, F.R.S., Colonel J. A. Grant, C.B., T. V. Holmes, Prof. A. Macalister, F.R.S., R. Biddulph Martin, Prof. Meldola, F.R.S., Prof. Moseley, F.R.S., C. Peek, F. G. H. Price, Charles H. Read, Lord Arthur Russell, H. Seebohm, Prof. G. D. Thane, M. J. Walhouse.

Chemical Society, December 16, 1886.—Dr. Hugo Muller, F.R.S., President, in the chair.—The following were duly elected Fellows of the Society:—Messrs. Horace Edward

Brothers, Francis J. H. Coutts, Tamemasa Haga, Henry John Hardy, Michitada Kawakita, Walter Leach, Stephen James Pentecost, Henry Joshua Phillips, P. Yeshwant Sheshadri, Tetsukichi Shimidzu, Joseph Stapleton, William Phillips Thomson, Hikorokuro Yoshida.—The following papers were read:—Researches on the constitution of azo- and diazo-derivatives; (1) Diazoamido-compounds, by R. Meldola, F.R.S., and F. W. Streatfeild.—The influence of silicon on the properties of iron and steel, part 1, by Thomas Turner.—The distribution of nitrifying organisms in the soil, by R. Warington, F.R.S.—Isomeric change in the phenol series; the action of bromine on the dibromonitrophenols, by A. R. Ling.—Some azines, by Francis R. Japp, F.R.S., and Cosmo Innes Burton.

January 20.—Dr. Hugo Müller, F.R.S., President, in the chair.—The following papers were read:—Some silicon compounds and their derivatives, by J. Emerson Reynolds, M.D., F.R.S.—Chromo-organic acids; part 1, certain chromoxalates, by Emil A. Werner.—Note on the constitution of the double chromic oxalates, by W. N. Hartley, F.R.S.—Remarks on recent papers by A. Baeyer and J. Thomsen on the constitution of benzene, by Alex. K. Miller, Ph.D.

Royal Microscopical Society, January 12.—Rev. Dr Dallinger, F.R.S., President, in the chair.—Mr. J. Mayall, Jun., directed the attention of the meeting to eleven photo-micrographs sent by Dr. van Heurck, and which the latter thought showed results of exceptional merit. The one of *A. pellucida* by transmitted light was rather striking; it showed apparently two series of lines which were resolved into dots, and, so far as he was aware, this was the best of the kind which he had yet seen. But Dr. van Heurck did not say whether it was taken from a specimen mounted in a dense medium or not, and he thought also that several important questions of technique were omitted which it would have been very useful to have had mentioned. In the pamphlet which accompanied the photographs, Dr. Royston-Pigott was quoted to the effect that they were quite free from what used to be called "diffraction-spectra," which now here have no existence whatever; but on examination, unless he was much mistaken, they had been painted out, or otherwise blotted out, from the negative, so that Dr. Royston-Pigott, in his remarks upon this supposed fact, had made what the French called a *boulette*. If it was desired to give each photograph a real value, the background should not be interfered with, and each impression should have the particulars as to magnification, mounting, and other data for identifying the object, the possession of which was essential in order to form any reliable opinion. As regards the longitudinal lines of *A. pellucida*, as shown in the untouched negatives of these photographs, Dr. van Heurck said he had submitted them to Prof. Abbe, who replied that, as they appeared closer than the diffraction-lines, that was a satisfactory demonstration of their existence in the object. As to the photograph of *P. angulatum*, in which a central spot was shown, all who were familiar with the object were aware that they could get the appearance of a central spot or not, according to how they looked at it; it was a question of change of focus. *Surirella gemma*, he thought, was not better shown than in Dr. Woodward's photographs. Then there were photographs of Nobert's lines, which were said to be of the 18th and 19th bands; but here again there was nothing to enable one to identify them or to say that they were not the 14th and 15th bands.—Mr. M. Pillischer exhibited his new "Kosmos" microscope.—Mr. T. Charters White read a note on tartar from teeth of the Stone Age.—Mr. Crisp exhibited a cylinder of glass, which, though it had plane ends, acted as a concave lens, and solved some of the questions which had been raised as to the images formed in insects' eyes. He also explained Prof. Exner's method of preparing similar cylinders from celloidin and gelatine, when the effect of convex lenses was obtained.—Mr. Crisp directed the attention of the meeting to the figures of enormous microscopes in Schott's "Magia Naturalis," 1657. These had long puzzled microscopists, who were at a loss to understand what could be the object in making microscopes of the large size which was indicated by the comparison with the observers as looking through them. In Traber's "Nervus Opticus," what was undoubtedly meant for drawings of the same microscopes, the mystery was solved, for if Schott's figures were rubbed out, and single eyes were substituted for them, as Traber did in his drawings, the scale of the microscope represented was, of course, strikingly altered, and it was seen that they were small hand microscopes after all.—Mr. J. Medland exhibited and described his portable cabinet for microscopic slides.—Mr. Crisp exhibited Stein's electric microscope.—Mr. A. W. Bennett gave a *résumé* of his paper on freshwater Algæ (including chlorophyllaceous Protophyta of North Cornwall), with descriptions of six new species, illustrated by coloured diagrams.—Mr. J. Mayall, Jun., gave a very interesting account of a recent visit to Jena, where he had been afforded every facility for examining all the processes of manufacture as carried out in the factories of Dr. Zeiss. He also described his interviews with Prof. Abbe, and the way in which they had together tested numerous objectives which he had taken for the purpose.—Dr. A. C. Stokes's paper, on some new American freshwater Infusoria, was read.—The nominations for the new Council were read, and auditors appointed.

PARIS

Academy of Sciences, January 31.—M. Gosselin, President, in the chair.—On the commensurability of the mean movements in the solar system, by M. F. Tisserand. The object of this paper is to throw some light on the delicate question, how far exact commensurability is compatible with the stability of two or more bodies revolving round a common centre, as maintained by Gauss, and more recently by Gyldén and Harzer, and denied by W. Meyer in his memoir on "The System of Saturn," Geneva, 1884.—Metals and minerals from ancient Chaldæa: on the sources of tin in the Old World, by M. Berthelot. The analysis of certain metallic remains from the Palace of Sargon at Khorsabad and from Tello in Babylonia, combined with recent reports of tin mines now being worked in various parts of Khorassan, suggests the question whether tin may not have been derived from that region by the Assyrians and Chaldæans long before its arrival from the more remote Sunda Islands and Malay Peninsula in the East, or from Cornwall and one or two other parts of Europe in the West.—Experiments on the effects of transfusions of blood in the head of decapitated animals, by MM. G. Hayem and G. Barrier. The results are described of experiments on the head of dogs immediately, and some time after separation from the trunk, such as those studied some thirty years ago by M. Brown-Séquard, but not since renewed by physiologists. The authors conclude generally that the extinction of feeling and will is extremely rapid, if not instantaneous, after decapitation; that conscious life may be sustained by the immediate injection of arterial blood from any animal of the same, or even of a different species; and that such transfusion, made after some minutes' delay, may stimulate certain automatic and multiple reflex movements, but is powerless to re-awaken either sense or will.—Observations of the new comets of Brooks and Barnard, made at the Paris Observatory (equatorial of the West Tower), by M. G. Bigourdan.—Observations of the same comets made at the Observatory of Bordeaux with the 0·38 m. equatorial, by MM. G. Rayet and Courty.—On a method for determining the constant of aberration, by M. J. C. Houzeau. The author points out that the fundamental principle of this method, as recently submitted to the Academy by M. Lœwy, had already been indicated by him in a paper on the study of the movements of the stars, published in 1871, in vol. xxxviii. of the Mémoires of the Belgian Academy.—On the mean periodicity of the spots in Jupiter, by Dom Lamey. By a careful study of older maps of this planet (which is still in a state of incandescence analogous to that of the sun), combined with more recent observations at the Observatory of Grignon, the author deduces a mean periodicity of 5·43 ± 0·07 years for its spots.—On the theory of algebraic forms with p variables, by M. R. Perrin.—Researches on the transmission of electricity of feeble tension through the medium of hot air, by M. R. Blondlot. This is a summary of the author's researches on the transmission of an electric current through heated air, which form the subject of a memoir presented by him to the Academy. It is shown that hot air has, properly speaking, no resisting power, and he feels inclined to attribute the phenomenon to the principle of *convection*, as described by Faraday.—On the variable period of the currents in the case of circuits containing an electro-magnet, by M. Leduc.—On a halo accompanied by parhelia, observed at Fontainebleau on January 28, by M. A. Bouisson. This phenomenon, observed between 9.30 and 10 a.m., presented the appearance of a luminous circle, with a radius of about 23°, concentric with the sun, passing from a light brown in the centre to a greyish-yellow on the periphery. A second luminous circle, concentric with the preceding, with a radius of about 47°, showed in its upper segment the colours of the rainbow, red on the inner side. Tangential to both circles were vividly coloured arcs, the brilliancy of the latter decreasing

rapidly towards the extremity, while a luminous horizontal band passing through the centre of the sun stretched across the firmament, showing three parhelia—two very bright on the small, one faintly illumined on the large, circle.—Combinations of the glycerinates of soda with the monatomic alcohols, by M. de Forcrand. This paper deals with the glycerinates of methylic, ethylic, propylic, isobutylic, and amylic soda.—On the comparative actions of solar heat and light, by M. E. Duclaux. It is shown that all the effects of combustion produced by heat may also be produced by light; but the reverse does not hold, there being a large number of reactions, which light alone seems capable of determining. All these reactions are resumed in the displacement of the primitive molecule, which becomes decomposed in a few simpler elements, such as the formic, acetic, and butyric acids, the methylic and ethylic alcohols, &c.—On the properties of inosite, by M. Maquenne. Continuing his study of this substance, the author shows that in its transformation it may give rise to several well-defined aromatic compounds. Its other properties, he considers, may now be anticipated theoretically.—On a combination of paratoluidine and chloride of copper, by M. E. Pomey.—On the composition of the grains of *Holcus sorgho*, and their application to the agricultural industry in the south of France, by M. Bordas. The analysis of this grain shows a mean of 42 per cent. of starch, 100 kilogrammes yielding 26 litres of good alcohol at 33° above proof.—On the jugal and pterygoid stems in the vertebrates, by M. A. Lavocat.—On the heterogamy of *Ascaris dactyluris*, by M. Macé.—Reply to M. Balbiani on the subject of *Leucophrys patula*, by M. E. Maupas. The author shows that he has in no way exaggerated the novelty and interest of his observations on the various reproductive processes of this organism, as asserted by M. Balbiani.—On diurnal and nocturnal physiological variations of the cerebral pulse, by MM. Rummo and Ferrannini. The authors' observations establish a complete cycle or periodicity in these variations, from which they hope to deduce the biological theory of normal sleep.—On the secreting ducts and aquiferous apparatus of *Calophyllum*, by M. J. Vesque.—On certain phenomena of linear corrosion in the limestone formations of Couzon, Rhone Valley, by M. Ferdinand Gonnard.—On the epoch when the submerged valleys of the Gulf of Gen a were formed, by M. A. Issel. All these riverain valleys along the coast of Liguria appear to have been submerged towards the close of the Messinian and during the Astian epoch.

BERLIN

Meteorological Society, December 7, 1886.—Prof. von Bezold in the chair.—Dr. Hellmann stated that he had examined the observations of the County Fire Insurance Society in Schleswig-Holstein for the years 1874-83 for the purpose of investigating the question of lightning flashes in this province, and communicated the results of that investigation. As is the case in every other locality in which investigations of this description had been carried out, it was shown that generally over the whole province of Schleswig-Holstein there is an increase in the amount of damage wrought by lightning for the decade in question. On a comparison, however, of the different districts, it was found that the territory to the south of the Eider had experienced an abatement of damage by lightning, while to the north of the Eider, along the North Sea, and especially in the marshes, there had been a considerable increase. A computation of damage from lightning for one year demonstrated a very decided maximum in August in the continental, southern, and south-eastern districts, whereas in the north and west a summer maximum of less intensity and two still weaker maxima in May and October became apparent. In respect of a daily period it appeared that in the case of the first group of districts a maximum appeared in the hours from noon to 3 in the afternoon, while in the remaining part of the province the maximum was attained from midnight to 3 in the morning. This night maximum was specially characteristic of winter. The frequency of thunderstorms had no relation to the danger from lightning. The number of destructive lightnings depended in large part on the way in which the houses were roofed. The number was considerably greater in the case of soft than of hard roofs. In the case of churches the danger from lightning was 39 times, in the case of windmills 52 times, as great as in the case of houses having hard roofs. In regard to the cause of the different degrees of danger from lightning in the different districts, investigation indicated two points as determinative: first, the way in which the ground was built upon, and second, the geological nature of the ground. Whilst in the west, which was very liable to destructive strokes of lightning, the farmsteads were detached and scattered over the whole land; in the east and south they were grouped together into villages, and the danger from lightning was always considerably less for larger collections of houses than for scattered houses forming the only prominent objects throughout wide spaces. In point of fact, the danger from lightning was everywhere considerably less for towns than for rural districts. With reference to the geological bearings of the question, the danger from lightning was least for calcareous sand and greatest for clay. Dr. Hellmann had likewise discussed the statistics of lightning for Baden and Hesse Darmstadt, with the result that he found during the period investigated a considerable increase of damage by lightning for the southern part of Baden, and a decrease for the north of Baden and for Darmstadt. Besides a confirmation of the results arrived at for Schleswig-Holstein there appeared in the Baden-Darmstadt region a decided preponderance of danger from lightning in the Rhine plain as contrasted with a very low degree of danger in the mountains.

BOOKS AND PAMPHLETS RECEIVED

Notes of a Naturalist in South America: J. Ball (Kegan Paul and Co.).—United States Commission of Fish and Fisheries, Report, 1884: (Washington).—Berichte von dem Erzbischöflich-Haynaldschen Observatorium zu Kalocsa in Ungarn: C. Braun (Münster).—The Steam-Engine: G. C. V. Holmes (Longmans).—The Esclepiad, No. 13, vol. iv. (Longmans).—Quarterly Journal of Microscopical Science, January (Churchill).—Brain, January (Macmillan and Co.).—Journal of the Statistical Society, December (Stanford).

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THURSDAY, FEBRUARY 17, 1887

THE ORIGIN OF MOUNTAIN RANGES

The Origin of Mountain Ranges considered Experimentally, Structurally, Dynamically, and in Relation to their Geological History. By T. M. Reade, C.E., F.G.S. (London: Taylor and Francis, 1886.)

THAT the skin of our mother Earth's face is wrinkled and shrivelled, is one of the common facts of geology. True it is that with fine feminine instinct she strives to hide the ravages of time beneath a fair covering of grass, moss, and herbage, and gracefully does her best to make her old age comely; and we love her for her skill in covering up the signs of her years. But we are fain, directly we look below the surface, to admit that the wrinkles are there. And the parallel is not a fanciful one, for it has long been a favourite theory among geologists that the wrinkled skin of old age, and the foldings and bendings which are everywhere to be discerned in the layers of the skin of the earth, are due to similar causes. In both cases, something underneath the skin, which in youth kept it stretched and tense, has shrunk away, and the skin has shrivelled up. In the case of the earth it is the gradual contraction of the interior as it cools, which has caused it to draw away from the outer shell; and the crust, as it follows down the shrinking nucleus, has to pack itself into a smaller space, and consequently becomes crumpled up. This explanation is known as the "Contraction Hypothesis." Numbering as it does many supporters, it has had at the same time some vigorous opponents. In his "Physics of the Earth's Crust," the Rev. Osmond Fisher was led to the conclusion that the contraction hypothesis would not furnish anything like the amount of elevation that has actually occurred in the case of the earth. We admire the ingenuity and elegance of Mr. Fisher's mathematical work, but we cannot help recollecting Prof. Huxley's warning, that mathematics is like a mill, and that what you get out of it depends entirely on what you put in. Mr. Fisher puts in a supposition made by Sir W. Thomson, as to the way in which the earth cooled. There have been people bold enough to think that in making this supposition a great master of physics for once lent his name to an hypothesis which is in itself physically not very probable; and these same people are inclined to hold that probably Mr. Fisher's calculations tend to show that this is the case, rather than that the contraction hypothesis is inadequate.

Capt. Dutton, of the United States Geological Survey, is another doughty opponent of the contraction hypothesis. His notion as to what that hypothesis is appears in the following passage, which is quoted in the volume before us (p. 126, note):—

"The line of argument which is relied upon to sustain a cooling globe proves, when pushed to its consequences, that the great interior of the earth has not as yet undergone any sensible amount of cooling. The only cooling which that argument admits of has been located in a thin external shell. . . . In short, the cooling would be only skin deep, while the nucleus is about as hot as ever."

This may be called "pushing an argument to its consequences"; but if it be, that phrase certainly means, in plain English, putting, of course unintentionally, into your opponents' mouths, statements which they never made. If it is asserted that the crust cools faster than the nucleus, which is all the supporters of the contraction hypothesis ask for, is this the same as saying that the nucleus does not cool at all?

Now Mr. Mellard Reade joins the attack, and in an elaborately illustrated volume of some 300 pages gives us his reasons for dissenting from the contraction hypothesis, and for preferring a modified form of the explanation put forward originally by Scrope and Babbage. These geologists pointed out that whenever a great thickness of sedimentary deposits was laid down the subterranean surfaces of equal temperature would necessarily rise, the increase in temperature would cause expansion, and as a result of this a rise in the surface would follow. Mr. Reade maintains that vertical elevation would not be the only result, but that pressures would be set up in the mass competent to produce folding, contortion, inversion, crushing, and all the violent disturbances which are found in mountain-chains and other disturbed portions of the earth's crust.

The book has two merits: it takes nothing for granted, and it does not err on the side of assuming too much knowledge on the part of its readers. But it is a question whether virtue may not run to excess, and there is reason to fear that this has been the case here, for a very large part of the volume is taken up with the establishment and illustration of physical facts of the most elementary character, and of geological truths which are to be found in every text-book. For instance, Chapters III. and IV. are devoted to the establishment of the facts that metals and stone expand when their temperature is raised; that, when they are prevented by constraint from relieving themselves by lateral expansion, they buckle up; and that if their elasticity, or, as the author prefers to call it, their tensile strength, is small, they do not return to their original shape on cooling. The cases quoted, and the experiments which are illustrated by six full-page plates, are apt and to the purpose; they would be admirably suited for illustrating class-teaching in an elementary school. But it is hard to believe that any one could have seriously thought they would be required by the class of readers to whom the book is presumably addressed.

Chapter V. opens with the statement that "It has been a subject of remark and wonder to more than one eminent geologist that all the greatest mountain ranges are, geologically speaking, so comparatively modern." A broad generalisation like this deserves to have stress laid upon it, but it has been so long one of the common truths of geology, that it has ceased to be, if it ever was, a source of wonder to any one who has an elementary knowledge of the science. Indeed, there is an air of *naïve* surprise running through the book which now and again moves a kindly smile as we read, and we feel it refreshing to discover that truths, which have grown somewhat hackneyed to the majority of geologists, still retain a certain charm of novelty for the author. Thus Mr. Reade seems in more than one passage to take a little credit to himself for having discovered that what are generally called "anticlinals" are really elongated ellipsoidal domes—a fact which is rapidly brought home to any one who happens to work for a few weeks in a

country where the rocks are moderately folded, and which was insisted on and fully illustrated in a manual of geology published fourteen years ago, and then could hardly have been said to be new. The distinctive characters of mountain chains are treated of in the same spirit. Little, if anything, is here added to the masterly summary of these characters which Dana gave us years ago, but much space is taken up with illustrations of truths which every one admits, in the form of long quotations from sundry sources. All this speaks to much reading and patient industry, and we cannot but admire the conscientious care with which Mr. Reade has striven to inform himself of all that has been said and done on the subject of which he is treating: but we cannot help asking ourselves whether it was necessary to print at length the contents of his note-books. This accumulation of evidence, where it is not needed, has brought with it an attendant evil: it has swelled the book to an undesirable size. Now in these busy days, and in the interest of readers, if there is one thing against which, more than anything else, a resolute stand ought to be made, it is unnecessary printing. The day is yet far distant when every page of printed matter shall contain something that is new, and nothing that is not new; but this is the impossible ideal, the asymptotic consummation, which all writers should ever keep prominently in view.

But we would not press this point, because, even if the author has given us rather an excess of matter that is not new, what he has given is good of its kind; and it is of more importance to weigh his arguments against the contraction hypothesis, and in favour of the Scrope-Babbage explanation with the additions he suggests to it. Holding as he does that expansion by heat is the main factor in producing the disturbances of the earth's crust, he made experiments to determine the coefficients of expansion of sundry rocks. He arrives at a mean which agrees very nearly with that found by Mr. Adie. Mr. Reade's experiments ranged from temperatures of 60° to 220° F., and he assumes that the coefficient of expansion will be the same for the enormously higher temperatures with which he has to deal when considering the case of the earth—a risky proceeding, to say the least. But he has fallen into a far more serious mistake: he has assumed that rocks weighted with a thickness of twenty miles of overlying strata will expand to the same extent for a given increase of temperature as rocks under atmospheric pressure. The oversight involved in this assumption so thoroughly vitiates all his numerical results that no conclusion can be drawn from them.

In Chapter XI. we have the objections to the contraction hypothesis succinctly stated. The numerical results we put aside for reasons just given, but in his general argument the author does not seem to us to realise the full meaning of the hypothesis. He seems to hold that according to the contractionists crumpling is produced by unequal contraction *in the solid shell itself*, which certainly is not their view. And he entirely omits all reference to the one fact which is the life and soul of the hypothesis, that the earth's crust is not strong enough to stand by itself without support, a fact which admits of rigid mathematical demonstration. It is a decided case of a seriously mutilated representation of the play of "Hamlet."

We cannot therefore admit that Mr. Reade's arguments are very damaging to the hypothesis against which they are directed; and we cannot see how expansion due to rise of temperature could alone produce the results which he attributes to it. The strains produced in this way would tend to be relieved by yielding in the direction of least resistance—that is, vertically; and if there were no impediment to the perfect transmission of strain, the yielding would be wholly in this direction. In the actual case a certain amount of deformation would doubtless be produced within the heated mass itself, but hardly enough, it would seem, to cant over a huge anticlinal and lay it nearly flat on its side. The machinery invoked by the contraction hypothesis may or may not have been the means by which such overthrusts were brought about, but it is the only machinery yet suggested which seems competent to produce them. "Seems," we say throughout, for the question between rival hypotheses is as yet only one of probability.

And we think no one will contend that the Scrope-Babbage hypothesis ought to be entirely put on one side when we speculate on the cause of earth-movements; great broad folds, such as those of the plateau-region of Utah, described by Capt. Dutton, and figured on Plate 39 of the book, may have been caused by the bulging up of heated masses below, though they can be explained equally well by the contraction hypothesis.

It remains to notice that the book is rich in figured illustrations. A number of the plates are devoted to somewhat diagrammatic landscapes of contorted rocks, and these bring out well the points they are intended to illustrate; but they do not add to the stock of our knowledge. They would be serviceable to a geologist, if such a one there be, who had never stirred out of the fen-country, but he of course would do still better if he took an excursion ticket to some of the localities from which the views are taken.

A. H. GREEN

ORGANIC EVOLUTION

The Factors of Organic Evolution. By Herbert Spencer. (London and Edinburgh: Williams and Norgate, 1887.)

MR. HERBERT SPENCER has done well to reprint in a permanent form his two articles on the "Factors of Organic Evolution," which were published last year in the *Nineteenth Century*; for, although they present substantially the same doctrines as are to be met with upon this subject in his "Principles of Biology," they do so in the light of fuller knowledge and more matured judgment.

The object of the essay is that of taking stock, so to speak, of natural selection as compared with other "Factors." Mr. Spencer's treatment of this subject is admirable, and ought to be read by all working naturalists who have any interest in the problems of evolution. The literature of Darwinism has now become so extensive that even first-rate naturalists who are engaged on other lines of work are apt to get left behind, or, with respect to Darwinism, themselves to become examples of what are now called "vestiges": their ideas are the superseded survivals of some previous phase of evolutionary science. And most of all is this true with regard to the funda-

mental question so ably discussed by Mr. Spencer. As he remarks, "Nowadays most naturalists are more Darwinian than Mr. Darwin himself," by which he means that most naturalists attribute more to the agency of natural selection than was attributed to it by the final judgment of its discoverer. The reason of this is that most naturalists have neither read with any care the later editions of Mr. Darwin's works, nor probably even so much as heard of the sundry essays which led him to modify his views upon the comparative importance of natural selection and other factors of organic evolution. Such naturalists, therefore, are not true Darwinians. Still believing in natural selection as almost the only factor of organic evolution, they are archaic enough to suppose that distinctions of specific value are almost universally of an adaptive kind. In this respect, indeed, they share what is no doubt still the popular impression of Darwinism, but an impression, nevertheless, which does a great injustice to the genius of their master. In order that there may be no mistake upon this matter, we will here supply a few quotations from the latest editions of Mr. Darwin's works, over and above the numerous extracts which Mr. Spencer has selected for the same purpose.

"I now admit, after reading the essay by Nägeli on plants, and the remarks recently made by various authors with respect to animals, more especially those recently made by Prof. Broca, that in the earlier editions of my 'Origin of Species' I perhaps attributed too much to the action of natural selection, or the survival of the fittest. I have altered the fifth edition of the 'Origin' so as to confine my remarks to adaptive changes of structure; but I am convinced, from the light gained during even the last few years, that very many structures which now appear to us useless will hereafter be proved to be useful, and will, therefore, come under the range of natural selection. Nevertheless, I did not formerly consider sufficiently the existence of structures, which, so far as we can at present judge, are neither beneficial nor injurious; and this I believe to be one of the greatest oversights as yet detected in my work." ("Descent of Man," 2nd edition, p. 61. He goes on to explain how he was led to the "tacit assumption that every detail of structure, excepting rudiments, was of some special, though unrecognised, service," and concludes by remarking that "any one with this assumption in his mind would naturally extend too far the action of natural selection.")

"In the earlier editions of this work I underrated, as it now seems probable, the frequency and importance of modifications due to spontaneous variability" ("Origin of Species," 6th edition, p. 171). "It appears that I formerly underrated the frequency and value of these latter forms of variation, as leading to permanent modifications of structure independently of natural selection. But as my conclusions have lately been much misrepresented, and it has been stated that I attribute the modification of species exclusively to natural selection, I may be permitted to remark that in the first edition of this work, and subsequently, I placed in a most conspicuous position—namely, at the close of the Introduction—the following words: 'I am convinced that natural selection has been the main but not the exclusive means of modification.' This has been of no avail. Great is the power of steady misrepresentation; but the history of science shows that fortunately this power does not long endure" (*Ibid.* p. 421).

"When, from the nature of the organism and of the conditions, modifications have been induced which are unimportant for the welfare of the species, they may be, and apparently often have been, transmitted in nearly the same state to numerous, otherwise modified, descendants. . . . A structure, whatever it may be, which is common to many allied forms, is ranked by us as of high systematic importance, and consequently is often assumed to be of high vital importance to the species. Thus, as I am inclined to believe, morphological differences, which we consider as important—such as the arrangement of leaves, the division of the flower or of the ovarium, the position of the ovules, &c.—first appeared in many cases as fluctuating variations, which sooner or later became constant through the nature of the organism and of the surrounding conditions, but not through natural selection; for, as these morphological characters do not affect the welfare of the species, any slight deviation in them could not have been governed or accumulated through this latter agency" (*Ibid.* pp. 175, 176).

These quotations are added to those which have been supplied by Mr. Spencer, in order still further to advance the "motive" with the expression of which his essay concludes. After directing attention to the present views of Prof. Huxley upon the subject—viz. "How far natural selection suffices for the production of species remains to be seen"; and "Science commits suicide when it adopts a creed"—Mr. Spencer closes with the following remarks:—

"Along with larger motives, one motive which has joined in prompting the foregoing articles has been the desire to point out that already among biologists the beliefs concerning the origin of species have assumed too much the character of a creed; and that while becoming settled they have become narrowed. So far from further broadening that broader view which Mr. Darwin reached as he grew older, his followers appear to have retrograded towards a more restricted view than he ever expressed. Thus there seems occasion for recognising the warning uttered by Prof. Huxley as not uncalled for. Whatever may be thought of the arguments and conclusions set forth in this article and the preceding one, they will perhaps serve to show that it is as yet far too soon to close the inquiry concerning the causes of organic evolution."

Of these two articles the first is devoted to a consideration of use and disuse as causes of such evolution, while the second treats of the influence of surrounding conditions. The latter is the more highly speculative, and therefore may be here considered in fewer words. The idea is that all external parts of organisms, being exposed to different physical conditions from the internal parts, must be differently affected thereby: natural selection apart, there must here be recognised the differentiating agency of a direct or purely physical kind. Hence a certain rough analogy is drawn between a cell-wall, or cuticle, and the oxidised exterior of an inorganic body. Many of the differentiations undergone by the epiblast in the course of organic evolution may, it is argued, be best explained by the immediate action of external agencies—just as we know that a surface of mucous membrane, when brought into permanent relation with such agencies, changes from cylinder epithelium to squamous epithelium: "the effect of the medium is so great that, in a short time, it overcomes the inherited proclivity, and produces a structure of opposite kind to the normal one." Many other examples of the same general principle are given; but the essay as a whole is ingenious rather than convincing. Not, of course, that we dispute the principle—which, indeed, is recognised by Mr. Darwin, in one of the passages above quoted, and elsewhere—but it is of too general a kind to

admit of being clearly traced in particular instances, where we have to do with all the other elements in the complex of living material.

The main question, however, with which Mr. Spencer is concerned is as to the place which should be assigned to use and disuse as factors of organic evolution. This long-standing question is one of fundamental importance to the whole philosophy of evolution; and as it has now reached a critical phase, the publication of Mr. Spencer's essay furnishes a fitting opportunity for considering its present position in all its bearings. This, therefore, we shall endeavour to do at an early date, in the form of a general article dealing with all the more important literature upon the subject. GEORGE J. ROMANES

TEXT-BOOK OF BRITISH FUNGI

An Elementary Text-book of British Fungi. By William Delisle Hay, F.R.G.S. Royal 8vo, cloth, illustrated. (London: Swan Sonnenschein, Lowrey, and Co., 1887.)

WE have little sympathy with such publishers as produce books written "to order" for the purpose of utilising illustrations, or matching. Still, we cannot help feeling some sympathy with, and pity for, the poor unfortunate who is called upon to perform such an unthankful office as the preparation of "copy." In so far as the book before us corresponds with such conditions our author commands our sympathy, perhaps he deserves it, for even in the preface he seems to fall on his knees, and sue, *in formâ pauperis*, for pity from readers and critics alike. There is doubtless a history connected with this volume. The woodcut blocks which accompany the text, but do not illustrate it, formerly did duty in the "Hand-book of Fungi" published more than fifteen years ago. In the way of business they were transferred, and, in order to utilise them, the "Text-book" seems to have been projected. There are 64 pages of figures and 238 pages of letterpress, but only about 16 pages of the plates have anything to do with the letterpress, and are not even mentioned, so that there are no less than upwards of 40 plates which are supplementary to the letterpress, and have nothing whatever to do with it, except to increase the bulk of the book. We do not know what purchasers would expect to meet with in "an elementary text-book of British fungi," but we suspect that they would scarcely be satisfied with a "treatise on edible and poisonous fungi," or, as set forth in the preface, an attempt "to cover as comprehensively and accurately as possible the entire subject of fungi, considered as aliment." Indeed, it would have been more correct to call this "An Elementary Text-book of some Species of British Fungi."

The professed object of this book, in so far as its writer was concerned, was to present a guide, which above all things should be safe and trustworthy, on the subject of fungus-eating—"so far as toadstool-eating goes," he writes, "I believe I have a right to speak with authority"—and hence if this professed object is not attained, the book must be confessedly a failure. "For the most part," he says, "subsequent authors have added little to what Dr. Badham had advanced." The inference must be that he was ambitious of making a considerable advance, "directed and inspired by a wide acquaintance with mycological literature." After this spontaneous confession it is surprising to find him stating as a fact that "some four hundred and fifty species of the genus *Agaricus* are recorded as occurring in Great Britain," on the faith of a work published now sixteen years ago; his knowledge of mycological literature having stopped short of the fact that nearly 700 species have already been figured, and the latest work on British fungi records 782 species as British, so that the total is nearly double that which his "wide acquaintance with mycological literature" had revealed to him. Leaving, however, such trivial details, let us turn to the "Comprehensive Catalogue of Esculent British Fungi." The first thought is naturally one of order. To assist in reference, and in producing favourable results, one would have hoped to see some method in the grouping of the 221 supposed esculent species. Scientific method there is none, for the white-spored, pink-spored, and brown-spored Agarics are jumbled together in glorious confusion. This would be tolerable if in compensation the species had only been grouped in sequence, or in sections according to their esculent value, but even this has not been done. In two or three instances, however, the species of a given genus are classed in the alphabetical order of their specific names.

Space will not permit of our remarking upon all the individual species included in this miscellaneous list of fungi recommended for common consumption by one who "believes he has a right to speak with authority." For ourselves, we should not have recommended *Agaricus asper*, for with considerable experience we do not remember to have met with it but once in thirty years; nor *Agaricus cæsareus*, for we venture to declare that it has never been found in the British Islands at all, and the same must be said of *Polyporus corylinus* and *Polyporus tuberaster*. Why, then, are they included in a "Catalogue of Esculent British Fungi"? Worse still—because far more dangerous—why are such species included as *Agaricus sinuatus*, which nearly killed Mr. Worthington Smith, and *Lactarius piperatus*, *Lactarius turpis*, and *Lactarius torminosus*? If there are such things as dangerous fungi at all, these are of them. If this writer is really acquainted with these species, and pronounces them edible, let him eat them and enjoy them, but not recommend them to an unsuspecting public. It is our firm and conscientious belief that a book which seriously recommends such things as articles of food might produce calamitous results, if widely circulated, or even, if not, in the event of other books or journals repeating upon its authority that these may be eaten. We read in the preface these significant words: "It has never been my privilege, as yet, to meet with any person versed in mycology from whom I could derive instruction." When the writer meets with such persons we advise him to propose to them an experiment in eating *Lactarius piperatus*, or *Lactarius torminosus*, or even *Agaricus sinuatus*, and we rather fancy that such mycologists will have but little faith in his practical mycology. We sincerely hope that he will not meet with "persons versed in mycology" for the first time in a coroner's court, over a case of poisoning induced by his recommendations. It would have given infinitely more satisfaction, and been far safer for his reputation,

had the list of esculent fungi been confined exclusively to species known to be good eating and worth the trouble of collecting, excluding such minute species as *Agaricus clavus*, and *Agaricus esculentus*, and *Agaricus griseus*, with a cap as large as one's little finger nail, and a stem but little thicker than a horsehair, and including *Agaricus elvensis* and *Agaricus hæmorrhoidarius*, with a few others, large, fleshy, and as safe and delicious as the finest mushroom ever cultivated. But perhaps, though known to mycologists, they were disregarded by the writer of the "Text-book," or contemptible in his eyes beside such delicacies as *Agaricus [illegible]atus* and *Lactarius piperatus*. Perchance some [illegible]logist, hesitating whether to purchase or not, may read this notice. Let us state for the information of such a one that the hard, woody *Polyporus fomentarius*, which grows on old trunks, and the equally well-known *Polyporus squamosus*, are with all seriousness and gravity introduced into the "Catalogue of Esculent British Fungi;" that the excellent *Agaricus sylvaticus*, which we are only too glad to get the chance of eating, is condemned to the "Catalogue of Poisonous British Fungi," together with *Agaricus lacrymabundus*, which is at least a considerable ingredient in the modern "mushroom catsup," as sold in the shops; and, if he seeks further evidence of "vast experience," he will find it in the novel information that *Agaricus mucidus* is rare, that *Cortinarius cinnamomeus* may be used as a substitute for cinnamon, that the difference between *Agaricus giganteus* and *Agaricus maximus* is only nominal, that *Lactarius subdulcis* is easily confounded with *Lactarius rufus*, that *Lactarius camphoratus* smells of camphor (when?), and that *Russula decolorans* is common under beeches and is "a good comestible."

Finally, we must protest against the wholesale manufacture of new names, many of them barbarous enough, and some of them ridiculous, under the vain supposition that they will become popular names for the species of edible and poisonous fungi. The old "fairy-ring champignon" is to be called the "oread," the common mushroom is the "white pratelle." The *Russula emetica* is "the sickener," and *Russula fragilis* is the "sickener's sister." In one place we are told "how to prepare parasols," but not whether this includes umbrellas, or whether it is based on the principle that "it's never too late to mend." Earnestly we hope it is, for there is vast scope for amendment in this book, and the sooner it is commenced the better. As it stands, it is difficult to determine whether it should be classed with comic literature, novels, or [illegible]ient history. M. C. C.

OUR BOOK SHELF

The Structure and Life-History of the Cockroach (Periplaneta orientalis). An Introduction to the Study of Insects. By L. C. Miall, Professor of Biology in the Yorkshire College, Leeds, and Alfred Denny, Lecturer on Biology in the Firth College, Sheffield. (London: Lovell Reeve and Co., 1886.)

THIS volume forms the third of a series of studies in comparative anatomy, the object of the authors being to lead the student, by the investigation of some one animal form, to an interest in, and a comprehension of, other kindred forms. While it will be generally conceded that this is a sound method of research, it is evident that its success will very much depend on the special forms selected, and we think that it may be open to some doubt whether, in selecting the cockroach for an introduction to the study of the Insecta, the authors have not selected a too little specialised form, since they have been obliged to omit the investigation of so characteristic a feature of insect life as that of metamorphosis. Nevertheless, they have given us a very fully detailed and interesting account of an easily obtained insect, and we hope it may be the means of encouraging many others to follow up the subject for themselves. As an introduction to this volume, we have a short account of the writings of those wonderfully patient pioneers in the field of minute anatomy—Malpighi, Swammerdam, Lyonnet, and Straus-Durckheim. This is followed by a sketch of the zoological position and the life-history of the cockroach. In this latter there is a brief record of the internal parasites of this insect—a record that might be greatly extended. The chapters on the outer skeleton, the myology, the neural system, the alimentary canal, and the organs of circulation and respiration, are well written and illustrated. The section relating to the respiratory movements of insects is written by Prof. Felix Plateau; that on the embryonic development, by Joseph Nusbaum, who very pertinently remarks that the inexperienced embryologist will find it more profitable to examine the eggs of bees, of Aphides, or of such Diptera as lay their eggs in water. Indeed, the difficulties in the way of the investigation of the eggs of the cockroach are so great that even the author has had to pass over the early stages of segmentation. A chapter on the cockroach of the past, from the able and experienced pen of Prof. S. H. Scudder, concludes a volume which, though not exhaustive of its subject, nor yet quite even in its treatment of all the branches of that subject, may be placed with the greatest safety and advantage in the student's hands. The authors tell us, in their preface, that, from the description of the cockroach in Huxley's "Anatomy of Invertebrated Animals," came the impulse which has encouraged them to write the present work. We hope that it will in its turn encourage many another to undertake equally honest researches.

The Administration Report of the Meteorological Department, India, 1885-86.

MR. BLANFORD'S Report, as usual, gives a good account of work. It commences with the actinometric observations. The records from Leh for twenty-three months were not found to be as valuable as had been expected, the climate having turned out unfavourable. The results have been sent home to the Solar Physics Committee, and meanwhile the observations are being continued at Dehra Doon and Mussooree, under the superintendence of Colonel Haig.

In the matter of forest observations, considerable activity is recorded; pairs of stations, on the system devised by Ebermayer for Bavaria, have been established at Dehra Doon and Ajmere. These observations have, however, been going on for too short a time for the results to be worth quoting, but much is to be expected from these investigations in India.

Mr. Blanford gives an account of his forecast of the character of the monsoon rains of 1885 from the character of the Himalayan snowfall, and he shows that the facts fully carried out his theory. The Report goes on with a brief notice of the theory of the South-west Monsoon, which, Mr. Blanford says, he is in a position to show, by his forthcoming Indian Ocean wind-charts, is not the South-east Trade simply drawn across the equator.

The remainder of the Report is occupied by details of the observational system, which seems to be in a good state of efficiency.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Mr. Romanes on Physiological Selection

I HAVE just seen Mr. Romanes's article in the *Nineteenth Century*, and his letter specially replying to myself in your issue of January 13 (p. 247). I do not propose to continue the discussion, but ask leave to make a few observations on some features of his reply in both the article and the letter.

On the question of the "inutility of specific characters," he appeals to authority against me, and especially to Darwin's very cautious remarks, which seem to me to support my view much more than they do those of Mr. Romanes; but in any case this is a matter in which I decline to accept authority as an infallible guide. The impossibility of proving a negative is proverbial, but my opponent declares that his negative—the uselessness of specific characters—wants no proving, but must be accepted till in every case the affirmative is proved. Here, again, is a canon of criticism the validity of which I wholly deny.

As to the swamping effects of intercrossing, there is again an appeal to authority, and Mr. Romanes now explains away (in the *Nineteenth Century*) what he had said about "simultaneous variations," by asking me to show such variations as the occurrence of an incipient spur on a duck's foot or horn on the head of a racehorse, in the belief, apparently, that these are the class of characters which are distinctive of closely-allied species! Such a demand, seriously made, appears to me so preposterous as to render further discussion of the matter with such an adversary out of the question.

The argument to show that the supposed physiological variations would be perpetuated, seems to me as weak and unsatisfactory as ever. The question is really not worth further discussion till the required variations are proved to exist in the requisite abundance and possessing the peculiar relations to each other and to the rest of the species which would alone give them any chance of survival.

I now leave the question, as between myself and Mr. Romanes, to the consideration of those naturalists who may be able to bestow upon it the requisite time and attention.

ALFRED R. WALLACE

Washington, U.S.A., January 30

Instantaneous Shutters

IN reference to the interesting paper by Mr. Mallock in NATURE (February 3, p. 325), I quite agree with him in his condemnation of a drop-shutter of any form.

But I would point out a form of shutter that I have myself found of the greatest value—one, namely, working horizontally across the lens. It has the very great advantage in landscape work that it can carry an aperture of this form ▽ or any modification thereof, the advantage gained thereby being that the sky receives a far shorter exposure than the foreground, a point of much importance in landscape photography. The ▽ piece is loose, and any shape cut out of black cardboard or paper can be inserted. Of this power I have frequently availed myself when photographing snow-clad mountains.

The shutter can be made to pass across the lens at any speed, from the most instantaneous flash to slower motions, and it has the further advantage of working immediately behind the lens—the proper place, I think, for a shutter.

H. STUART-WORTLEY

South Kensington Museum, February 4

Svastika Cross and Sun

Is there any evidence that the *svastika* represents the sun? and is it not a simple conjecture? (NATURE, February 10, p. 345).

The *svastika* 卐 is a complex emblem, and there is a possible origin which has not been investigated. It decomposes into two ⅂, and this is a character to be found extensively distributed throughout the syllabic and alphabetic systems. If ⅂ is a symbol for man and fish, it will not be related to sun immediately.

The theory of Mr. Haliburton and others, and mythological conformity, give the cross or Tau as naturally derived from the Pleiades, and not from the sun. The cross is also a symbol for the nose in prehistoric sculpture.

HYDE CLARKE

32 St. George's Square, S.W., February 12

Life-Energy, or the Dynamics of Health and Disease

SINCE it is admitted that matter is indestructible, it is obvious that life can be only the manifestation of that energy which is set free by the reduction of compounds embodying more energy to states of combination which embody less energy.

Life therefore is the result of the continuous interchange of partners between the compound molecules constituting chemical and organic compounds.

"In any transformation which takes place without the application, or the giving out, of work, the heat developed is the equivalent of the excess of the original over the final potential energy due to the chemical affinities involved; the *final state of every combination is that in which the potential energy of chemical affinity is a minimum*" (Tait).

If these words formulate the law which governs those combinations of elementary substances known as inorganic compounds, how much more must they refer to the combinations of the same elementary substances which go to form organic compounds?

Life thus becomes an expression for the sum of the difference between the original potential energy of the food and the final potential energy of the excretions. All change in the configuration of matter, whether physical or chemical, must be accompanied by either the evolution of, or the absorption of, energy.

Energy, as far as is known, has but one source, the sun.

Whether that energy act by direct impingement of solar rays producing the ascending scale of effects from genial warmth to fatal sunstroke, or whether it be second-hand, from the decomposition of vegetable matter, or third-hand, from the decomposition of animal substances which obtained it from vegetable substances, its origin is still the same.

Assuming then the universality of this energy, which shows itself in all the intangible forms of life, and growth, and all organic change, it will be the effort of the writer to adduce evidence to prove that much which is still mysterious in both health and disease is due to its subtle action too.

The vibrations of direct solar energy which fall upon the optic nerve give rise to those molecular disturbances which produce the subjective sensation of light.

Physical change is thus originated by an immaterial agent. Work is done, and cannot continue to be performed without renewal of the material acted on.

But when the vibrations of direct solar energy fall upon the tissues of a growing plant, energy is incorporated into those tissues. This energy so attunes the atomic vibrations in the plant molecules as to bring them into combining harmony with the carbon and hydrogen atoms present in the forms of carbonic acid and water.

The hydrocarbon compound, starch, is formed, and embodies within itself the energy which made it starch.

Each molecule of starch maintains its individuality as starch only so long as it retains within itself that solar energy under the influence of which it became starch; as soon as part of that energy is lost the starch is degraded to its original condition of carbonic acid and water. Yet that energy which works such molecular miracles is sought for among the products of decomposition in the form of heat only, and if not recognisable as such is put out of count in the world's work.

While it is thus evident that the vegetable kingdom lives a constructive life, storing up energy from an extra-terrestrial source, it is equally demonstrable that the animal kingdom lives a destructive life, unable to add aught to the sum of energy required for the work of the planet. Consequently an approximate expression for the value of the energy incorporated in the plant may be found in the work done, as a result of its consumption, by the animal.

4500 grains of plant carbon are daily excreted by every average man in the form of carbonic acid. Carbon and oxygen independently embody a greater sum of original energy than is

found in the compound formed by their union; therefore the result of their combining together must be a loss of energy: the value of this energy is estimated by the heat evolved. The heat recognisable on the combination of 4500 grains of carbon with the required equivalent of oxygen amounts to 118 units, and represents in foot-pounds the raising of 40 tons one foot high.

Such, then, is the enormous supply of solar energy obtained by a man when he compels the elementary atoms of carbon and oxygen to enter into a combination of greater stability and less energy, and to surrender their surplus energy that he may live.

But the converse of this is also true, viz. that when a plant proceeds to utilise this carbonic acid for the reproduction of 4500 grains of carbon, it can do so only by obtaining from some external source energy equivalent to the raising of 40 tons one foot high and adding this to the rates of vibration already existing in the carbonic acid. Thus the condition of energy of the carbonic acid is altered till finally the oxygen and carbon atoms are compelled to dissociate themselves and to resume their elementary forms of less stability and greater energy. They then become available for plant assimilation, and fix in its tissues the energy which forced them apart.

If, then, the union of oxygen and carbon in the human body sacrifices such energy that man can live thereby, is it not obvious that under whatever circumstances that union takes place the same energy must appear? If that be so, the question must arise whether in estimating the effect of vegetable decomposition upon the health of man too much notice has not heretofore been taken of the carbonic acid and kindred stable products given out, and too little attention paid to the energy evolved,—in fact, whether from the surface of every seething swamp there be not poured forth streams of that powerful energy which originally fed the growing plants, and which when eliminated within the body of man is known by the name of Life. To assume that such energy is powerless is to assert that the mother's heat is not the force that hatches out the egg.

That the theory which attributed all noxious influence to the gaseous resultants of decomposition did not satisfy the requirements of science is shown by the greedy acceptance of the germ theory which now prevails. But this, after all, is but coming one step nearer to the action of that universal energy which is the inseparable concomitant of all material interchange. For has not Dr. Burdon Sanderson well said, "Bacterial life is a middle term between chemical antecedents and consequents"? They reduce all unstable compounds in the world to final stable products, and live with vigour or in apathy in proportion to the effect upon themselves of the energy evolved from the medium they destroy. Thus, too, is produced much of that form of secondary energy recognised as heat of decomposition, and while this heat is known to possess marvellous influence over vegetable germination it has up to the present been credited with but little action on the life of man.

The gaseous consequents and the bacterial agents have borne the blame of every human ill, while that energy which ruled the universe before the first vegetable cell had varied towards animal functions is allowed to go unchallenged.

If, then, suspicion can be legitimately directed towards this heat as a factor in physiological change hitherto overlooked, it becomes necessary to pursue the subject of heat in all its latest developments.

Dr. Doherty, in his "Organic Philosophy," says: "Light is nothing but the velocity of a force which in slow motion is called heat." From the facts that are known in relation to light it may be possible to deduce by analogy much that is yet unproven with regard to heat.

It has been shown that light consists of certain colours which, when taken together, produce the sensation of light; each of these colours acts upon certain specialised molecules of the optic nerve and not upon the remainder, just as Professor Tyndall has shown that the invisible heat rays, "powerful as they are, and sufficient to fuse many metals, can be permitted to enter the eye and to break upon the retina without producing the least luminous impression."

May it not therefore be inferred that heat consists of a series of velocities of force which when taken together produce the sensation of heat, yet each of which is capable of acting upon certain specialised molecules of the nerves of sensation, while being unperceived by the remainder?

Light has been proved by Captain Abney to be the visible velocities of wave-lengths from 38,000 to the inch to 60,000, and within this range from 38,000 to 60,000 to the inch all the varied sensations of colour are produced; nevertheless, by the higher velocities, from 60,000 to 120,000 wave-lengths to the inch, the great chemical actions of the world are performed. Is it not evident, then, that if the recognition of wave-lengths from 38,000 to the inch and upwards depended solely upon the subjective sensation of light all appreciation of them must cease at the 60,000 wave-lengths, and that the great powers of the ultra-violet wave-lengths must have remained in darkness for ever?

But Captain Abney has also shown that there are measurable wave-lengths extending downwards from 38,000 to 10,000 to the inch; if, therefore, these are credited with such action only as is recognisable by the subjective sensation of heat, is it not equally possible that powerful influences which change for good or ill the configuration of the molecules of the nerves of sensation may be left unregistered?

It is therefore allowable to infer from this analogy that in the dark region descending from the fading red to the cold of zero there may be many rates of velocity, some of which, harmonising with some phase of life, produce the most potent physiological effects without at the same time exciting the molecular resistance which corresponds to the sensation of heat.

In other words, is it not probable that in estimating the actions of the forces of Nature upon the animal system some most subtle influences have been overlooked because unrecorded by the index of the thermometer?

Professor Tait says: "The energy of vibrational radiations is a transformation of the heat of a hot body, and can be again frittered down into heat, but in the interval of its passage through space devoid of tangible matter, or even while *passing unabsorbed through tangible matter, it is not necessarily heat.*" And Mr. Pattison Muir in his work on "Thermal Chemistry" asks: "Must all energy which is lost by a changing chemical system during a definite operation make its appearance in the form of heat? Energy appears in chemical operations in forms other than that of heat, electrical energy for instance; we must distinguish in chemical processes between that part of chemical energy which is freely changeable into other forms, and that which can leave the system only in the form of heat."

The most recent researches thus point to the probability that while the bacterium carries on through Nature its never-ending work of reducing chemical antecedents to chemical consequents it must as continuously set free energy in forms other than that of heat.

One of the most pregnant discoveries made of late is that which demonstrates that, even in the case of the powerful friction requisite for boring iron, heat ceases to be recognisable as heat when the iron operated on is strongly magnetised; that is, that heat developed by friction in a magnetic field disappears in some form other than heat. By this the idea is suggested that heat energy impinging upon the sentient extremity of a nerve in action may be taken up and carried in a form other than heat to the central brain, just as sound is conveyed in a form other than sound across the interval between the telephone and the receiver; and if the multiple wave-lengths which produce the subjective sensation of heat can be thus transferred from the surface to the centre, why not fractions of that multiple which when taken together make the whole?

Since, then, science cannot specify the difference between the energy contained in dead carbonic acid and that of the living hydrocarbon, neither can it draw a line more definite than the equator between those series of decompositions which on the one side are termed life, and on the other are designated death. In each and all the compound descends from instability towards stability, and in every degradation is energy evolved.

Yet that energy, no matter in what companionship it may be found, or through how many existences it may have transmigrated, has still but one original source, and consequently it is impossible to conceive a condition in which that energy, primarily possessed of such "phenomenal modes of action," can be regarded as absolutely inert.

So far, then, it is claimed that grounds have been established for asserting that from the surface of every decomposing swamp forms of energy must be momentarily poured forth, the potency of which is as yet unknown.

Again, while it is at present impossible to isolate the fractions of energy the sum of which make heat, still it would contribute vastly to the proof of their independent existence if it could be shown that the nerves of sensation are specialised in sections, each reacting separately, to different gradations of heat.

This has been apparently accomplished.

"Dr. Goldscheider at a meeting on April 9 of the Physiological Society of Berlin discussed the action of menthol on the sensory nerves; he therefore concluded that the sensations in some places of cold and in other places of heat, produced by menthol, were purely subjective, and consequent on the direct stimulation of *the special nerves of temperature, those usually cognisant of cold* being far more sensitive to its influence than were those adapted to receive impressions of higher temperatures."—*Brit. Med. Journ.*, August 21, 1886.

Here, then, is strong evidence that the sentient nerve-endings over the surface of the body are graduated to respond to the various rates of energy that may impinge thereon; and if so, how can it be admitted that the varieties of energy by which these nerve-endings are stimulated must be limited to those already identified?

That some such idea has shaped itself in the minds of observers may be gathered from the independent opinions expressed by several of the members of the Cholera Commission of 1885.

Prof. Aitken sums up his valuable contribution in these words:—

"Some influence (as yet unknown, and therefore so far mysterious) seems to create in cholera times and places an epidemic activity. It is probable that this may be due rather to some meteorological condition—some peculiar state of the atmosphere, electrical or other—combined with unwholesome conditions of surroundings, and conditions of life; a co-existence of physical phenomena rather than anything in the individual. It is well known that electrical conditions such as prevail in a thunderstorm will cause milk to become sour, the formation of the acid being associated with, or due to, the formation of the bacterium lactis, and thus confined to very definite areas."

In the last paragraph lies the key to some of the foregoing mystery.

The mode in which to use it can be learned from the marvellous researches of Pasteur.

It is obvious that if the cause of sourness be the bacterium, the cause of greater sourness will be the bacterium still, and that the reason for the increased reduction by the bacterium of chemical antecedents to chemical consequents, which produces the additional sourness, must lie in some condition affecting the life of the bacterium too.

Pasteur has shown that a fundamental difference exists in the mode of action of the beer and grape ferments when "the introduction of the free oxygen of the atmosphere is permitted and when such introduction is prevented." When free oxygen is admitted, "the ferment shows an activity *even more extraordinary* than it did in the deep vats; the life of the ferment is singularly enhanced, *but* the proportion of the weight of the decomposed sugar to that of the yeast formed is absolutely different in the two cases: while, for example, in the *deep vats* a kilogramme of ferment sometimes decomposes 70, 80, 100, or even 150 kilogrammes of sugar; in the *shallow* troughs 1 kilogramme of the ferment will be found to correspond to only 5 or 6 kilogrammes of decomposed sugar. In other words, the more free oxygen the yeast ferment consumes the less is its power as a ferment; the more, on the contrary, the life of the ferment is carried on *without the presence of free oxygen* the greater is its power of decomposing and of fermenting the saccharine matter."

Here, then, is the clue to the cause of the increased sourness of milk during electrical conditions such as prevail in a thunderstorm. The bacterium lactis evidently finds itself in a situation in which the free oxygen of the atmosphere has, owing to some atomic disturbance in its molecules, become less available as an energy-provider.

The organism is consequently compelled to revert to the *condition of the ferment in the deep vats*, and to find in the increased decomposition of the constituents of the milk that energy which is necessary for its existence.

Further, it is known that electricity does affect the condition of oxygen, that the conversion of its molecules from the di-atomic to the tri-atomic state can be brought about by its influence, and that this latter state has been recognised as ozone.

If, then, it can be thus proved that the presence or absence of oxygen so materially alters the mode of existence of microscopic organisms, is it not reasonable to accept changes in the lives of the organisms as evidence of the altered condition of oxygen? and since certain conditions of free energy are thus found to interfere with the mode of nutrition of the minutest forms of life, can it be doubted that similar forces may exercise a material influence upon the most complex being, who, after all, is but a larger multiple of the original protoplasmic element?

Thus it becomes possible that energy existing in forms other than those of light or heat exerts a power which has up to the present been ignored.

By this reasoning too, based on the altered mode of nutrition of the bacterium lactis during a thunderstorm, much that has been hitherto obscure in the history of the diseases, or blights, of the vegetable world becomes intelligible.

When it is found that all the bacteria lactis over a considerable area at the same moment change their mode of existence, and, from leading a comparatively sluggish life in the milk substance, suddenly break up almost the whole of that substance at a time when electrical disturbances are present, it is easily conceivable that in the case of potato-blight, which is almost invariably accompanied by obvious atmospheric changes, like conditions may arise; in fact, that the universally present bacteria, which, under ordinary circumstances, continue to exist without apparent injury to the tuber and leaves with which they are in contact, may, when driven by the stress of altered atmospheric conditions, turn upon the tissues of the plant for nutrition as the bacterium lactis upon the milk.

If, then, these effects of certain unrecognised forms of energy be established, it will go far to help the elucidation of the mysterious subject of cholera.

Dr. Bryden, from prolonged study of the cholera statistics of India, arrived at the following conclusions: "That the disease was endemic in the Soonderbunds, and that its cause was *earth-borne* and *air-borne*;"—to repeat the words of Prof. Aitken, "due rather to some meteorological condition, some peculiar state of the atmosphere, to a co-existence of physical phenomena;" and Deputy-Surgeon-General Marston has added: "Cholera spreads along rivers, but against their current in Bengal. It invariably advances from Bengal proper to the Himalayas, and never the reverse."

Here, then, are the conclusions arrived at by some of the most skilled observers on this subject.

It is thus admitted that cholera is endemic in the Soonderbunds, and that its track from thence lies in a north-westerly direction; that is, that its home is a surface of 12,000 square miles of decomposing tropical vegetation, and its direction that from whence the Ganges and its tributaries flow.

From this it may be inferred that its cause is such that it can be carried atmospherically, and that its course is the line of the least resistance.

Were the cause of cholera solid or liquid, it would doubtless long ere this have been demonstrated. Were it gaseous, it must follow the law of the diffusion of gases. What, then, remains to be sought for over the surface of the Soonderbunds? Naught but some form of that universal energy which fell as a sunbeam upon the growing plant, but which, when filtered through its substance, is evolved in a less vivid but still a potent form from its decaying structure.

That such returned energy has the power of incorporating itself with water, till it passes upward as a vapour, every steaming dung-heap shows; and in what prodigious force it can be again eliminated may be understood from the calculation of Prof. Haughton, that the condensation of vapour sufficient to afford one gallon of rainfall gives out sufficient heat to melt 45 pounds of cast iron.

From this may be estimated the enormous output of bottom heat which must day and night pass from a decomposing surface of 12,000 square miles to the vapour-carrying air above.

To comprehend the distance to which this energy may be transported before doing visible work it is only necessary to consider the Gulf Stream, which is described by Prof. Tait as "a vast convection current whereby the solar heat of the tropics is carried into the North Atlantic;" and to measure the work done thereby it needs but to weigh the luxuriant vegetation of the United Kingdom against the frigid barrenness of Labrador.

If, then, such vast stores of force can be transported from the tropics to England, it cannot be irrational to assert that from the surface of the Soonderbunds, and like places, much of the energy of decomposition must ascend with the rising vapour, and that whether drawn landward by the heated earth-surface, or pushed inward before the advancing monsoon, this vapour must follow the line of least resistance along the course of the river beds.

Again, when it is remembered how intense are the effects on

the nerves of the animal body of the chemical affinity evolved as electricity from a few square inches of decomposing zinc, it may well be contended that the energy of chemical affinity evolved from so great an area of decomposing organic substances cannot be innocuous, and that the fact of its action not being acknowledged by the subjective sense of feeling is no proof that it is non-existent.

Thus it becomes conceivable how the energy evolved in the Soonderbunds may, when vapour-borne across the interval, affect the inhabitants of Oude, and so alter the individual condition as to admit of local causes producing foreign effects.

Many of the most careful observers have asserted that malarious fevers arose from chill; yet, while this did not solve the question, it at least established one fact, that malarious fevers arose under circumstances which necessitated vapour condensation, one gallon of which would set free energy sufficient to melt 45 pounds of cast iron.

Familiarity with malaria will furnish many arguments in support of the contention that fever infection is at least coincident with vapour condensation. A boat's crew ashore at night on a West African station will often be affected, while those but a few miles seaward will remain exempt.

In the deep valleys of Zululand leading from the St. Lucia swamp, fever is contracted at a distance of many miles inland, while high ground much nearer to the swamp may be occupied with impunity. In the Terai, at the foot of the Himalayas, a night's sojourn brings to the unseasoned traveller certain fever, while a day journey is almost free from risk.

Since, then, the search for a material cause of cholera and of malaria has been as unsuccessful as if one sought a material cause for sunstroke, it may legitimately be suggested that, as the more rapidly fatal affection is the result of the action of direct solar energy upon the sentient nerve-endings, so the less rapid maladies may result from subordinate rates of the same energy acting upon subdivisions of the nerve-endings, which, as Dr. Goldscheider has shown, are specialised to respond to lower velocities of that force, and that the chill to which so many attribute the origin of fever is really the acknowledgment, by what Dr. Goldscheider terms "the special nerves of temperature usually cognisant of cold," of that obscure energy hitherto unregarded as a factor in the production of disease, but which the investigations of thermo-electricity may one day bring within the ken of man.

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THE CRUISE OF THE "MARCHESA"[1]

THIS is one of the most interesting books of trave that it has been our good fortune to meet with for several years. Apart from its excellent maps and wealth of illustration, it commends itself by a charm of style not usually to be met with in works of this nature, and by the judgment shown in the narrative. Many countries were visited which lie in the well-beaten track of every tourist round the world, but these have not even been alluded to. The attention is riveted to the details of discoveries among little-known scenes, and sometimes in quite unexplored regions.

The *Marchesa*, an auxiliary screw schooner of 420 tons, Mr. C. T. Kettlewell, captain and owner, was commissioned in the Clyde in November 1881, and left Cowes on the 8th of the January following. She reached Colombo on April 24, having touched at Socotra and Oolegaum Island, one of the Maldive group, on her way from Aden. From Ceylon she proceeded *viâ* Singapore to Formosa; and, coasting along the south-eastern side of Formosa, she visited the small Island of Samasana. While she was running nearer to the coast at Chock-e-day, the stupendous cliffs of this part of Formosa were seen rising, to a height of some 5000 feet, upright from the water's edge.

The little-known islands of the Liu-Kiu group were next visited. These lie some 250 miles to the east-north-east of Formosa; they are partially volcanic, and lie just north of the tropic. The account of the short sojourn at Napha, and of the wonderfully successful visit to Shiuri, the capital, where are the ancient palaces of the Liu-Kiu kings, will be found in Chapters II. and III. Some time was spent at Japan, then the yacht's head was turned northwards for Kamschatka, and on the morning of August 13, when the fog lifted, the sharp peak of Vilutchinska Volcano enabled them to steer for Avatcha Bay, within which lies the once well-known little harbour of Petropaulovsky.

"Avatcha Bay is one of the finest harbours in the world, if not actually the finest. Rio and Sydney have no mean claims for this position of honour, but those of us who had seen both were unanimous in awarding the palm to their Kamschatkan rival. A nearly circular basin of some nine miles in diameter, and within a narrow entrance opening to the south-south-east, it is roomy enough to accommodate the navies of the world. It is entirely free from dangers, has an even depth of ten or twelve fathoms, and owing to its affording excellent holding ground and being well protected from all winds it is perfectly safe in all weathers. But the ordinary traveller will be struck not so much with its nautical excellences as with the superb scenery with which it is surrounded. To the south rises the Vilutchinska Volcano, now quiescent, a graceful cone of about 7000 feet; and a little farther eastwards a huge flat-topped mass exceeding it in height by a thousand feet or more obtrudes itself, as a rare exception to the rule of cone-shaped mountains which seems to obtain throughout the country. It is nameless in the charts, for we are in the land of volcanoes and it is only 8000 feet in height! On either hand on entering are the two secondary harbours, Rakova and Tareinska—the latter nearly five miles in length—and within them again are others on a still smaller scale. Nature here at least has treated the mariner right royally. The iron-bound coast without may be as bad a lee shore as any skipper need wish to see, and the Pacific Ocean may too often belie its name, but here he can rest quietly, and sleep *sur les deux oreilles*, until such time as he weighs anchor for the homeward voyage" (vol. i. p. 67).

In spite of its imposing name, it did not take the explorers long to see all the sights of Petropaulovsky, and a plan was soon formed to make an expedition into the interior. Travelling northwards from Avatcha Bay, they soon struck the head waters of the great Kamschatka River, on which they floated down to the sea. The well-known naturalist Dr. Dybowski gave them great assistance in their undertaking. The yacht was to remain in harbour for some six weeks, and then to proceed, as it did, to the mouth of the river to await their arrival. Of this delightful river journey our space will permit us to give no details. As far as Narchiki, where they met the river, they journeyed on ponies, and then they floated down its stream, sometimes in boats, sometimes on rafts, until, after many an adventure, and, indeed, many a trial, they reached Ust Kamschatka in safety. In places, the river swarmed with salmon; bears were in abundance; the weather, though not always of the best, was generally bright and clear; but the natives were very difficult to deal with—always exorbitant in their charges, and often placing the travellers in sad dilemmas; and constant rows took place about the hire of the canoes. One morning, after a harder fight than usual with the Mashura men, with much time and some temper lost, they came in sight of the magnificent range of volcanoes on the lower reach of the great river. The five already-known volcanoes have elevations of from 11,700 to nearly 19,000 feet, and there were two much lower cones, now first described, which they called after Gordon and Herbert Stewart. The account of the travellers' first view of these mighty peaks must be told in their own words.

"We floated silently down stream for a couple of hours or more, thinking over the discussions that we knew only too well would be renewed at the earliest opportunity,

[1] "The Cruise of the *Marchesa* to Kamschatka and New Guinea: with Notices of Formosa, Liu-Kiu, and various Islands of the Malay Archipelago." By F. H. H. Guillemard, M.A., M.D. (Cantab.), &c. With Maps and numerous Illustrations. Two Volumes. (London: John Murray, 1886.)

when turning a sudden corner we found ourselves face to face with a view that banished all thought of past and future annoyances in a moment. Before us, eighty miles or more away, stood one of the grandest groups of volcanoes in the known world. Others there are, it is true, that are higher, although in most cases the elevation of the ground from which they take their rise detracts in no little degree from their apparent height. But here, from a base elevated scarce a hundred feet above the sea, a series of cones of the most exquisitely symmetrical shape



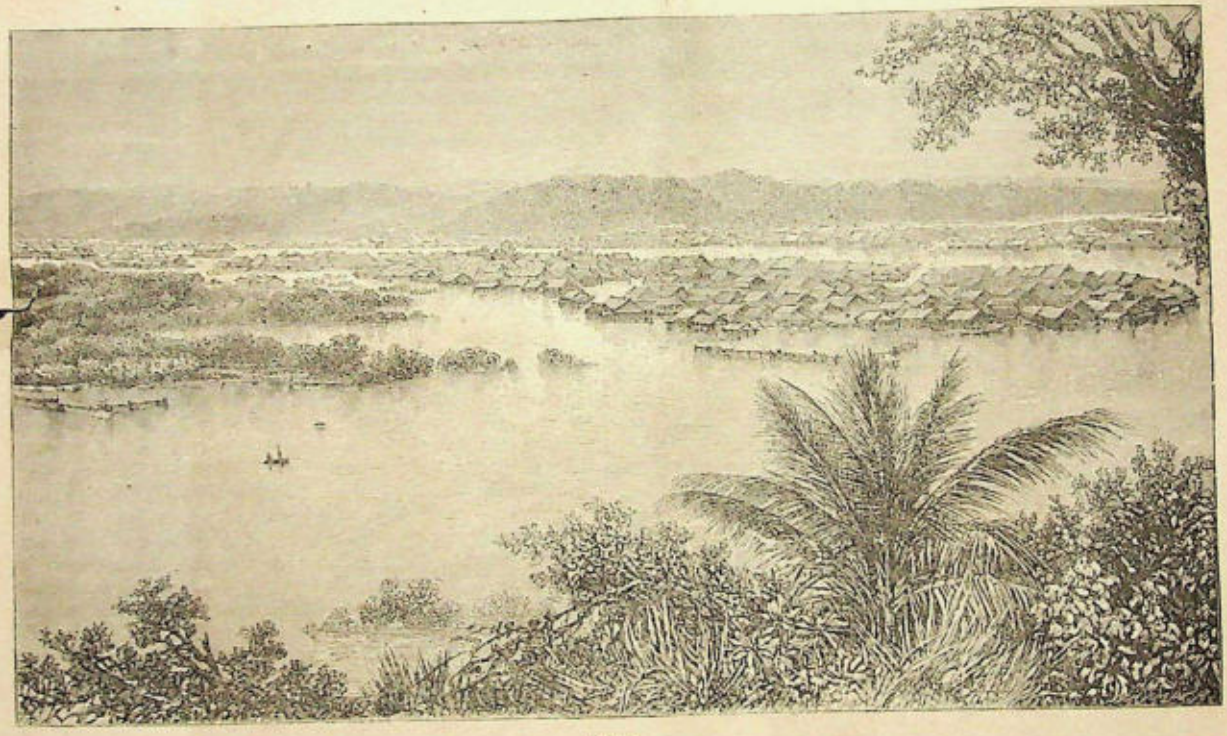
The Volcano of Kluchefskaya.

rose in heights varying from twelve to seventeen thousand feet. They were three in number. Nearest us was Tolbatchinska, dog-toothed in shape, with its apex on the western side, a long thin puff of white smoke drifting from its shoulder; and beyond, apparently in close proximity to one another, rose the twin peaks of Kojeievska and Kluchefskaya, perfect in their outline, pyramids of the purest snow, before which one felt how poor was all language to express the sense of their perfect beauty. Snow mountains were no novelty to us. We had seen the

Andes and the Alps, and had watched the sun rise on Cotopaxi, on Etna, on Fujiyama, and a dozen other mountains of equal note. But here all questions of comparisons would have been a sacrilege; and floating noiseless over the unruffled surface of the river, we sat spellbound drinking in the view. The sun sank slowly as we crept along, and slope and peak, at first a dazzling white, turned slowly to a glowing gold. On either hand the fast-approaching night had changed the glories of the autumn tints to a sombre shade of violet, and behind us the river was a mere streak of light. The glow of the fire upon the other raft lit up the bearded faces of our Russian guides around it; and when the daylight had fairly waned, the head of Kluchefskaya stood out a pale greenish white—a spectral mountain against the fast-darkening sky. Come what might, even if we were never again to get a glimpse of them, we had seen the great volcanoes, and we felt that the sight was one that we should not easily forget for many years to come" (vol. i. p. 149).

After rejoining the yacht the party visited the well-known breeding-places of the fur seal at Bering Island; from thence back to Kamschatka, and then to Yokohama to refit and repair. A brief history of Russian discovery in these seas, and a record of a little-known defeat of the allied forces of England and France in 1854 at Avatcha, will also be found in this volume.

In Volume II. the scene changes from the snowy north to the tropics, where for a long time the *Marchesa* wandered from one island of the Indian Ocean to another. The little-known Island of Cagayan Sulu is described as perhaps the most beautiful of all tropical islands. A revised chart of the island is given; and its three crater-lakes, one of the most interesting phenomena to be met with in the Eastern seas, were visited and described. The third lake had escaped the notice not only of Admiral Keppel, who had twice visited this island, but also of Captain Chimmo, who had in 1871 surveyed Cagayan Sulu. This lake was of rather smaller size than the others, being two-



Brunei.

fifths instead of three-fifths of a mile in diameter; but the basin was perfectly circular, and filled with water to about the level of the second lake. Thick jungle clothed its precipitous sides, but the latter, instead of running sheer down into the water, left room for a small beach on which wild bananas were growing.

The islands of the Sulu Archipelago are described in Chapters II. to IV. of this volume. Natural history rambles were made over Sulu; and the Sultan, with and without his wives, visited the yacht. Some days were spent with the Spaniards at Jolo, a fortress on the northern side of the island. The fauna and flora of the Philippines and Borneo are contrasted with those of Sulu, and the Sulu Archipelago is determined to be, zoographically, purely Philippine, the Sibutu Passage forming the boundary line.

The newly-acquired territories of the British North Borneo Company were next visited, and some details are given of the existing state of things in this new colony. The colony at Labuan was found to be retrogressing. The Sultan was interviewed; and Brunei, the Venice of the East, in which, except its market, there is little of interest, was explored. The great dexterity of the boatmen in the use of their paddles is noted. "From a rapid and beautifully clean stroke of forty or more to the minute, they would drop instantaneously to a long steady swing of twenty, without any apparent signal having been given, and without a hair's-breadth of deviation from the perfect time."

We pass over the chapter on Sumbawa, and next find the yacht at Celebes. Macassar is the Hong Kong of the Dutch, and is not attractive from the sea.

"The town is much as other Dutch Malayan towns. A row of white shops and merchants' offices lines the sea; and dust of a lightness and powderiness that is not excelled even in California or the Diamond Fields covers the streets to the depth of an inch or more. These are otherwise clean enough, and the spare time of the native servants, and they appear to have plenty of it, is occupied

in perpetual watering. There is of course a fort, and equally of course a '*plein*.' The cemetery is significantly full. Almost all the tombs are kept whitewashed, and as many of them are curious chapel-like erections with flying buttresses, the effect at a distance is something between an ice palace and a clothes'-drying ground. The houses of the Dutch residents, shadowed in peepul or galela trees, stand back a little distance from the road, long, low, and cool, with thick white posts at their entrance gates. A long avenue of magnificent overarching trees leads eastwards from the pier, adown which the Governor may be seen driving any afternoon in a four-in-hand, with sky-blue reins. It is lighted by means of lamps hung midway between the trees, for the Hollander, even although gas may be unattainable, considers civilisation incomplete without these adjuncts. Then too there is the club, with its zinc-topped tables set out *café*-fashion beneath the trees. It is called the 'Harmonie,' as is every Dutch club in Malaysia, and within all is dark and deserted and cool during the mid-day heat. The servants are curled up asleep behind the bar or in the corners of the rooms, and would stare in dumb astonishment at the apparition of a European; for the early business of the day over, and the *rijst tafel*, or lunch, despatched, the white residents get into their *pyjamas* and take a siesta till three or four o'clock. A couple of hours or so are then devoted to business, and towards sunset the male portion of the population meet at the 'Harmonie' to chat and drink *pijtjes*. Billiards is the most violent exercise taken; cricket, bowls, and lawn-tennis are unknown" (vol. ii. p. 156).

Among the pleasant reminiscences of the travellers about their travels in the north of Celebes will doubtless be those of their visits to the Tondano Lake with its pretty waterfall; to Talisse Island, where at "Wallace Bay" the habits of the maleo (*Megacephalon maleo*) were observed, and a good store of their eggs and bodies were collected; and to Kema, where a great babiroussa hunt was held.

The name Moluccas, at one time restricted to the little chain of volcanic islets lying off the western coast of Gilolo, of which Ternate is the chief, now includes all the islands between Celebes and the Papuan group. As regards magnificence of scenery, Ternate is perhaps the finest harbour in the Dutch Indies. The Resident, Mr. Morris, kept a large aviary of rare birds, amongst which the gems were two superb specimens—both full-plumaged males—of the twelve-wired bird of paradise. These exquisite creatures were fed on the fruit of the pandanus, with an occasional cockroach as a *bonne bouche*. "The feelings of admiration with which I watched these birds, which are among the most beautiful of all living beings, I need not," says the writer, "attempt to describe." The concluding chapters of this volume bring us to New Guinea, the very home of paradise birds. The portion of this great island visited was the western half, that claimed by the Dutch; which, from the variation in species from island to island, and the peculiarity of these birds of paradise, is perhaps the most interesting to a naturalist. A safe anchorage was secured at the extreme east end of the Island of Batanta, in "Marchesa Bay." The first ramble on shore was unsuccessful. Scrambling over the mangroves' slimy roots, and struggling up to their knees in liquid ooze, they found that the land was hard to reach; the shore rose steeply from the sea; and the dripping wet jungle made progress all the more difficult. The party returned disappointed to the yacht, to find that some of the hunters were already back, equally empty-handed. Presently, however, "Usman and his *compagnon de chasse* appeared triumphant, carefully carrying a prize that we had hoped, but hardly expected, to obtain—the curious and exquisitely lovely little *Diphyllodes wilsoni*, smallest of all the birds of paradise. Behind the head, a ruff of canary-coloured feathers stands erect above the scarlet back and wings. The breast is covered by a shield of glossy green plumes, which towards the throat are marked with metallic green, and violet spots of extraordinary brilliancy. The two centre feathers of the tail, prolonged for five or six inches beyond the others, cross one another, and are curved into a complete circle of bright steely purple. But the chief peculiarity of the bird is the head, which is bald from the vertex backwards, the bare skin being of the brightest imaginable cobalt blue (the figure in Gould's 'Birds of New Guinea' gives no notion of the extreme brilliancy of the colouring of this part). The *bizarre* effect thus produced is still further heightened by two fine lines of feathers which, running lengthways and from side to side, form a dark cross upon the brilliant azure background. I could hardly make up my mind to skin this little ornithological rainbow, whose exquisite plumage it seemed almost a sacrilege to disarrange, but the climate of New Guinea allows of but little delay in this operation, and I set about my task at once. The bird had been scarcely injured by the shot, and I succeeded in making a perfect skin of it" (vol. ii. p. 254).

Dorei Bay, well known as the settlement of the Dutch missionaries, and the residence of Mr. Wallace in 1858, was the next station. Some few miles south of Dorei Bay is Andai, a small village nestling at the foot of the Arfak Mountains. The dense forests that clothe these mountains are the favoured haunts of such magnificent paradise birds as the great velvet-black Epimachus, with its tail a yard in length; the Astrapia, in its uniform of dark violet, faced with golden-green and copper; and the orange-coloured Xanthomelus. There D'Albertis had shot his Drepanornis, with its two fan-like tufts, one flame-cloured, the other tipped with metallic violet; and there Beccari braved the climate and made such splendid collections. The summits of the mountains were less than ten miles from where the yacht was, and yet this land of promise could not be entered. Our readers must seek the reason why in the narrative: here we can only add that the homeward voyage had begun.

In so short a sketch it is simply impossible to do more than give the reader an idea of what he may expect to find within the pages of these volumes. Students of geography, ethnology, and, above all, zoology, will discover therein a great deal that is of interest, and also much that is novel; and every reader will be pleased by the writer's freshness of style and keen enjoyment of Nature. To enjoy travelling, especially in the tropics, one must be of an equable, not to say of a cheerful, frame of mind. We close the perusal of Dr. Guillemard's delightful volumes with the impression that the company on board the yacht *Marchesa* was certainly of this kind.

In several appendixes to Volume II. there are lists of the birds met with in the various regions visited, and of the shells. There is also a list of the Rhopalocera collected in the Eastern Archipelago, and of the languages of Sulu, of Waigiou, and of Jobi Island. Tables are given of the total export in 1884 of the chief articles of produce in the Netherlands India, North and South Celebes, Amboyna, and Ternate.

THE SMITHSONIAN INSTITUTION

THE annual Report of Prof. Baird, Secretary of the Smithsonian Institution, has just been issued. It relates to the period from July 1, 1885, to the close of June 1886, and includes, in addition to the account of the operations of the Institution itself, a summary of the work done by the branches of the public service placed by Congress under its charge, namely, the National Museum and the Bureau of Ethnology. To this is added a sketch of the work of the U.S. Fish Commission, which is also under Prof. Baird's charge, and of that of the U.S. Geological Survey, which, although independent of the Smithsonian Institution, is in close relation with it by

reason of its field of exploration, and especially through the valuable accessions of material furnished by it to the National Museum.

With regard to the Smithsonian Institution itself there is not much to be said, except that its usual operations were steadily carried on during the year, with a marked increase in routine work. In the way of explorations there was less activity in the year 1886 than there has been in some previous years, but important collections of objects of scientific interest were received from various parts of America and Asia. Of the different classes of works issued by the Institution, the most valuable are the quarto "Contributions to Knowledge." A work in this series, entitled "Researches upon the Venoms of Poisonous Serpents," by Dr. S. Weir Mitchell and Dr. E. T. Reichert, was printed during the past year, and will soon be ready for distribution. Among the "Smithsonian Miscellaneous Collections" of 1885-86 may be mentioned "A Catalogue of Scientific and Technical Periodicals (1665 to 1882), together with Chronological Tables, and a Check-List," "The Scientific Writings of Joseph Henry" (not yet published, but entirely stereotyped), "Index to the Literature of Uranium, 1789-1885" (one of a series of bibliographies especially directed to the indexing of chemical literature), and "Accounts" of the progress of astronomy, chemistry, physics, geography, anthropology, and other sciences in 1885. The Smithsonian Institution has also issued the Bulletins and Reports of the Proceedings of the National Museum, and valuable publications of the Bureau of Ethnology.

It is well known that in bequeathing to the United States the fund with which the Smithsonian Institution was established, Mr. Smithson stipulated that his bequest should be devoted to "the increase and diffusion of knowledge among men." The Institution has always complied with this condition in a most liberal spirit, and now its system of "free exchanges" has reached vast proportions. For the year ended June 30, 1886, the receipts for foreign transmission were 94,093 packages, weighing 195,404 pounds. The transmission filled 764 boxes, having an aggregate bulk of 5208 cubic feet. For domestic exchanges the number of parcels received and distributed during the fiscal year was 14,496, of which 2533 parcels (or about one-sixth) were received for the library of the Institution. Twenty years ago the Institution was made by law the agent of the United States Government for conducting the international exchanges of public official documents between it and foreign Governments, and during the past year 29 boxes, containing 56,229 packages, were received for Government exchanges, and 114 boxes were sent abroad. The exchange system of the Institution is found to be of so much public service that Congress supports it by an annual grant of 10,000 dollars.

Perhaps the most interesting part of the report is that which relates to the National Museum. It is five years since the work of moving into the new Museum building was begun. Two years ago the Director reported that the packing-boxes, several thousand in number, containing the accumulations of many previous years, had for the most part been unpacked, and that the entire floor space of the building would soon be occupied by exhibition collections. During the past year this result was attained, and (with the exception of one corner of one of the central halls still occupied by one or two collections received at the close of the New Orleans Exhibition, and which have not been opened on account of delay in preparation of cases for their reception) the entire floor space of about 100,000 square feet is open to the public, and the collections arranged in accordance with the provisional plan of installation. The work of mounting and labelling is still in progress, and each month shows marked advances.

The development of the Museum during the past year was unexpectedly great. About fifteen hundred separate lots of specimens were received. A certain proportion of these were obtained from Government expeditions and surveys, and material of perhaps equal value through exchange, but by far the largest part of the increase, both in quantity and value, was in the form of gifts.

A census of the collections made in 1884 showed an estimated total of 1,471,000 "lots" of specimens in the Museum. The number at the present time is 2,420,934. The total number of "lots" of specimens received during the year and separately entered on the record of accessions was 1496, including 6890 separate packages. The construction of cases was constantly in progress, and during the year there were received and fitted for use and placed in the exhibition halls 84 cases, chiefly of the standard patterns. Forty-five storage cases were made for use in the laboratories, 5400 wooden drawers and trays, and 54,000 pasteboard trays. There were also purchased 3504 glass jars, for storage and exhibition of alcoholic specimens, and 24 barrels (1115 gallons) of 98 per cent. alcohol.

The distribution of duplicates was much the same as in previous years. About twenty-four thousand specimens were sent out to 118 institutions and societies: those to institutions in the United States are generally gifts, though many were sent in the way of exchange. For all foreign sendings, equivalents in the way of exchange were received or promised.

Many interesting details are given as to the various Departments in which the collections of the Museum are grouped. In the Department of Arts and Industries a prominent place is held by the section of textiles, which includes a very full series of the animal and vegetable fibres used throughout the world, together with good representations of devices for spinning and weaving, and of the various products of the textile industries. This collection is nearly all permanently installed, provided with printed labels, and illustrated by diagrams. For lack of room, fully half of the material ready for exhibition has been stored away, and the cases prepared for its display are in boxes in the Armoury building. The space assigned to the exhibition series is still so crowded that the objects cannot be satisfactorily examined. To the collection of food substances, in the same Department, is assigned a large quantity of unassorted material. The few cases now on exhibition contain the foods of the North American Indians, of Japan and China, and some of the more curious and unusual articles of diet. There are also two cases of educational importance, which exhibit graphically the composition of the human body and its daily expenditure of tissues, and the manner in which this is compensated for by daily rations of food. This collection is modelled after the famous collection of a similar character prepared by Dr. Lankester and others for the Bethnal Green Museum in London. It is, however, based upon an entirely new series of analyses, and upon a revised plan prepared by Prof. W. O. Atwater, of the Wesleyan University and corresponds to the latest views in physiological chemistry. The collections in chemical technology already have a good nucleus, and the increase during the year in the collections of materia medica was greater than during any previous year except the first. The fisheries collection was opened to the public in May 1884, and since that time there has been constant improvement in the condition of the material exhibited. Some gaps in the series of illustrations of foreign fisheries have been filled by collections received from the Governments of Siam and Japan, and by the extensive collections from Great Britain, Sweden, Spain, France, Holland, and Greece, acquired at the close of the London Exhibition.

Of the collection of historic relics in the Department of Arts and Industries, we learn that it includes several hundred objects of national interest connected with the history of soldiers, statesmen, and important events. Closely related to the historical collection is the series illustrating the history of steam transportation, under the

charge of Mr. J. E. Watkins, of Camden, N.J. The "John Bull" engine, imported from England in 1831, the model after which all subsequent American engines have been constructed, has been given to the Museum by the Pennsylvania Railroad Company, and placed on exhibition; and adjoining this is a case in which there are already assembled about forty objects illustrating the beginnings of the American railroad system. The collection of scientific instruments owes its interest at present chiefly to the historical associations of most of the apparatus displayed, including, as it does, instruments used by Priestley, Henry, and Hare. The original telegraphic instrument of Morse and Vail is also here shown. The collections of musical instruments, modern pottery, and porcelain, lacquer, and the process of engraving are partially displayed, and when cases and floor space shall become available, will soon develop into important features.

The Department of Ethnology, although one of the youngest, is one of the largest in the Museum; and its growth during the last year was very great. Certain large classes of objects, such as weapons of war and the chase, implements of agriculture, and other primitive industries, have been carefully grouped. In addition to these great series of objects, classified according to function, other groups of objects have been arranged in accordance with another idea of classification, which is deemed of equal importance, namely, that of race. The Eskimo collection, for instance, has been arranged in table cases in one of the exhibition halls, in accordance with the ethnic idea, although, in the minor details of classification, function and form, as well as geographical distribution, have been followed. A preliminary study of the collection of basketry has been completed. A paper upon the baskets of uncivilised peoples, with numerous illustrations, was published in the Museum Report for 1884, and a representative series placed on exhibition with provisional labels. The throwing-sticks and sinew back-bows have been the subject of papers, and are now on exhibition. The curator has in progress investigations upon several groups of objects, notably the history and technology of archery; upon transportation as effected by man without the aid of domestic animals or mechanism; upon the peculiar industries of several handicrafts; upon the Hoopah Indians of California. The underlying ideas in these investigations, a first instalment of which was published in the last Report of the Museum, are (1) that the methods of strict classification and nomenclature already applied in the other natural sciences are equally applicable to anthropology; (2) that a trustworthy and minute study of modern savage and barbarous *technique* is absolutely requisite to the archæologist and technologist in reconstructing the history of civilisation.

The collections in the Department of American Aboriginal Pottery have continued to increase with astonishing rapidity, and the extensive accessions which have been received through the Bureau of Ethnology, and from other sources, have been of the greatest scientific importance and popular interest. One of the four large central halls of the Museum is devoted entirely to this subject, and the removal of the collections of South American aboriginal pottery and of the extensive collections from the mounds which have for many years been accumulating in the Archæological Hall of the Smithsonian building, have filled it up to such an extent that it is difficult to find room for the new material as it comes in. During the year a portion of the hall was thrown open to the public. The exhibition case surrounding the walls of this room is probably the largest in existence in any museum, being 260 feet in length, 4 feet 9 inches in depth, and, being double throughout, its entire length is virtually 520 feet. Double the space now allotted to this Department is necessary for its proper display, and the value of the material here concentrated is practically inestimable; since even the modern tribes, who are still making pottery similar in its general character to that which is here preserved, have deteriorated to such a degree in their artistic capacity or skill that their products are not an exponent of their original artistic capabilities. So exhaustive is this collection that it is impossible that any thorough work can be done upon the American aboriginal pottery which shall not in great part be based upon it.

The total number of accessions in the Department of Antiquities was 2751; and all excepting eighty-four were of sufficient importance to be added to the exhibition and study series, which now include over 40,000 specimens. Dr. Rau, the Curator of this Department, is engaged upon the preparation of an illustrated work on North American prehistoric objects, which is designed to serve as a guide for visitors to the Department, and as an explanation of the terminology of North American archæology. This will bear the title, "A Classification of the North American Prehistoric Relics in the United States National Museum." This book will be fully illustrated, and, it is hoped, will be published in the ensuing year.

The most important accessions to the Department of Mammals, as in previous years, were in the shape of single specimens sent from zoological gardens and menageries, which have shown a great deal of liberality to the Museum in this respect.

The growth of the Department of Birds during the year was very satisfactory, the number of specimens added to the collection being 4147. The largest single accession was the collection made by the U.S. Fish Commission steamer *Albatross* in the Bahamas, of 1000 specimens and about 75 species, of which 5 were new to science. Another valuable collection, 243 specimens, 81 species, 1 new to the fauna of North America, was obtained in Alaska by Mr. Charles H. Townsend, while on a mission for the Fish Commission. Mr. Henry Seebohm, of London, gave to the Museum 171 specimens, 68 species, chiefly from Siberia, and of great value to the collection. The number of specimens in the collection is now 55,945, 7000 of which have been set apart for the exhibition series.

Very much was accomplished during the year in the classification and arrangement of the collection of eggs and nests of birds. The total number of specimens added is 2556, in 253 lots, and there are now more than 44,000 specimens in the collection, of which 1491 are in the exhibition, and 31,124 in the reserve collection, the remainder having been set aside as duplicates.

The remaining Departments of which accounts are presented are those of Reptiles, Fishes, Mollusks, Entomology, Marine Invertebrates, Comparative Anatomy, Invertebrate Fossils, Fossil and Recent Plants, Minerals, Lithology and Physical Geology, and Metallurgy and Economic Geology. In dealing with the Department of Entomology, the author of the Report has to record a fine instance of the generosity and public spirit for which the best class of American citizens are famous. In October last, Dr. C. V. Riley formally presented to the Museum his private collection of North American insects, representing the fruits of his own labours in collecting and study for over twenty-five years. This collection contains over 115,000 pinned specimens, and much additional material unpinned and in alcohol. This generous gift to the Government had long been contemplated by Dr. Riley, who wishes to be, as far as possible, instrumental in forming a national collection of insects. In his letter of presentation he remarked:—"While the future of any institution dependent on Congressional support may not be so certain as that of one supported by endowment, I make this donation in the firm belief and full confidence that the National Museum is already so well established in public estimation that it must inevitably grow until it shall rival, and ultimately surpass, other institutions in this country, or the world, as a repository of natural history collections.

If there shall in the future result the concentration here at the national capital of the extensive entomological material which naturally comes here, and which in the past has been scattered among specialists in all parts of the country, so that in the future the student may find valuable material to further his work in any order, I shall feel amply rewarded for the action I have taken."

The Curators of all the Departments complain that in the new Museum building there is not nearly room enough for the display of the treasures placed under their care, and Prof. Baird presses upon the attention of the Board of Regents the urgent necessity [illegible] additional quarters." One of the arguments used [illegible] may, perhaps, not be without effect on public [illegible]ion. Efforts are being made to secure that in 1892—the four hundredth anniversary of the discovery of America by Columbus—there shall be an exposition, presenting a complete illustration of the New World at that date, and of its progress in the arts and industries in the 400 years intervening. Prof. Baird points out that the collections of the National Museum for the most part tend towards such a display, and expresses his belief that if the new building for which he asks were erected it would be a very easy matter to organise and arrange it with this object in view, without unnecessary labour or great expense, and by the date mentioned, as the result of the current work of the Museum, without any spasmodic or unusual effort.

Of the Bureau of Ethnology we need only say that, during the fiscal year 1885 86, it continued its ethnologic researches among the North American Indians. Enthusiastic investigators carried on mound-explorations, explorations in ancient and modern stone villages, and general field studies. Much good office work was also done. This was, as usual, to a large extent the supplement to, and discussion of, the results obtained by exploration, and was executed by the same officers who had previously sought for materials and information in the field.

We have not space for further details, but probably we have said enough (as far as possible in the words of the Report itself) to indicate the very flourishing condition of the Smithsonian Institution and the establishments associated with it. The Institution is one of which Americans have good reason to be proud, and we cannot doubt that the claim for a new building, advanced by Prof. Baird on behalf of the National Museum, will be promptly and very carefully considered by Congress.

NOTES

PROF. BÉCLARD, Dean of the Medical School of Paris, died a few days ago of pneumonia. He was buried with great ceremony on the 12th inst. A large number of professors and students attended the funeral. His best work is on the thermic phenomena accompanying muscular contraction. He was a pleasant man, of fluent and happy eloquence, and a good writer. His place will probably be filled by Ch. Richet, the editor of the *Revue Scientifique*.

THE Academy of Vienna intends to have a special meeting for the celebration of the centenary of the death of Father Boscovich, the astronomer. A similar ceremony will take place at Ragusa, his native place.

WE have received a proof copy of the annual address to the Asiatic Society, Calcutta, delivered by Mr. E. T. Atkinson, the President, on the 2nd inst. It is an able and very interesting survey of the work done by the Society in the past year, and of the progress made outside the Society in the subjects to which the attention of its members is directed.

THE sixth annual meeting of the Sanitary Assurance Association was held at the offices, 5 Argyll Place, W., on Monday last. Mr. Joseph Hadley, Secretary, read the annual Report, from which it appeared that the business of the Association during 1886 was much greater than in any previous year. The Report said that, of all the properties inspected, in only two cases of first inspection had the arrangements been such that the Council could certify the sanitary condition of the property without alteration. The Executive Council reported having held several meetings for the purpose of revising the Sanitary Registration of Buildings Bill of 1886, and a new Bill had been prepared for presentation to the House of Commons. In the new Bill, the principle of compulsory registration would be restricted to schools, colleges, hospitals, asylums, hotels, and lodging-houses. On the motion of Mr. Mark H. Judge, seconded by Mr. H. Rutherfurd, the following resolution was unanimously passed:—"That, as soon as the Sanitary Registration of Buildings Bill, 1887, is in the hands of members of the House of Commons, the President of the Local Government Board be asked to receive a deputation in support of the Bill."

ON Tuesday last the forty-first session of the General Medical Council was opened, and an address was delivered, as usual on such occasions, by the President, Dr. Acland, F.R.S. Starting with a reference to the Jubilee, he traced some of the changes which have taken place during the last fifty years in medicine and in the methods of medical education.

LORD RAYLEIGH will begin a course of six lectures on "Sound" on Saturday, February 26, at the Royal Institution.

IN the latest of his annual reports, President Eliot, of Harvard University, refers to the present position of science in the secondary schools of America. "A serious difficulty," he says, "in the way of getting science well taught in secondary schools has been the lack of teachers who knew anything of inductive reasoning and experimental methods. This he attributes in part to the fact that "good school methods of teaching the sciences have not yet been elaborated and demonstrated," and he urges that "it is the first duty of University departments of science to remove at least this obstacle to the introduction of science into schools."

WE have received the third part of the first volume of "The Proceedings of the Linnean Society of New South Wales," second series. It contains the papers read at the meetings held in July, August, and September 1886, and there are four plates. Among the contents are the fifth part of a "Catalogue of the described Coleoptera of Australia," by Mr. George Masters, an elaborate paper on the "Revision of Australian Lepidoptera," by Mr. E. Meyrick, and "Miscellanea Entomologica: No II. The Genus Liparetrus," by Mr. William Macleay.

IN the United States there is a very much larger number of female than of male teachers. According to the *Woman's Journal*, men are hardly ever employed in elementary schools in cities, save as principals or as teachers of some special branch. In the ten cities of Baltimore, Boston, Brooklyn, Chicago, Cincinnati, New Orleans, New York, Philadelphia, San Francisco, and St. Louis together, there are 12,719 public-school teachers, of whom 11,540 are women. The average percentage of male teachers in these cities is 9.

DR. M. TREUB, Director of the Botanical Gardens in Buitenzorg (Java), will be on furlough in Holland from the beginning of March till the end of November. In Dr. Treub's absence Dr. W. Burck will serve as Acting Director of the Gardens. Only the correspondence about the *Annales du Jardin Botanique de Buitenzorg*, together with private correspondence, is to be addressed to Dr. Treub himself (Voorschoten, near Leyden, Holland).

A FRENCH translation has just been issued of Preyer's "Physiology of the Embryo." This book is a valuable one, dealing with a very obscure subject, and also one of great interest to the physician as well as to the psychologist and physiologist. All the functions of the adult being are in turn considered in the embryo, the differences and similitudes being well pointed out. M. Preyer understands the value of a good method.

MM. CHARCOT AND RICHER have issued an interesting book on "Les Démoniaques dans l'Art," that is, on hysteria studied in art manifestations of the past. The book contains quite a number of pictures after the old masters, which show that all the convulsions and attributes due to hysteria had been noticed and accurately pictured, although the manifestations were ascribed to diabolical influence. The scenes figured in this book relate especially to exorcising and similar feats, and very well illustrate the power of observation of many of the old painters.

A NEW medical paper is to be published shortly in Paris, under Prof. Grancher's direction, at a very low price, containing much matter and appearing twice a week. It will be called the *Univers Médical*, and the editor intends to devote a much larger part to foreign news than is usually given in French papers.

M. DUCLAUX, Professor in the Faculty of Sciences, issued on February 12 the first number of a new scientific periodical, the *Annales de l'Institut Pasteur*, of which he is editor, with a Committee comprising Messrs. Chamberland, Grancher, Nocard, Roux, and Straus. This periodical is to be published monthly, and will contain papers on bacteriology, physiologically and clinically considered. The first number contains a letter from Pasteur, giving very encouraging and positive facts concerning the efficacy of preventive inoculations, obtained in his own laboratory and in those of Russia and Italy.

HERR W. ENGELMANN, of Leipzig, has issued the first number of a monthly scientific periodical called *Zeitschrift für physikalische Chemie*. The editors are Profs. W. Ostwald, of Riga, and J. H. van't Hoff, of Amsterdam.

ACCORDING to the *American Meteorological Journal*, an attempt is about to be made at St. Augustine, Flo., to sink a 12-inch artesian well to a depth sufficient to obtain water hot enough to heat buildings, pure enough for domestic purposes, and with pressure enough to run heavy machinery. Water can be found in Florida by boring 250 feet; and it is known that the artesian wells in that State have considerable pressure, and from a depth of 600 feet send water of warm temperature to a height of 45 feet when piped. The earth's internal heat is already forced into practical service at Pesth, where the deepest artesian well in the world is being sunk to supply hot water for public baths and other purposes. This well supplies daily 176,000 gallons of water heated to 158° F., and the boring is to be continued until the temperature of the water is raised to 176°. Heavy machinery is run by artesian well power in many parts of France, and the experience of the French shows that the deeper the well the greater the pressure and the higher the temperature. At Grenelle, a well sunk to the depth of 1802 feet, and flowing daily 500,000 gallons, has a pressure of 60 lbs. to the square inch, and the water from this well is so hot that it is used for heating the hospitals in the vicinity.

THERE is now ample evidence that the use of oil may be of considerable service in lessening the effect of dangerous seas. In one case the "slick" made by the oil extended 30 feet to windward, and the U.S. Hydrographic Office concludes that the oil is of use when the vessel is reaching ahead at the speed of eight or nine knots, with a beam wind and sea.

HERR SCHILLER, a well-known German architect, reports some facts which are of interest as indicating the radius of the circle of protection of good lightning-rods. On June 17 last, at the village of Mottingen, lightning struck a pear-tree 33 feet high. On one side, 115 feet away, was a school-house, with a rod 56 feet high. On the other side was a church, 328 feet away, and having a lightning-rod reaching up 154 feet. Both rods are well placed, and had worked well when tested, and the level of the foot of the tree is about the same as that of the two buildings. It is evident, then, if the facts have been accurately reported, that the radius of the circle of protection is not more than twice the height of the rod.

ANOTHER earthquake is reported from Aquila. On the night of February 3, three shocks were felt, two of which were accompanied by strong undulatory motion.

EARTHQUAKES are also reported from the Vilayet Konia, in Asia Minor. On January 8, a subsidence of the ground was noticed at Holan Gola (Feneke district), accompanied with loud subterranean noises; many landslips took place in the adjacent hills. The shocks continued for six days, and the inhabitants of Feneke and the neighbouring villages took refuge in the fields. The earthquakes have destroyed seven villages.

ON January 15 the Hawaiian volcano Mauna Loa began to discharge. Frequent shocks of earthquake were felt. A letter written on January 19 says:—"There have been thirty-six hours' continuous earthquakes. The lava flows down the south slope, and if its course be unchanged it will flow into the sea without doing much damage."

THE Russian traveller M. Ogorodnikoff was told at Meshed that there are tin mines near that city and in various parts of Khorassan. In an article in the *Revue Scientifique* M. Berthelot points out that this accords with a passage in Strabo, who speaks (book xv. ch. ii. 10) of tin mines in Drangiana, the ancient name for the region now called Southern Khorassan. If there really have been tin mines in this district from time immemorial, there can be little doubt that they supplied the tin for the bronzes of ancient Egypt and Assyria.

THE first zoological station in the tropics has been founded by Dr. Sluiter, at Batavia. This gentleman is already well known by his works on the fauna of the Sunda Islands. The Natural History Society of the Dutch Indies has presented Dr. Sluiter with sufficient means to establish three work-tables with the necessary apparatus, and to purchase a sailing-boat.

MR. ABBOTT KINNEY writes to the Los Angeles *Weekly Tribune* that the floods in Southern California are becoming every year more violent and destructive. The testimony on this point, he says, is uniform, complete, and unimpeachable. The streams now nearly all bring down more sand, gravel, and boulders, rise more rapidly, cut away more land, and dry up more quickly than formerly. Valuable valley lands are thus cut away or covered up, and in some cases the streams have spread out and deposited great fan-shaped mounds of sand and boulders. Mr. Kinney attributes the change chiefly to the destruction of forests. The brush and forests on the hills and mountains have been to a large extent swept away, and the result is that there is nothing to hold the water back. The rains do not penetrate into the soil and rocks which supply the springs, but rush suddenly off the mountains as from a roof, carrying the soil first, and then the gravel and boulders with them. The springs, deprived of their supply, diminish. The principal agent in the destruction of the natural verdure and protection of the mountains has been fire. Fires accidentally lighted, fires made by stock-men, bee-men, and fools, are, according to Mr. Kinney, producing effects that must eventually make Southern California a desert.

It is proposed that a school of hygiene shall be established at the University of Michigan, and the State Legislature is about to be asked to authorise the necessary expenditure. The scheme was suggested by the State Board of Health. The school would include in its curriculum climatological studies, air analyses and ventilation.

Last week there was a Convention of Photographers in the Hall of the Society of Arts, and the attendance was good and representative. The proceedings in the morning were opened by a few remarks from Capt. Abney, the President, who, in the afternoon, delivered a more elaborate address, projecting on for ⁻een a succession of diagrams and pictures illustrative of his by hints. At a dinner in the evening the toast of the Camera opin⁻was proposed by Mr. V. Blanchard, who, in recalling the ⁻ when he made his first practical acquaintance with photo-⁻y by watching a friend develop a paper negative, expressed the opinion that photographers might perhaps return to the use of paper negatives.

Prof. Liversidge, of the University of Sydney, who is about to return to England on leave of absence, has been requested by the Minister of Public Instruction of New South Wales to inquire into and report upon the mode of teaching natural science in the elementary schools of Great Britain and Ireland.

New South Wales will be represented at the Conference of Astronomers to be held in Paris in April next, by Mr. H. C. Russell, the Government Astronomer.

A valuable "Report on the Medusæ collected by the U.S. Fish Commission Steamer *Albatross*, in the Region of the Gulf Stream in 1883-84," by Mr. J. Walter Fewkes, has lately been reprinted, at the Government Printing Office, Washington, from the Annual Report of the Commissioner of Fish and Fisheries for 1884. Mr. Fewkes is not sure that certain of the Medusæ recorded by the *Challenger* from great depths do not also live and flourish at or near the surface. There is need, he thinks, for greater accuracy in the determination of the exact depth from which a deep-sea Medusa is taken, and for an improvement of the apparatus used in this kind of collecting. In the case of fixed hydroids, or such Medusæ as *Cassiopeia* and others, which live upon the bottom, the determination of the depth at which they live is an easy task. With such genera as *Atolla*, *Rhizophysa*, and others, this determination is more difficult. Mr. Fewkes points out that it is of great importance, from a morphological stand-point, that the question whether Medusæ are confined to certain depths, should be definitely answered. "I can at present," he says, "imagine no place on the globe where the uniformity of conditions under which Medusæ are placed can be the same as at great depths of the ocean. I do not mean necessarily on the floor of the ocean, since that may be raised or depressed, and the varieties of conditions which come from such motions may result, but in the depth of the sea, separated from the surface by a wall of water of great depth, and from the ocean-bed by a similar wall of equal amount. Here, if anywhere, may we look for the continuance of ancestral features unmodified by environment. On this account the determination of the bathymetrical limits of free Medusæ, no less than that of those animals which inhabit the bottom, is a most important thing, and from it should be eliminated all possibility of error."

Dr. Otto Hermes has just published the results of some interesting investigations concerning the phosphorescence of marine fish. He wished to ascertain whether the phosphorescence was caused by the same Bacillus which Dr. Fischer, an eminent authority on Bacteria, has discovered and brought from the West Indies. Marine fish are easily rendered phosphorescent after death by being moistened with a little sea-water. Dr. Hermes took a fragment of a specimen of *Gadus callarias*, which had been made strongly phosphorescent in this manner, to the laboratory of Councillor Koch; and Dr. Frank, a pupil of the latter, was enabled to isolate it after a few days. This is undoubtedly a new species. Like Dr. Fischer's Bacillus, it can be transferred upon sterilised fish, and after forty-eight hours it emits an emerald-green light; the sea-water is also rendered phosphorescent. A point of difference is that the Bacillus of Dr. Fischer develops best in a high temperature (20°-22°), while that of Dr. Hermes develops better in a low one. Examined microscopically, the latter is much smaller than the former. Dr. Hermes has given it the name of *Bacterium phosphorescens*.

The German Fishery Association lately asked the German Chamber of Commerce to put a premium on seals, it being maintained that these animals are most destructive to the fisheries. The petition was refused. The Association, in support of its views, stated that a full-grown seal requires 10 lbs. of fish a day for its food, making 3650 lbs. in a year. At the same rate, 1000 seals would consume the enormous quantity of 3,650,000 lbs. a year. As the seal is a faithful attendant upon herring-shoals, it causes enormous havoc among a species of fish which is one of the greatest sources of revenue to the fishermen on the North German coast. It is maintained that these depredations have greatly decreased the quantity of fish in recent years. Complaints of the serious destruction of fish by seals have also lately been made by Swedish fishermen in the Baltic.

The additions to the Zoological Society's Gardens during the past week include a Green Monkey (*Cercopithecus callitrichus* δ) from West Africa, presented by Mr. Charles W. Demprey; a Bonnet Monkey (*Macacus sinicus* δ) from India, presented by Mr. G. S. Copeland; a Common Otter (*Lutra vulgaris*), British, presented by Mr. John Hall; two Rufous Tinamous (*Rhynchotus rufescens*) from Brazil, presented by Mr. Francis Monckton; two White-throated Finches (*Spermophila albogularis* δ ♀) from Brazil, deposited; a Collared Fruit Bat (*Cynonycteris collaris*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

A Method for the Determination of the Constant of Aberration.—Referring to M. Lœwy's plan for the determination of the constant of aberration by measuring the relative positions of stars situated in distant parts of the sky at successive epochs by means of a double mirror placed in front of the object-glass of an equatorial (Nature, vol. xxxv. p. 282), M. Houzeau points out (*Comptes rendus*, tome civ. No. 5) that the same idea occurred to him some years ago, and that the fundamental principle of the method, and an enumeration of the advantages attending its application, were published by him in 1871, in a paper entitled "Considérations sur l'Etude des petits Mouvements des Etoiles," which appeared in tome xxxviii. of the Mémoires de l'Académie de Belgique. It appears, therefore, that M. Lœwy's method cannot, strictly speaking, be considered a new one, though we believe it has never been put into actual practice—a work which we hope to see before long accomplished at the Paris Observatory.

The Application of Photography to the Determination of Stellar Parallax.—In the *Monthly Notices* for January 1887, Prof. Pritchard publishes the results of his measurements of the photographs of 61 Cygni and neighbouring stars, taken on fifty nights ending December 7, 1886, with a view to the determination of the parallax of this well-known star. Using measures of distance only, the relative parallaxes of each of the components, referred to each of four comparison-stars, are:—

Star	Parallax of 61¹ Cygni	Probable error	Parallax of 61² Cygni	Probable error
	"	"	"	"
a ...	0·4412	... 0·0154	... 0·4204	... 0·0229
b ...	·4529	... ·0330	... ·4139	... ·0185
c ...	·4433	... ·0197	... ·4721	... ·0215
d ...	·4158	... ·0161	... ·4574	... ·0252

The means for the parallaxes thus obtained for the four independent sets of measures of 61¹ and 61² Cygni respectively are as follows :—

For 61¹ Cygni, 0″·438 ; for 61² Cygni, 0″·441.

Prof. Pritchard explains that this determination is to be regarded as provisional only, and that the work will be continued to the end of the annual cycle. The method certainly appears to be a most promising one, and the publication of the full details of the Oxford researches will be awaited with interest.

Observations of Variable Stars in 1885.—No. 151 of Gould's *Astronomical Journal* contains Mr. Edward Sawyer's observations of variable stars made in 1885. The following epochs of maximum brightness were observed :—R Andromedæ, 1885 January 10 ; R Leonis, about 1884 December 24 ; R Leo. Min., 1885 June 26 ; R Bootis, 1885 May 16 ; R Ursæ Majoris, July 1 ; S Ursæ Majoris, May 7 ; U Herculis, July 8 ; g Herculis, June 4, August 2 (?), October 16 ; S Coronæ, May 11 ; χ Cygni, 1885, January 10 ; R Scuti, 1885 June 17, August 10 (?), and November 16 ; Mira Ceti, February 10 ; R Aquarii, January 4. β Pegasi and α Cassiopeiæ appeared constant, and ρ Persei nearly so, during the observations. R Coronæ was well observed, and showed numerous but slight fluctuations of light. An unusually bright phase, 6·2 m., occurred on August 15, followed by a rather faint minimum, 7·4 m., on October 13. T Monocerotis was well observed : last minimum, April 20, 15h. 26m. Camb. M.T. ; last maximum, April 27, 15h. 55m. U Monocerotis was observed at minimum on April 1, and at maximum on April 14. W Cygni was observed at maximum on August 20 and December 16, giving a period of 118 ± days, and at minimum on October 30.

The Alleged Ancient Red Colour of Sirius.—Mr. Lynn, in the current number of the *Observatory*, shows that the evidence for this star having formerly been of a red colour is much less strong than has frequently been supposed. Prof. Schjellerup had pointed out in his notes on his translation of Sûfi, that the designation ὑπόπυρρος applied to the star in our editions of Ptolemy was probably an error of transcription for σείριος ; whilst it had been suggested long ago that, for the word "rubor" which we find used in reference to it by Seneca, we should really read "fulgor." It certainly has always seemed improbable that a star of such vast dimensions as Sirius must be should have so entirely changed its colour in less than 2000 years.

Bright Lines in Stellar Spectra.—Mr. O. T. Sherman, in No. 149 of Gould's *Astronomical Journal*, brings together various observations of the bright lines which have been observed by Vogel or Copeland in the spectra of β Lyræ, γ Argûs, R Geminorum, and some smaller stars, and compares them with Hasselberg's observations of the low-temperature spectrum of hydrogen and the high-temperature spectrum of oxygen, and draws the inference that the stellar bright lines belong to these spectra. The inference seems scarcely warranted, however, for, on the one hand, the lines in the spectrum of hydrogen are so numerous that, wherever the star-lines lay, it would be easy to find lines near them, so that the accord would have to be very close for any such deduction to be safely based upon it ; and, on the other, the observations of the lines in the stellar spectra are less accurate than Mr. Sherman seems to think. The slight differences in the recorded positions of the bright lines as given by different stars are probably indications simply of a roughness in the readings, and the lines are most likely the same in general in the different spectra. The following may be taken as rough mean positions for the bright lines in these interesting spectra : 600 mm., 581, 568, 540, 466, together with the F line of hydrogen, and, in some cases, D_3 and the third line of hydrogen at 434, assuming that the lines are the same in the various spectra of the type. The close correspondence of the bright lines in R Geminorum to those observed by Cornu in Nova Cygni, 1876, indicates that we probably have there the coronal line 1474 K, the principal chromospheric lines, and the typical nebular line at about 500.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1887 FEBRUARY 20-26

(For the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on February 20

Sun rises, 7h. 6m. ; souths, 12h. 13m. 56·7s. ; sets, 17h. 21m. ; decl. on meridian, 10° 55′ S. ; Sidereal Time at Sunset, 3h. 22m.

Moon (New on February 22) rises, 5h. 52m. ; souths, 10h. 25m. ; sets, 15h. 2m. ; decl. on meridian, 17° 6′ S.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury ...	7 33 ...	12 58 ...	18 23 ...	7 34 S.
Venus	7 49 ...	13 27 ...	19 5 ...	4 59 S.
Mars	7 38 ...	13 9 ...	18 40 ...	6 23 S.
Jupiter... ...	23 16* ...	4 17 ...	9 18 ...	12 11 S.
Saturn... ...	12 59 ...	21 8 ...	5 17* ...	22 23 N.

* Indicates that the rising is that of the preceding evening and the setting that of the following morning.

Feb.	h.	
20 ...	2 ...	Jupiter stationary.
22 ...	— ...	Annular eclipse of the Sun ; visible only in parts of South America, Australia, and the South Pacific Ocean.
24 ...	17 ..	Venus in conjunction with and 1° 17′ north of the Moon.

Variable Stars

Star	R.A. h. m.	Decl. ° ′		h. m.	
U Cephei	0 52·3 ...	81 16 N. ...	Feb. 20,	20 38	*m*
			,, 25,	20 17	*m*
Algol	3 0·8 ...	40 31 N. ...	,, 25,	6 5	*m*
W Virginis	13 20·2 ...	2 48 S. ...	,, 22,	23 0	*M*
δ Libræ	14 54·9 ...	8 4 S. ...	,, 24,	0 31	*m*
U Coronæ	15 13·6 ...	32 4 N. ...	,, 20,	23 19	*m*
S Libræ	15 14·9 ...	19 59 S. ...	,, 21,		*m*
U Ophiuchi... ...	17 10·8 ...	1 20 N. ...	,, 20,	3 27	
			and at intervals of 20		
β Lyræ...	18 45·9 ...	33 14 N. ...	Feb. 24,	4	
W Cygni	21 31·8 ...	44 52 N. ...	,, 24,		
T Pegasi	22 3·4 ...	11 59 N. ...	,, 20,		
δ Cephei	22 25·0 ...	57 50 N. ...	,, 23,	21 0	*m*

M signifies maximum ; *m* minimum.

Meteor-Showers

February 23–25, near β Trianguli, R.A. 30°, Decl. 35° N
Also from Monoceros, R.A. 120°, Decl. 5° S.

GEOGRAPHICAL NOTES

It would seem that Dr. Oscar Lenz is only to leave Zanzibar this week. The *Times* Vienna Correspondent is mistaken in thinking that the Royal Geographical Society expects Dr. Lenz to come direct to London. He must, of course, first render his account to the Vienna Society, which sent him out ; but after that, it is hoped, he will come to London and tell his story. It is possible that before leaving Zanzibar he may have an opportunity of giving Mr. Stanley the benefit of his experience. Mr. Joseph Thomson, in a letter to the *Times*, endeavours to show that Mr. Stanley is taking a too rosy view of the prospects of his expedition. Mr. Thomson naturally insists on the superiority of the Masai Land route over all others. Certainly Mr. Stanley exaggerated the difficulties of this route, and we are inclined to believe that, had it been selected, the expedition might have reached Emin Pasha sooner than by the Congo. It should be remembered that, even if all the vessels on the Middle and Upper Congo are available, they could not possibly convey a thousand people in one journey—a good authority assures us that there must be at least three journeys ; so that, unless Mr. Stanley starts on his land journey with only one-third of his caravan, instead of 35 days after leaving Stanley Pool it will take 100 days to reach the mouth of the Aruwimi. At the same time we must believe that Mr. Stanley knows what he is about, and is not likely to lay himself open to the reproach of being so far out in his calculations.

In the official report, just issued, on the administration of Lower Burmah during 1885-86, and Upper Burmah during 1886, there are some interesting passages relating to the resources of the new British province. Agricultural products, such as rice, wheat, maize, and other cereals, are grown in large quantities. The country is believed to be rich in mineral resources, and the subject is at present under the examination of the Geological Survey. Meanwhile it is known that the country to the north-east of Mandalay is the richest, if not the only, ruby-

producing tract yet discovered. As to gold and silver, nothing trustworthy is known. Jade and amber are found in parts. But the most valuable of the Upper Baraah minerals is likely to be coal, of which there are certainly four fields, one of which has already yielded excellent fuel.

DR. HOLUB, whose murder to the north of the Zambesi is doubtfully announced, may be remembered as the author of "Seven Years in South Africa," published about six years ago. He set out some three years ago to march from the Cape to Cairo, partly for purposes of exploration, and partly to open up markets in Central Africa for Austrian commerce. He does not seem to have made much speed.

PROF. MIGUEL MARAZTA has made what seems a curious anthropological discovery in the valley of Rebas (Gerona) at the [illegible]e Eastern Pyrenees. There exists in this district a [illegible]what numerous group of people, who are called *Nanos* ([illegible]s) by the other inhabitants, and as a matter of fact are not more than four feet in height (1'10 to 1'15 metres). Their bodies are fairly well built, hands and feet small, shoulders and hips broad, making them appear more robust than they really are. Their features are so peculiar that there is no mistaking them among others. All have red hair; the face is as broad as long, with high cheek-bones, strongly developed jaws, and flat nose. The eyes are not horizontal but somewhat oblique, like those of Tartars and Chinese. A few straggling weak hairs are found in place of beard. The skin is pale and flabby. Men and women are so much alike that the sex can only be told from the clothing. Though the mouth is large, the lips do not quite cover the large projecting incisors. The *Nanos*, who are the butt of the other inhabitants, live entirely by themselves in Rebas. They intermarry only among themselves, so that their peculiarities continue to be reproduced. Entirely without education, and without any chance of improving their condition, they lead the life of pariahs. They know their own names, but rarely remember those of their parents, can hardly tell where they live, and have no idea of numbers.

JOHN HUNTER

THE Hunterian Oration was delivered on Monday afternoon in the theatre of the Royal College of Surgeons by the President, Mr. Savory, F.R.S., Senior Surgeon to St. Bartholomew's Hospital. After a few introductory remarks, Mr. Savory proceeded to say that surgeons with one voice have proclaimed the supremacy of Hunter above all who have ever studied surgery. Students of science have acknowledged him to be among the chief of those who have in any age advanced human knowledge. He was, and is, beyond and above all surgeons, a philosopher in surgery. His idea of the subject of his thoughts was far more adequate than that of other men. He was supreme in the scope and method of his work. He understood much better than those around him how to engage in the interpretation of Nature; he knew best how to approach and to disclose truth. For he not only understood that the problems which lay immediately before him were, of all, the most complex and difficult to solve, but he could see also that they were not isolated but dependent ones. He saw in the necessary relation in which they stood to others the only means by which they could be worked out; and on this understanding he resolved to investigate the questions he desired to answer. Mr. Savory next spoke of the passion of Hunter for collecting. His museum included, he said, not only—to use the words of Professor Flower—"illustrations of life in all its aspects, in health and in disease; specimens of botany, zoology, palæontology, anatomy, physiology, and every branch of pathology; preparations made according to all the methods then known; stuffed birds, mammals, and reptiles, fossils, dried shells, corals, insects, and plants; bones and articulated skeletons; injected dried and varnished vascular preparations; dried preparations of hollow viscera, mercurial injections, dried and in spirit; vermilion injections; dissected preparations in spirit of both vegetable and animal structures, natural and morbid; undissected animals in spirit, showing external form or awaiting leisure for examination; calculi and various animal concretions; even a collection of microscopic objects, prepared by one of the earliest English histologists, W. Hewson; but it extended to minerals, coins, pictures, ancient coats of mail, weapons of various dates and nations, and other so called 'articles of *virtu*.'" Hunter's labours in surgery were next referred to. He was ever searching for principles, but strove to reach them only through facts. Facts always first, but never facts only; from facts to principles. He understood that all progress mainly depends on the power of grouping and uniting for some new purpose facts that have been discovered independently and that are daily being revealed, yet with little or no reference to the principles they are found to support. He saw that surgery, in his time, was but a rude, empirical art, consisting of little else than a knowledge of many facts which stood in no visible relation to each other, and of many more opinions which, for the most part, had no relation, or but a very distant one, to any facts whatever. He held that surgery should be raised from a collection of such creeds to the rank of a science, but this could be only by founding its practice upon some principles. The discovery of some, at least, of these principles was Hunter's final aim. But those principles could not be reached by guessing. They could be approached only through the orderly investigation of facts. But then an explanation of these facts themselves could be only through the truths of physiology. The signs of disease could be understood only by him who had studied the laws of life and health. An intelligent interpretation of the one could be only in proportion to a previous knowledge of the other. But the problems of life, of health, are presented to us in man in their most complex form—in a form so difficult that even Hunter could not solve it. They must be reduced to simpler terms through a study of the lower forms of life. Thus, with the ultimate aim of relieving human suffering, Hunter studied the phenomena of motion in plants. Nay, he went further, to crystals and other forms of inorganic matter; and he says: "The better to understand animal matter, it is necessary to understand the properties of common matter, in order to see how far these properties are introduced into the vegetable and animal operations." The singleness of purpose with which Hunter worked is made evident, Mr. Savory continued, not only in the actual result of his labours, for no human being with divided interests could rival such achievements, but in the record, as we have it, of the life he led. He gave not only the whole of his time—yes, the whole of it in no mere conventional sense—and all his great powers, his mind and body alike, to the one object of his life; but to this he sacrificed all that he possessed, all that he could gain. To this he devoted, without stint or scruple, his money, his friendships, all his other interests. What any other man would have considered impossible, he made practicable. And this to no personal end. He was careless of all rewards save that which was to him paramount, the discovery of truth. A noteworthy point in the character of Hunter appears to be found in the relation which, in him, thought bore to action. He combined in himself in a singular degree the power of conception and of execution. He not only saw much further, but he was able to do much more than most others. He saw as Bacon saw—and the idea was probably as original with him as with Bacon—that the systematic and thorough examination of facts was the first thing to be done in science, "and that, till this had been done faithfully and impartially, with all the appliances and all the safeguards that experience and forethought could suggest, all generalisations, all anticipations from mere reasoning, must be adjourned and postponed; and further, that, sought on these conditions, knowledge, certain and fruitful, beyond all that man then imagined, could be obtained." But he went immeasurably further than the great prophet of science in putting his conceptions to the proof in imperishable work on the lines he had laid down. "I only sound the clarion," said Bacon, proudly, "but I enter not into the battle." Hunter sounded a clarion the echoes of which are reverberating still, but he entered into the battle also, and was always found where the blows fell thickest, and we are in possession of the spoils. In his museum there is, at once, the clearest evidence of the idea and the richest fruits of execution. In speaking of Hunter's general education, Mr. Savory proceeded to say that if Hunter had received a good general education in early years he would have been all the better for it. He would have lost nothing. His mental powers could have been in no way impaired; on the contrary, enhanced. He would have recorded the results of his labours in better order, with more light and greater effect, and we should have had the advantage of a clearer revelation of his thoughts. But all this is very far from saying that Hunter was not, in the strictest sense, an educated man. He was not, indeed, a scholar. If the subtle rendering of a Greek poet, or the skilful turning of a Latin verse be the sole test of culture, he gave no sign of it. Of ancient lore he was sadly destitute. In *Literis Humanioribus* he could have

had no place. But if a transcendent knowledge of Nature and her ways, if a firm and ample grasp of her noblest truths, be accounted education, if the devotion through a lifetime of gigantic intellectual powers and of a truly loving heart to the reverent study of God's works be culture, then Hunter, though not a man of letters, was surely a highly educated man. The fame of Hunter, after all, falls far short of him. It may, without exaggeration, be said that he is really greater than to most men, even to most surgeons, he appears to be. It is only after a review of the whole of his vast labours, in their mutual relation, not merely after a study of the merits of his numerous papers, each taken by itself, but in an attempt to apprehend the scheme to which all his labours were subservient, that we are in any measure able to realise the strength of Hunter's genius. Then, as the chief merit of his work is not of a character to catch at once the eye, even of one who searches for it, so his subject is not one of widespread or popular interest. Of all men who have achieved greatness, Hunter requires to be studied with most diligence, the more so because of the absence of all literary skill. And there can be no doubt that he shared the fate of all those who have been, like him, in advance of their time. He was so far beyond his contemporaries as to be, for the most part, out of their reach, and therefore they left him alone; and even his successors have not always found him out. It may, indeed, be said to have been almost by an accident that, in association with the possession of his museum, we have periodically a festival in honour of his memory. Such, then, at least in the eyes of one who, though from afar, has long and earnestly looked up to him, was John Hunter. Beyond all cavil, if the word have any meaning for us, he was a man of genius—a man supremely endowed with power and faculties for the discovery of truth. With little education at the outset of life, without the advantage of the schools, he found himself face to face with the deepest and most mysterious problems of Nature, and he was forthwith able to take full measure of the magnitude of the task. It seems never to have occurred to him that he could snatch an answer by surprise; that a solution could be reached by any short or sudden means. But his survey assured him that upon one plan only, but by that abundantly, could success be made certain. So with patience, which of itself has been called genius, he went back to the beginning. It was genius too, and that of the highest order, to discern, at so vast a distance, where the beginning lay. But there he placed himself, and from that point went forward only when he had made each footstep sure. Who shall say that his imagination was not fertile, or that he faltered in the use of it? Yet no seductive theory tempted him into undue haste, and though sometimes drawn aside by a specious speculation, he seems hardly ever to have been lost in an unsound conclusion. And when he fell, the treasures he had won were found not only in the multitude of facts he had garnered, or even in the principles which, by virtue of the facts he had discovered, were made plain, but also in the very plan and purpose of his work. For, from the height on which at length he stood, not only can the path he trod be clearly traced, but the highway thenceforward is disclosed. So is the greatness of John Hunter to be estimated, not only by what he discovered, but rather by the lesson and example of his work. Truly it may be said of him that he did much. Truly it may be said of him that he showed how much more there is to be done. "He being dead yet speaketh," still speaks to us as no other man before or since has spoken. But when and where can his voice be heard most plainly? Are the spirits of those who have shaken off "this muddy vesture of decay" permitted to revisit the scenes of their earthly labours? Can they still be with us on our way? If the soul of this mighty son of science is ever in our midst, surely his favourite haunt must be now within these walls—in the museum which will soon almost surround us, at once his most graphic and glorious monument. The memory of Hunter, like the memory of the greatest men of every age, is imperishably enshrined. Art, in her noblest efforts, has striven to make his form familiar to us. His name is stamped in indelible characters on the records of human progress. But, before all, he lives in, and draws the breath of life from, his own immortal works. And of these none can be so truly a memorial of the very man as this; no other can so resemble him, can possess so much of him, can tell so fully of what he was; can so perpetuate him in the vast store of facts, in the purpose for which they are set forth, in the illustration of principles, in the suggestion of truths beyond those it can show, above those it can reach—in all this, I say, no memorial, however majestic, can rival our museum. The foundation of this with his own hand and his whole heart he laid; it has grown, and still is growing, from his strength, and it must be made for ever worthy of his name.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

OXFORD.—The following new Examiners have been appointed in the Natural Science School: Mr. V. H. Veley (Chemistry), Dr. W. H. Gaskell and Prof. Ray Lankester (Biology), Mr. J. V. Jones (Physics). Mr. W. W. Fisher and the Rev. F. J. Smith are to be Examiners in the Pass Schools.

The Sibthorpian Professorship of Rural Economy [redacted] vacant, and canditates for it are requested to send in their applications to the Registrar of the University before March 10.

The Board of the Faculty of Medicine has issued a list of subjects to be offered in the first examination for the B.M. degree under the new medical statutes.

Scholarships in Natural Science are announced for competition at Merton, Corpus, and Queen's, and at New College.

SCIENTIFIC SERIALS

American Journal of Science, January.—The Muir glacier, by G. Frederick Wright. The paper contains an exhaustive study of this interesting glacier, which lies in the Alpine region of Alaska at the head of Muir Inlet, Glacier Bay, in 58° 50′ N. lat., 136°40′ W. long. It forms a frozen stream some 5000 feet wide by 700 deep, entering the inlet at a mean rate of 40 feet, or 140,000,000 cubic feet, per day, during the month of August. The vertical front at the water's edge is from 250 to 300 feet, and from this front icebergs are continually breaking away, some many hundred feet long, with a volume of 40,000,000 cubic feet. The glacier appears to be rapidly retreating, there being indications that even since the beginning of this century it has receded several miles up the inlet, and fallen 1000 or 1500 feet below its former level.—On the age of the coal found in the region traversed by the Rio Grande del Norte, by C. A. White. The carboniferous beds occurring at various points in this region vary greatly in quality, but none of them appear to be earlier than late Cretaceous age.—The viscosity of steel and its relations to temper (continued), by C. Barus and V. Strouhal. Among the chief results of the authors' further experiments, as here described and tabulated, is the light thrown on the crucial importance of the physical changes which steel undergoes during annealing at high temperatures between 500° and 1000° C. Within these limits occur several nearly coincident phenomena: such as Gore's sudden volume expansion; Tait's sinuously broken thermo-electric resistance; Gore-Baur's sudden disappearance of magnetic quality; the passage of carbon from uncombined to combined; Jean's critical cementation temperature; and the authors' own unique maximum of viscosity.—On the nature and origin of lithophysæ, and the lamination of acid lavas, by Joseph P. Iddings. The data upon which the conclusions here stated are based were obtained from a study of the various forms of structure and crystallisation assumed by acid lavas in cooling, as observed while prosecuting the work of the United States Geological Survey in the Yellowstone National Park under Mr. Arnold Hague. The lithophysæ, composed of prismatic quartz, tridymite, soda-orthoclase, fayalite, and magnetite, appear to be of aqueo-igneous origin, having been produced by the action of the absorbed gases upon the molten glass from which they were liberated during the crystallisation consequent upon cooling. It also seems highly probable that the differences in consistency and in the phases of crystallisation producing the lamination of this rock were directly due to the amount of vapours absorbed in the various layers of the lava and to their mineralising influence.—The latest volcanic eruption in Northern California, and its peculiar lava, by J. S. Diller. The volcanic district here described is that of the so-called "Cinder Cone," near Snag Lake, North California, where the recent character of the eruptive phenomena is most striking as compared with other outbursts in the same region. The lava field, some three square miles in extent, is of basaltic type, but remarkably anomalous in containing numerous grains of quartz, and very high percentages of silica and magnesia with correspondingly low quantities of the oxides of iron.—On the texture of massive rocks, by

George F. Becker. From his researches the author infers that porphyries may form at any depth and no matter how slowly the temperature of the magma may sink, while granular rocks can scarcely ever have been thoroughly fluid or homogeneous, but have often consolidated at pressures extremely moderate compared with those at which it is certain that porphyries would form.—A fifth mass of meteoric iron from Augusta County, Virginia, by George F. Kunz. This specimen, which comes from the same place where was found the largest of the three masses first described by Prof. Mallet, yielded, on analysis: iron 90·293; nickel, 8·848; cobalt, 0·486; phosphorus, 0·243; carbon, 0·177; with traces of copper, tin, sulphur, silica, manganese, chromium, and chlorine.—Note on the origin of comets, by Daniel Kirkwood. It is argued that, although most comets are of interstellar origin, some of short period may have had their rise within the solar system.—The bichromate of soda cell, by Sowerby Lewis Harding. The experiments here described tend to show that this is a most efficient cell, whose effectiveness, as far as its constancy is concerned, might be materially increased by interchanging the positions of the electrodes with their surrounding liquids, after the fashion of the Fuller cell.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, January 13.—"Supplementary Note on the Values of the Napierian Logarithms of 2, 3, 5, 7, and 10, and of the Modulus of Common Logarithms." By Prof. J. C. Adams, F.R.S.

In vol. xxvii. of the Proceedings of the Royal Society, pp. 88-94, the author has given the values of the logarithms referred to, and the value of the modulus, all carried to 260 places of decimals.

The calculations in that paper were carried to several more decimal places, but the application of an equation of condition which supplied the means of testing the accuracy of the whole work, showed that errors had crept into the work which vitiated the results beyond 263 places of decimals.

Through inadvertence, however, the results were printed in the above paper exactly as they were given by the calculations, although several of the later decimals, especially in the value found for the modulus, were known to be wrong.

The author has now succeeded in tracing and correcting the errors which occurred in the former calculations, and the equation of condition which tests the accuracy of the work is now satisfied to 274 places of decimals.

The present paper gives the parts of the several logarithms concerned which immediately follow the first 260 decimal places as already given in the former paper, and likewise the corrected value of the modulus, which is found to be—

M=·43429 44819 03251 82765 11289 18916 60508 22943 97005 80366
65681 14453 78316 58646 49203 87077 47232 24942 33843 17483
18706 10674 47663 03733 64167 92871 58963 90656 92210 64662
81226 58521 27086 56807 03295 93370 86765 83266 88331 16360
77384 90514 28443 48666 76864 65860 85135 56147 21234 87653
43543 43573 17253 85562 21868 25

which is true to 272 or 273 places of decimals.

February 10.—"Contributions to the Metallurgy of Bismuth." By Edward Matthey.

"An Inquiry into the Cause and Extent of a Special Colouration between certain Exposed Lepidopterous Pupæ and the Surfaces which immediately surround them." By Edward B. Poulton.

Linnean Society, February 3.—W. Carruthers, F.R.S., President, in the chair.—Dr. M. C. Grabham and Capt. G. Wingate were elected Fellows of the Society.—Mr. G. Maw exhibited a *Narcissus cyclamineus* grown by him from bulbs sent by Mr. A. W. Tait, of Oporto. The plant in question was known to Parkinson (1640), afterwards was lost of, and rediscovered by Mr. Johnston, near Oporto, in 1885.—Mr. Maw showed a drawing of *Crocus Karducharum*, and another, for comparison, of *C. zonatus*, from the Taurus, to which it is allied.—Brigade-Surgeon J. E. T. Aitchison read a paper on the fauna and flora of the Afghan boundary. The zoological collection obtained comprised, in round numbers, 20 species of mammals, 130 species of birds, 35 species of reptiles, 7 species of fish, and over 100 species of insects. Among these, many were new to science. Of special interest is the mole-like rat, *Ellobius fuscicapillus*, hitherto only known from the type obtained forty years ago at Quetta. In certain places the ground is riddled with the burrows of this and other rodents. The geographical range of the tiger goes east and north to Bala Murghab; that of the cheetah to the valley of the Heri-rud. A pheasant (*Phasianus principalis*) and woodpecker (*Gecinus gerii*) are new. With some exceptions, the birds are chiefly migratory, their arrival in spring following each other in quick succession. The Brahmini duck (*Casarca rutila*), unlike its congeners, nests and remains throughout the year. The most abundant species of birds are, among the genera *Saxicola*, *Lanius*, *Sylvia*, *Motacilla*, and *Emberiza*. An adult fine example of *Naia oxiana* is a museum acquisition, as the species heretofore has only been recognised from young undeveloped specimens. Regarding the insects, 20 are new, though, taken as a whole, the insect fauna resembles that of Arabia and North Africa, rather than that of India proper. The botanical collections amount to 800 species, and probably 10,000 specimens of plants. Over 100 are new to science. The author gave some account of the physical features of the districts traversed, and of the climate. Taking these into consideration, he states that the plants do not represent what is generally recognised as an Oriental flora, being chiefly composed of northern Persian and Arabian forms, augmented by Central Asian and Siberian types, with a few West Himalayan or Tibetan, and still fewer representing the Punjab or Scind. Beside these are a fairly representative local flora; say, one-sixth of the collection. *Juniperus excelsa* is the only indigenous conifer; neither oaks nor species of *Æsculus*, *Olea*, or *Myrtus* were met with. *Populus Euphratica* forms forests in the river-beds, but as long as the tree is situated near water it is indifferent to altitude. Out of 75 natural orders, Compositæ and Leguminosæ greatly preponderate over the others, containing 81 and 80 species respectively. In Compositæ, *Cousinia* heads the genera with 18 species; *Centaurea* has 10 species. Of 80 species of Leguminosæ, 39 belong to the genus *Astragalus*, 14 of these being new. Of 61 species of Gramineæ, all are well known. The Cruciferæ collected number 56 species; several are new. Chenopodiaceæ follow with 39 species, Labiatæ with 35, Boraginaceæ 32, Umbelliferæ 30, Caryophyllaceæ 30, Rosaceæ 27, Lilliaceæ 26, Euphorbiaceæ 16, Polygonaceæ 15, Ranunculaceæ 14, Rubiaceæ and Cyperaceæ each 13, Scrophularineæ and Plantagineæ 10 and 11 respectively. The orchards at some of the villages are surrounded with high walls, inside which is a row of mulberry-trees grown for the breeding of silkworms. In the Afghan gardens, beetroot, carrots, turnips, cabbages, radishes, and tomatoes are raised, and these are of excellent quality. In the fields, besides wheat, rye, and barley, opium, tobacco, melons, and certain oil-seeds are cultivated. Cotton is grown, but the quality of the fibre is poor. Several plants of pharmaceutical value flourish—Galbanum, Ammoniacum, &c., and of these the author gave a full account.

Zoological Society, February 1.—Dr. St. George Mivart, F.R.S., Vice-President, in the chair.—Mr. F. Day exhibited and made remarks on a hybrid fish supposed to be between the pilchard and the herring, and a specimen of *Salmo purpuratus* reared in this country.—Mr. W. L. Sclater exhibited and made remarks upon some specimens of a species of *Peripatus* which he had obtained in British Guiana during a recent visit to that country, and added some general observations on the distribution and affinities of this singular form of arthropods.—Mr. A. Thomson read a report on the insects bred in the Society's Insect House during the past season, and exhibited the insects referred to.—A communication was read from Dr. B. C. A. Windle, containing an account of the anatomy of *Hydromys chrysogaster*.—Mr. Martin Jacoby read a paper containing an account of the Phytophagous Coleoptera obtained by Mr. G. Lewis in Ceylon during the years 1881, 1882. About 150 new species were described and many new generic forms.—Mr. F. E. Beddard read some notes on a specimen of a rare American monkey, *Brachyurus calvus*, which had died in the Society's Gardens.—Mr. Oldfield Thomas read a note on the mammals obtained by Mr. H. H. Johnston on the Camaroons Mountain.—A paper was read by Capt. Shelley, containing an account of the birds collected by Mr. H. H. Johnston on the Camaroons Mountain. The collection contained thirty-six specimens referable to eighteen species, and of these four were new to science.—Mr. G. A. Boulenger read a list of the reptiles collected by Mr. H. H. Johnston during his recent visit to the Camaroons Mountain.—Mr. Edgar A. Smith read a paper on the Mollusca collected at the Camaroons Mountain by Mr. H. H. Johnston,

and gave the description of a new species of *Gibbus*, proposed to be called *Gibbus johnstoni*, of which specimens were in the collection.—A communication was read from Mr. Charles O. Waterhouse, containing a list of some coleopterous insects collected by Mr. H. H. Johnston on the Camaroons Mountain.

Geological Society, January 12.—Prof. J. W. Judd, F.R.S., President, in the chair.—The President announced the sad loss which the Society had sustained since the last meeting by the death of Mr. John Arthur Phillips, F.R.S., who had been for several years a valuable member of the Council, and one of the Vice-Presidents of the Society.—The following communications were read:—The Ardtun leaf-beds, by J. Starkie Gardner, with notes by Grenville A. J. Cole. The description of these beds by the Duke of Argyll thirty-five years ago indicated that enormous tracts of trap in the Inner Hebrides were of Tertiary age. Prof. Edward Forbes, who described the leaves, inclined to the idea that they might be Miocene; but in estimating the value of this conjecture, we must remember that at the time the existence of Dicotyledonous leaves of similar aspect, but of undoubtedly Cretaceous age, was quite unsuspected, and that no typical Eocene flora had then been properly investigated or described. Prof. Heer adopted the opinion that the age of this formation was Miocene, and unfortunately extended its application to formations containing similar floras in Greenland and elsewhere. The writer of the present communication tried to show that instead of belonging to the Miocene, these floras are of Eocene age, and in fact older than the Thanet beds. He also re-described the plant-beds, and maintained that they are part of a rather extensive series of sedimentary rocks interealated among the traps.—On the Echinoidea of the Cretaceous strata of the Lower Narbadá region, by Prof. P. Martin Duncan, F.R.S.—On some Dinosaurian vertebræ from the Cretaceous of India and the Isle of Wight, by R. Lydekker.—Further notes on the results of some deep borings in Kent, by W. Whitaker.

January 26.—Prof. J. W. Judd, F.R.S., President, in the chair.—The following communications were read:—On the correlation of the Upper Jurassic rocks of the Jura with those of England, by Thomas Roberts.—The physical history of the Bagshot Beds of the London basin, by the Rev. A. Irving. The author, in reviewing the position taken up by him, attempted to estimate the value of such palæontological evidence as exists, and insisted on the importance of the *physical* evidence in the first place. He gave reasons for considering the evidence of pebbles, pipe-clay, derived materials, irony concretions, percentages of elementary carbon (ranging in the more carbonaceous strata up to nearly 2½ per cent.) taken together with the evidence of carbon in combination, as adduced in former papers, *freshwater Diatoms* (now, perhaps, recorded for the first time in the Middle and Lower Bagshot), and the microscopic structure of the sands and clays, as furnishing such a cumulative proof of the fluviatile and delta origin of the majority of the Middle and Lower Bagshot Beds, as can hardly be gainsaid; while he regarded the wide distribution of the Sarsens as indicating, along with the fauna, a much greater areal range formerly of the Upper Bagshot than of the strata below them.

Mineralogical Society, January 11.—Mr. L. Fletcher, President, in the chair.—Messrs. A. Pringle, G. T. Prior, and J. M. Thomson, were elected Members.—The following papers were read:—On a specimen of meteoric iron found at Youndagin, West Australia, in 1884, by Mr. L. Fletcher, President.—Additional notes on the felspar from Kilima-njaro, by Mr. L. Fletcher, and Mr. H. A. Miers.—On the occurrence of greenockite in a new locality, by Prof. M. F. Heddle.—Note on a form of calcite from Heilim, Sutherlandshire, by Prof. M. F. Heddle.—Note on the occurrence of bismutite in the Transvaal, by Mr. H. Louis.—Notes on celestine from Gloucestershire and on apatite from East Cornwall, by Mr. R. H. Solly.—Note on the presence of lead in calcite from Leadhills, by Mr. J. Stuart Thomson.—On the use of gnomonic projection, by Mr. H. A. Miers.—Prof. Judd exhibited a specimen of a new terrestrial alloy of iron and nickel (Ni_2Fe) discovered in New Zealand by Prof. Ulrichs.—Colonel MacMahon exhibited a crystal of sapphire from a vein which had been revealed by a landslip in the south-east of Cashmere, about the year 1880.

PARIS

Academy of Sciences, February 7.—M. Gosselin, President, in the chair.—Movements of a bird's wing represented according to the three dimensions of space, by M. Marey. In continuation of his first communication on the flight of birds, the author here shows, by a series of chrono-photographic images, how the movement of the wing is made according to the three dimensions of space. One of the illustrations gives a synoptic view of the projections of the wing on three different planes at ten successive instants of a single revolution, thus containing all the elements necessary to determine the continuous action of the wing. Further chrono-photographic experiments are promised, which will convey a complete representation of all the alar movements, and in general of all notions relating to the kinematics of flight.—On the red fluorescence of alumina, by M. Lecoq de Boisbaudran.—On the composition of the ashes of cider, by M. G. Lechartier. The study of the composition of the ashes which ciders yield by incineration is here undertaken, both for its scientific interest and on account of the indications it may give of their purity. The author inquires whether this composition presents uniform distinctive characters whatever its local origin, and finds that the ashes of the cider apple are in no way modified by the nature of the soil. He also shows the differences existing between the ashes of the fruit, the leaf, and the wood of the apple-tree.—Experiments relative to the anti-phylloxeric disinfection of the grape-vine, by MM. Georges Couanon and Etienne Salomon. The varying results of M. Balbiani's already-described process are here reported from various districts throughout France for the year 1886. Although generally satisfactory, the remedy was found in some cases to be as bad as the evil, the failure being attributed either to the unhealthy state of the plant or to climatic or other local conditions.—Fresh researches on the action exercised by cuprous preparations on the development of the Peronospora of the vine, by MM. Millardet and Gayon. These experiments, carried out last September, fully confirm the conclusion already anticipated by the authors, that in these mixtures the essential prophylactic agent is the copper dissolved by rain-water and dew.—Memoir on the developments of naval geometry, with application to the calculation of stability, by MM. Guyou and Simart. The authors consider their method as a distinct improvement on those of their predecessors, Charles Dupin, Bravais, Rankine, Reech, Leclert, and Daymard. Thanks to their new formulas, the still laborious calculations which are required even by Daymard's method (recently crowned by the Academy) are much shortened.—Geographical co-ordinates of Punta-Arenas, by M. Cruls. For this important station the following values have been recently determined: Latitude 53° 9′ 38″·6 S.; Longitude 4h. 43m. 36·09s. west of Greenwich.—Equatorial observations of the new comets, Brooks and Barnard, made at the Observatory of Algiers with the 0·50m. telescope, by MM. Trépied and Rambaud.—On entire algebraic series, by M. L. Lecornu.—Some experiments on aerial eddies, by M. Ch. Weyher. The experiments here described deal with waterspouts in the open air, with whirlwinds in an inclosed space, with the attraction produced by vortices, and with the variation of temperature in an eddy.—On the electrolysis of alkaline solutions, by M. Duter. In the electrolysis of aqueous solutions of potassa, soda, baryta, or lime, the volume of oxygen liberated on the positive electrode is considerably less than half that of the hydrogen liberated on the negative electrode. But with a wide platina plate for positive and a fine platina wire for negative electrode, the author obtains one volume only of oxygen for four of hydrogen. In the electrolysis of alkaline solutions there appear to be formed small quantities of a superoxygenated compound combined with an alkali in such a way that it cannot be liberated by ebullition but only by an acid. This appears to be a peroxide of hydrogen, by the existence of which M. Berthelot explains various reactions, such as that of the permanganate of potassa on oxygenated water.—The principle of maximum labour and the laws of chemical equilibria, by M. H. Le Chatelier. It is shown that under a single law may be reduced all the phenomena without exception of vaporisation, allotropic transformation, and dissociation from − 200° C., boiling-point of oxygen, to + 1000° C., point of dissociation of the oxide of iridium.—Action of the oxide of lead on some dissolved chlorides, by M. G. André. Some true oxychlorides are here described, which the author has obtained by studying the action of certain oxides on the solutions of the alkaline earthy chlorides.—Combinations of the glycerinate of potassa with the monatomic alcohols, by M. de Forcrand. The glycerinates here studied are those of methylic, ethylic, propylic, amylic,

and isobutylic potassa.—On pho phoplatinous chloride, $PhCl_3PtCl_2$, by M. E. Pomey.—On a combination of orthotoluidine and the bichloride of copper, by M. E. Pomey. The formula of the combination here determined is shown to be $CuCl_2 . 5(C_7H_9N . 4Cl)$.—On the hydrochlorate and platinochlorate of di-isobutylamine, and the platinochlorate of tri isobutylamine, by M. H. Malbot. These substances, apparently not hitherto produced, have for formulas: $HCl . N(C_4H_9)_2H$; $PtCl_4 . 2HClN(C_4H_9)_2H$; and $PtCl_4 . 2HClN(C_4H_9)_3$.—On gluconic acid, by M. L. Boutroux. The author has succeeded in preparing sufficient quantities of this acid by means of the process indicated by MM. Kiliani and Kleemann.—On the characteristic properties of olive oils, by M. Albert Leval[illegible] shown that the most constant character of olive oils [illegible]d in the laboratory from various berries from the south [illegible]ance is density. A simple method is described for distinguishing these from the oils of sesame, cotton, colza, linseed, and cameline.—On sardine-fishing, by M. Launette. The abundance and scarcity of this fish on the west coast of France is shown to be intimately associated with the animal refuse drifting across the Atlantic from the Newfoundland cod-fisheries.—On the formation of the so-called "red wood" (*bois rouge*) in the fir and Epicea, by M. Emile Mer. The occasional development of these hard and yellow-coloured layers in the relatively soft and white wood of the fir and Epicea is here attributed to the superabundance of nutritive elements at certain points under various conditions of growth.—On the Miocene vertebrate fauna of Grive-Saint-Alban, Isère, by M. Charles Depéret. Amongst the most interesting remains of this fauna is an anthropoid ape, Sansan's *Pliopithecus antiquus*, whose molars point to a relationship with the present gibbons.—Synthetic experiments on the abrasion of rocks, by M. J. Thoulet. These experiments have been carried out to determine the laws regulating the weathering of rocks under the action of drift sand.—On the age of the bauxite deposits in the south-east of France, by M. Louis Roule. This formation seems to have been deposited on the bed of the lake formerly stretching between Provence and Languedoc, and belongs to the lacustrine series closing the Chalk epoch in this region.—On the distribution of mean cloudiness on the surface of the globe, by M. L. Teisserenc de Bort.

BERLIN

Physiological Society, December 10, 1886.—Prof. du Bois-Reymond in the chair.—Dr. Hermes showed the luminous Bacillus brought some time ago with marine fish from the West Indian Ocean and bred in pure cultures. In nutrient gelatine the Bacillus formed funnel-shaped cultures at the surface. Inoculated into sterilised fish it rendered them luminous to a very high degree. The Bacillus developed also in fresh-water fish, but only when these were placed in salt water. In fresh water the Bacillus disappeared. At temperatures below 15° Celsius, the luminosity ceased. It was easy with this fish-Bacillus to render a large quantity of sea water luminous. If, however, the water were allowed to stand for twenty-four hours, only the surface was luminous; but by stirring it up the whole mass again became luminous in consequence of the interpenetration of the air.—Prof. Zuntz reported on experiments which, in conjunction with Dr. Berder, he had instituted with a view to ascertaining the effect of alcohol on metastasis in man. The respiration was especially examined. An essential preparatory condition for such experiments was the complete cessation of all muscular activity, which increased the absorption of oxygen and the formation of carbonic acid, as was also protection against the too rapid cooling, promoted by the flow of blood in the skin, consequent on the operation of the alcohol. With the moderate use of alcohol (20 ccm.), so as to produce no perceptible sign of intoxication, the absorption of oxygen was somewhat increased without corresponding increase in the formation of carbonic acid, a relation corresponding with the combustion of the alcohol, in which two molecules of carbonic acid are formed for every three molecules of oxygen consumed.—Dr. Wurster described a new reagent for the demonstration of active oxygen in the living organism. Tetramethylparaphenylenediamine and dimethylparaphenylenediamine were colourless substances not liable to be changed in the air; but with active oxygen, in form of ozone, peroxide of hydrogen, or nitrous acid, they formed colouring matters, the tetramethyl-compound giving a blue colouring matter, which with an excess of active oxygen again lost its colour; whilst the dimethyl-compound with a little oxygen yielded a red colouring matter, and with excess of oxygen a violet colouring matter. The speaker had saturated paper with these substances. Reagent papers of this description were admirably adapted in all cases for the detection of active oxygen. In cutaneous evaporations, and, in particular, in perspiration, copious quantities of active oxygen were in this way capable of being demonstrated. The presence of such active oxygen might further be demonstrated in the saliva of healthy persons, and in the sap of plants, especially in the milky juices of plants. Seeing that in all these cases ozone was absent, otherwise it would have been recognised by its odour, only peroxide of hydrogen or nitrous acid could be present. By means of other reactions it was shown that in these cases there was no question of anything but peroxide of hydrogen.

January 14.—Prof. Munk in the chair.—Dr. Gad communicated the results of some experiments, which had been carried out by him in conjunction with Dr. Wurster, respecting the active oxygen in the animal organism. By means of the two reagents in active oxygen discovered by Dr. Wurster—dimethylparaphenylenediamine and tetramethylparaphenylenediamine, the properties of which were demonstrated by Dr. Wurster at the last meeting of the Society—animal fluids and tissues were tested in respect of the presence in them of active oxygen. On the skin the reagent papers either remain colourless, or they become coloured symptomatic of slight oxidation, or they become rapidly coloured and rapidly discoloured, which was an invariable phenomenon in the case of stronger oxidation of the diamines. Blood produced no change on either the dimethyl or the tetramethyl, whereas fresh muscles, and even flesh bought at the butcher's, yielded a very strong reaction, an energetic oxidation. If moderate quantities of a solution of the two diamines were injected subcutaneously into frogs or rabbits, or into their venous system, then they got completely oxidised in the body and were no longer capable of being demonstrated. They were altered into colourless combinations; and only in the heart, in the liver, and at the places of application were strong colorations discernible. The stomach was coloured at all places to which the oxygen of the air had entrance; the places, on the other hand, which were protected from the air were colourless, and became coloured only when they were exposed to the air. The brain presented a colouring of olive-green—a phenomenon which would have to be more particularly investigated, seeing that the colourings of oxidation under dimethyl were red or blue, under tetramethyl, blue. In consideration of the fact that the living protoplasm of the cells did not readily take up foreign substances, and taking account of the fact above demonstrated, that the blood did not oxidise either of the two substances in question, the speaker assumed that the complete consumption occurring after the introduction of the two bodies into the living organism was accomplished by the juices of the tissues, or by the fluids which secreted the protoplasm of the cells. The objection made against the experiments, that the diamins were not found because they were not absorbed, was refuted by the fact that the animals operated on always showed the phenomena of intoxication proceeding from the central nervous system. Experiments would be further continued by Dr. Gad and Dr. Wurster. The experiments had hitherto yielded the important fact that in the living organism the protoplasm worked in an especially oxidising manner.

Physical Society, December 17, 1886.—Prof. von Bezold in the chair.—Prof. Neesen exhibited a tuning-fork of variable pitch of tone. It had a hollow stem and hollow prongs, so that it could be filled with quicksilver to any desired height. With the increasing mass of the vibrating-fork the pitch of its tone changed. The excitation was effected by electro-magnetic methods.—Dr. Aron developed the theory of the inductionless coils constructed by him. In this task he pursued the practical object of putting an end to, or at least very much reducing, the spark arising from the extra-current on the interruption of the electric current, and very soon rendering the contacts unavailable. The induction exercised by the iron-nucleus on the windings might, as was well known, be obviated by a copper case, and the induction of the different windings of the spirals on one another was overcome by the speaker by intercalating a tin-foil layer between each layer of windings and embedding the isolated wires in a good conductor. The speaker showed theoretically that by this encasement the heat, and consequently the opening spark, became considerably reduced, especially in the

case of weak currents. The efficacy of this method of procedure was confirmed by the experience that a contact which had been in constant operation for two years remained unchanged.—Dr. Richarz spoke of the formation of peroxide of hydrogen by electrolysis. If a current were conducted through diluted sulphuric acid, then there was formed at the positive electrode a strongly oxidising substance, formerly taken for peroxide of hydrogen, but demonstrated by M. Berthelot to be per-sulphuric acid, S_2O_7. In experiments on the electrolysis of concentrated solutions of sulphuric acid with wire-shaped platinum electrodes, the speaker had obtained in the solution, beside per-sulphuric acid, ozone and peroxide of hydrogen, and assumed that all three bodies made their appearance at the positive electrode. This assumption had been disputed by Traube, and, on the ground of experiments with diluted acids, he had maintained that the peroxide of hydrogen arose only at the negative electrode by reduction of the atmospheric oxygen. Dr. Richarz repeated his experiments, and found that in concentrated sulphuric acid, on electrolysis, peroxide of hydrogen occurred always at the positive electrode when per-sulphuric acid was formed; but that it occurred temporarily later on, and was not a direct product of the electrolysis, but arose through secondary chemical reactions, by oxidation of water through the per-sulphuric acid. The following experiment served as a proof thereof:—A 40 per cent. sulphuric acid solution was subjected to electrolysis, and thereby, on account of too great attenuation, no peroxide of hydrogen, but only per-sulphuric acid, came to view. If, now, into the 40 per cent. sulphuric acid 60 per cent. acid were poured, after the electrolysis was finished, then did peroxide of hydrogen show itself in the fluid.—Dr. Dieterici communicated how he rendered galvanometers insensible to the disturbances of the earth's magnetism by surrounding with an iron cylinder, and setting in an iron box provided with suitable apertures for observation, the windings of the galvanometer up to the height of the mirror set above the needle. Residual magnetism, which was readily recognised, was easily removed by heating and by adjusting the mutual position of the two parts of the iron case.

Meteorological Society, January 4.—Prof. von Bezold in the chair.—The yearly report having been read by the Secretary, and officials elected, Dr. Zenker explained the arrangement and contents of the meteorological calendar edited by him.—Dr. Sprung then read a paper on Hadley's principle. Starting from the phenomenon, now and again observed, of an air-current proceeding in the direction of the meridian, while the gradients of atmospheric pressure operated in a direction perpendicular thereto, the author referred to the circumstance that Hadley had last century resolved the direction of the trade-winds into the simultaneous action of the difference of temperature and of the earth's rotation resulting in a mean course, an explanation which first obtained general acceptance through Dove. The derivation of the curve described by a mass-particle on the earth when it had received an impulse to the north and was rotating in a parallel with the earth had been attempted in two different ways—one way by Mousson and another by Schmidt. The speaker discussed such derivations for the simplest case—that of a rotating disk and of a mass-point thereupon impelled with a certain energy and free from friction towards the centre. Through analytical development of the results, he adopted the method of taking as approximately accurate Schmidt's derivation, which presupposed the force in the direction of the meridians to be a constant value, but the force in the direction of the circle of parallel to augment with the time. After further consideration of the centrifugal force, a basis for the mechanics of atmospheric currents on the earth might be determined by Hadley's principle.

Chemical Society, January 10.—Prof. A. W. Hofmann, President, in the chair.—Prof. Rud. Weber communicated the results of his experiments on some compounds of sulphuric anhydride with phosphoric and iodic anhydrides: he has isolated compounds of the composition $P_2O_5 + 3SO_3$ and $I_2O_5 + 3SO_3$, and he describes their preparation and analysis.—O. N. Witt described a new method of producing the azines; they can be obtained from the decomposition of the azo-compounds produced from diazobenzenesulphonic acid and phenyl-, paratolyl-, and xylyl-β-napthylamine.—C. Friedheim criticised the method recommended by Weil for the volumetric determination of hydrogen sulphide; the method is not only troublesome and complicated, but the reaction does not take place in the manner assumed by Weil. The author gives analytical results showing that the method cannot be depended on.—Prof. Pinner read abstracts of papers by Liweh, and Ramsay and Young.

BOOKS AND PAMPHLETS RECEIVED

Westindische Skizzen, Reise-Erinnerungen: K. Martin (Brill, Leyden).—Sitz. der Kaiserlichen Akademie der Wissenschaften (Mathematische-Naturwissenschaftliche Classe), Zweite Abth., 1, 2, 4, 5, 6, 7, 8, 9, 10; Dritte Abth., 3 to 10; Erste Abth., 1, 2, 3, 5, 6, 7, 8, 9, 10 (Gerold's Sohns, Wien).—Journal of the Chemical Society, February (Gurney and Jackson).—Bulletin du Musée Royal d'Histoire Naturelle de Belgique, tome iv., No. 4.—A Text-book of Euclid's Elements, part 1: H. S. Hall and F. H. Stevens (Macmillan and Co.).—Observatory Temperature-room and Competitive Trials of Chronometers in 1884-86 (Washington).—On the Flora of Shetland: W. H. Beeby (Cowan, Perth).—The Coleoptera of the British Isles: W. [illegible] (Reeve and Co.).—Loch Creran: W. Anderson Smith (A. [illegible]).—The Survival of the Fittest: A. S. Wilson (A. Gardner).—Sitzung[illegible] der Physikalisch-Medizinischen Societät zu Erlangen. 18 Heft (Erlang[illegible]).—Bulletin of the American Museum of Natural History, vol. i. No. 8.—Bollettino della Società Geografica Italiana, Anno xxi. fasc. 1 (Roma).—Bulletin de la Société de Géographie 4e. trimestre, 1886 (Paris).—Meteorologische Beobachtungen in Deutschland, 1884, Jahrg. vii. (Hamburg).—Le Climate de la Belgique en 1886: A. Lancaster (Hayez, Bruxelles).—Liste Générale des Observatoires et des Astronomes: A. Lancaster (Hayez, Bruxelles).—Mineral Physiology and Physiography: T. S. Hunt (Cassino, Boston).—Notes on South African Hunting; A. J. Bethell (Whittaker).—American Journal of Mathematics, vol. ix. No. 2 (Baltimore).—Imperial University of Japan; Calendar for the Year 1886-87 (Marruya, Tokio).—Anuario de la Oficina Central Meteorolojica de Chile, tomo 18, Correspondiente a 1886 (Santiago).—Journal of the Royal Microscopical Society, February (Williams and Norgate).—Studies in Life and Sense: A. Wilson Chatto and Windus).—Proceedings of the American Association for the Advancement of Science, Twenty-fifth Meeting (Salem).—Annalen der Physik und Chemie, 1887, No. 2 (Barth, Leipzig).—Lehrbuch der Allgemeinen Chemie, Erste und Zweite Haft, Zweiter Band: Dr. W. Ostwald (Engelmann, Leipzig).—Quarterly Journal of the Geological Society, February (Longmans).—Beiblätter Annalen der Physik und Chemie, 1887, No. 1 (Barth, Leipzig).—Verhandlungen der Gesellschaft für Erdkunde zu Berlin, Band xiv. No. 1 (Remier, Berlin).—Zeitschrift der Gesellschaft für Erdkunde zu Berlin, Nos. 126 und 127 (Remier, Berlin).—City of York; Report on the Prevalence of Typhoid Fever in York, 1886 (Johnson, York).

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THURSDAY, MARCH 3, 1887

ENDOWMENT OF MEDICAL RESEARCH

OUR readers will probably have seen that a memorial, signed by some of the most able and trusted leaders in science and in medicine, has been presented to the Council of the Royal College of Surgeons, asking it to consider the propriety of establishing a new institution for the prosecution of such branches of science as are most closely connected with the objects of the College. There is no doubt that the memorial will be carefully and maturely considered in a spirit worthy of the eminent men who guide the policy of the College, but it seems fitting that in these columns the excellence of the suggestion should be acknowledged, whatever may be found to be the best method of meeting it.

In the first place, all who care for English biology and English surgery can heartily rejoice that the College which has done so much for both is now in a position not only of dignity but of affluence. Just before the foundation of the present College, the Company of Surgeons which preceded it was almost bankrupt, and, by want of observing a legal formality, well nigh forfeited its charter. But for fifty years past the College has grown in honour and in wealth. Its Membership stands deservedly first among the surgical diplomas which admit to practice. Its Fellowship involves higher training and more thorough examination than most University degrees. It possesses the second Medical Library in the kingdom, and the most complete, extensive, and well-arranged Museum of Anatomy—human, comparative, and pathological—which exists in the world. The original Hunterian Collection which was purchased by the nation after the death of the great anatomist, was intrusted to the care of the College of Surgeons on condition of providing a suitable building and a competent Curator. The trust has been nobly dealt with. The museum left by Hunter, still cherished with reverence and still remarkable in varied aspects, has been many times multiplied by successive additions. Buildings of great size and admirable design have again and again been added. Curators have been appointed who have made their names familiar through Europe—Clift, Quekett, Owen, and Flower. And Hunterian Professors and Lecturers have been appointed who have made the Museum as well known as that of the Jardin des Plantes—Sir Everard Home and Sir Richard Owen, Huxley, Flower, and Parker, among anatomists; and, among surgeons, Abernethy, Cline, Astley Cooper, Laurence, Hilton, Fergusson, and Paget. Far from reserving its theatre for the veterans only, the College has shown a laudable liberality in founding Junior Lectureships; and now some of the most industrious, thoughtful, and brilliant of the younger generation of anatomists and pathologists are describing their new investigations from the Chair of the Hunterian Museum.

Now, however, there seems to be a probability of the College making another and an enduring addition to the benefits which it has conferred on science.

A large bequest has enabled them seriously to consider the foundation of such an institution as is suggested in the memorial above mentioned. With some the impulse to save is stronger than the impulse to spend; and even if it is determined to spend the Wilson bequest, part at least might be safely applied to further extension and improvement of the Museum, fresh buildings, and an increased staff of officials. Still we hope that it may be found possible to meet such current needs by current income, and that the large sum placed at the free disposal of the College will be devoted to some new, useful, and appropriate scientific purpose.

The appropriate purpose is not far to seek. A museum is necessary for the study of anatomy, the one half of the science of living creatures; but for the prosecution of the other half, for the study of physiology, a laboratory is needful, where the physical, chemical, and vital phenomena of man and animals can be observed. Hunter himself was never content with the mere demonstration of a fact in living structures, normal or diseased. His acute and fertile intellect at once inquired: How came it about? What is its use? Of what process is it the evidence? How can that process be either checked or fostered for the relief of suffering and preservation of life?

The progress of knowledge since Hunter's day has vastly increased our power of dealing with these questions: many have been already more or less perfectly answered; more are ripe for solution to anyone who can give time and pains to the work; and most lie still untouched, a rich and virgin field ready to reward the man of thought as well as skill. But the methods of research have become more and more elaborate. The easy things have been done; or rather what was once hard has now become easy, and what once was impossible is now practicable, with greater expenditure of time and money. The change is only what has taken place in navigation, in war, and in engineering. Few scientific investigations can now be carried on except in properly equipped laboratories.

There are many departments in which work is urgently needed, and in which our own country is discreditably behindhand. In Germany and France and America, even in smaller countries like Holland and Sweden, adequate, or something like adequate, provision is made for the investigations of which we speak. Edinburgh has made great strides of late years, and there the University laboratories of physiology and pharmacology are worthy of the place. Cambridge has, since Prof. Foster was called to the University, been known through Europe for the first time as a great school of physiology. Oxford has lately built and furnished a laboratory for Prof. Sanderson. But London is still far behind the three chief Universities of the kingdom, and behind Paris and Lyons, Strassburg, Berlin, Leipzig, Bonn, and a host of petty towns in Germany.

It is true that before he was carried away to Oxford Dr. Burdon Sanderson had established a laboratory at University College which is a credit to London, and where work of the best kind has been and is being done. At King's College, though the accommodation is not what it should be, Prof. Gerald Yeo and his assistants put forth no less excellent results. In two at least of the great medical schools physiological laboratories have long existed, and have contributed to the progress of knowledge, as well as to instruction. Lastly, the titular University of London has, owing to the exertions of two

or three of its medical graduates on the Senate, founded an institute for the study of comparative pathology which, under Sanderson, Klein, Greenfield, Roy, and Horsley, has accomplished results of great benefit both to domestic animals and to man.

If, however, physiology and pathology are to some extent provided with means for research, others of the sciences allied to medicine and surgery are absolutely destitute. Physiological chemistry has scarcely existed in England since the days of Prout, and at the present day there is not a single laboratory where this difficult and important branch of knowledge is pursued. When Dr. Gamgee's excellent text-book is completed, the Index Auctorum will scarcely contain an English name.

Pharmacology—the experimental investigation into the action of drugs—is another foreign science. Fraser and Brunton have done much to redeem this country from absolute sterility, but in London there ought to be a laboratory like that of Prof. Schmiedeberg for this most obviously and practically useful of all medical sciences.

A laboratory for the study of Physiology would be the most closely connected with the memory of Hunter, with the Museum, and with the traditions of the College. A laboratory of physiological, pathological, or therapeutical chemistry would perhaps fill the most absolutely vacant space. A laboratory devoted to the direct study of the nature, origin, and propagation of Diseases, to their prevention, and to surgical methods of treatment would be the most directly useful and probably the most immediately fruitful.

So much is needful before England can begin to contribute her fair share to the common sum of knowledge, that it is scarcely possible to go far wrong in deciding what branch of medical science should first be taken up.

The Royal College of Surgeons has a great opportunity, and one that is not likely to return. If the great accession to its resources should be frittered away on a multitude of objects, the opportunity will be missed, and probably for ever. But we cannot doubt that the leading scientific surgeons in the kingdom will decide on using the Wilson bequest for the endowment of some new and urgently needed institution for research, which will be an honour to the College, a credit to the nation, and an instrument for increasing knowledge and diminishing suffering for centuries to come.

THE ELECTRIC MOTOR

The Electric Motor and its Applications. By T. C. Martin and Jos. Wetzler. (New York: Johnson, 1887.)

CONSIDERING the very rapid strides that have been made during the past six years in the industrial application of electric motors, the appearance of this handsome volume, giving the latest information on this topic, is thoroughly timely. It constitutes, though somewhat popular in style, a welcome addition to the library of the electrical engineer. Those who are accustomed only to the slow and steady development of industries in the Old World can hardly appreciate the revolution that is setting in in consequence of the employment, especially in small workshops and factories, of electric motors in place of steam-engines or gas-engines. They win their way because, though the actual cost of power is no cheaper, the expense of the electric motor is less than that of the steam-engine or gas-engine. It is less troublesome to keep in order, takes less room, runs at a more uniform speed, and is more cleanly. What wonder, then, that thousands—literally—of electric motors are already in use in New England, where an invention is welcomed, not sneered at, because it is new.

Much of the volume before us has already seen the light in another form in the pages of our American contemporary, the *Electrical World*, but the matter has been very carefully edited and arranged. It is by no means a scissors-and-paste affair; but a well-considered treatise abundantly illustrated with drawings of motors and their various applications. It treats the subject both historically and systematically.

The first chapter is devoted to an exposition of the elementary principles of electric motors. Almost at once we are plunged into the essence of the matter, the development in the armature of the motor of the counter-electromotive force, that *crux* of the untrained electrician. In this connection Jacobi's law, that the electric motor does its greatest possible work when it diminishes the original current to one-half, is given, and correctly given, not as a law of maximum efficiency, for which it has been so often mistaken, but as a law of maximum activity. But the authors have missed the point that Jacobi's law even in this sense is only true when the condition of supply of the electric energy is that of a given constant electromotive force. Jacobi's law would obviously not apply to motors placed in a circuit in which the given condition of supply was that of a constant current. The chapter concludes with some very apposite remarks on the general principles of construction of electric motors, quoted from a paper in the *Philosophical Magazine* by an English electrician, Mr. W. Mordey.

Chapter II. is devoted to early motors and experiments in Europe, from Barlow's wheel and the primitive engines of Jacobi and Froment down to the famous Pacinotti machine. The complement to this narrative is found in Chapter III., which deals with the early motors and experiments in America, beginning with Davenport in 1837. The most celebrated of these was that of Prof. C. G. Page, who succeeded in constructing a motor of 10 horse-power. The authors incidentally mention that, in the period of the Civil War, between 1860 and 1867 not a single patent on electric motors was issued in America.

Chapter IV. deals with the electric transmission of power, as developed successively by Pacinotti, Fontaine, and Marcel Deprez. In this connection the theory of the efficiency of electric transmission is explained by the use of graphic diagrams in which the areas are proportional to the energy transmitted or to the work performed. The experiments of Marcel Deprez are mildly criticised, and rules for calculating the cost are given.

The modern electric railway and tramway in Europe occupy Chapter V. Here several of Sie mens's tramways are described, also those at the Giant's Causeway, at Brighton, and at Blackpool. Chapter VI. gives a similar account of the modern electric railway and street-car line in America. From this account it appears that Mr. Stephen D. Field is in America awarded the sole right to use "the combination of an electric motor operated by means of a current from a stationary source of electricity conducted through the rails," which "combination" he patented in 1880. Drawings of the electric

locomotives of Field, Edison, Daft, and others, are given. Several electric railroads of some magnitude are at work in the States. Chapter VII. resumes the subject of street railways in which storage batteries are employed for driving the electric motors. The work done in this country by Mr. Reckenzaun receives due recognition, and Mr. Elieson's tramway engine is also described. The industrial application of electric motors in Europe and in America occupies the next two chapters, the special form of motors devised by Profs. Ayrton and Perry being noticed in the one and those of Griscom and Daft in the other. Electrically-propelled boats and balloons are treated by themselves; so also is the subject of telpherage. This subject—the transmission of freight along a wire road by electricity—originated with the late Prof. Fleeming Jenkin, and it has found imitators in America. The twelfth and last chapter is devoted to the latest American motors and motor systems, the motors of Brush, Sprague, Van de Poele, and others, being here described at length.

And here we must pause to point out the one blot on this otherwise excellent work: namely, that the entire theory of the self-regulating motor, which was discovered and worked out in 1882 by Profs. Ayrton and Perry, and which forms the basis of their epoch-making paper read in 1883 before the Society of Telegraph-Engineers, is appropriated *en bloc*, and accredited to Lieut. Sprague. From p. 160 it appears that Sprague's method of securing self-regulation is to use a differential compound winding; but this is exactly Ayrton and Perry's method. Even the equation on p. 161, which is given as the Sprague law of winding, is identical with the equation given on p. 367 of the present writer's book (edition of 1884) on dynamo-electric machinery in the section on the theory of the differential compound winding. Another matter credited to Mr. Sprague by the authors is the discovery of a motor which, when supplied at constant potential, runs faster when the strength of the magnetic field is diminished. But this is no new principle: it is an inherent law of nature, common to all motors old and new, being the simple converse to the equally fundamental fact that a dynamo, if it is to generate a constant electromotive force, must be run faster in a weak field, and may be run slower if the field is strengthened. Lieut. Sprague has done good work in producing motors of excellent design and having points of original merit: this we may freely acknowledge without ascribing to him what was known before his work was begun. The authors will do well to correct these slips in the second edition, which will probably soon be demanded. The book is creditable alike to authors and publisher.

SILVANUS P. THOMPSON

THE FLORA OF LEICESTERSHIRE

The Flora of Leicestershire, including the Cryptogams. With Maps of the County. Issued by the Leicester Literary and Philosophical Society. 372 Pages and 2 Maps. (London and Edinburgh: Williams and Norgate, 1886.)

THE county of Leicestershire covers an area of 800 square miles of the centre of England, at the summit of drainage between three of the great streams, the Trent, the Severn, and the Midland Ouse. Almost the whole of the county is at least 100 feet above sea-level. A large portion of the surface is between 300 and 500 feet, and Charnwood Forest rises at its highest point to 900 feet, so that Leicestershire is very different from such low-lying level Midland counties as Cambridgeshire, Bedfordshire, and Huntingdonshire. Half the area of the county is in grass, about one-quarter is under arable cultivation, and there are 20 square miles of woodlands. In Charnwood Forest there are slate and granite, and the sedimentary rocks are represented in the county from the middle of the Palæozoic to the middle of the Mesozoic series—Carboniferous Limestone, Coal-measures (Permian missed out), Trias, Lias, and Lower Oolite—so that there is every variety of soil.

Competent botanists have resided in the county for the last three generations. The fathers of Leicestershire botany are Dr. R. Pulteney, F.R.S., who was a surgeon at Leicester, and the author of "A General View of the Writings of Linnæus" (1781), and the well-known "Historical Sketches of the Progress of Botany in England up to the date of the general adoption of the Linnæan System" (1790); and the poet Crabbe, who lived at Belvoir from 1782 to 1813, when he removed to Wiltshire. Between 1820 and 1850 Leicestershire was the home of three clergymen, all of whom were enthusiastic botanists. The Rev. Andrew Bloxam lived at Twycross for more than forty years. He is best known as one of the special investigators of the British brambles, and partly, perhaps, because he worked them so thoroughly there is a general idea that Leicestershire is the richest county in England in forms of this complicated genus. He was one of the last survivors who kept up the old tradition of botany as it was in the days of Smith, Hooker, Turner, Dillwyn, and Forster, when a collector swept through the whole vegetable kingdom, from the flowering plants down to the fungi. The Rev. W. H. Coleman was a most energetic and capable botanist. He was for many years one of the masters of the Ashby-de-la-Zouch Grammar School, and it was he who laid the basis of the present work, dividing the county into a dozen districts, and tracing out the distribution of the plants through them as fully as he had opportunity. He died in 1864, and in 1875 his manuscript was handed over by his friend Mr. Edwin Brown, of Burton-on-Trent, to the Leicester Literary and Philosophical Society, which appointed a Committee to amplify and revise it. Of this Committee Mr. Mott, of Leicester, has acted as Chairman, and Mr. Carter, Dr. Finch, and Messrs. E. and C. Cooper are the other members. The other clergyman who worked in conjunction with Messrs. Bloxam and Coleman was the Rev. Churchill Babington, for many years the Disney Professor of Archæology at Cambridge, and now Rector of Cockfield, in Suffolk. In 1850 Miss Mary Kirby (now Mrs. Gregg) published a small flora of the county, which contained a substantially complete list of the flowering plants and ferns of Leicestershire, but no attempt was made to trace out their distribution in detail.

In the present work the number of flowering plants and ferns, native and naturalised, in Britain is estimated at 1546, and of these, 825 are admitted for Leicestershire. This number of 1546 is reached only by counting the sub-species of such variable types as *Ranunculus aquatilis* and

Rubus fruticosus, and by including a large number of plants that have no claim to be considered as really wild, such as *Linaria Cymbalaria*, *Corydalis lutea*, and the wall-flower. Mr. Watson's estimate was 1425, and, as compared with this, the flora of Leicestershire will stand at a little over 700. He worked out carefully in detail the distribution over the island of all these species, and showed that they fall into, broadly speaking, three geographical or climatic groups: that 532 species are spread generally over the whole island; that 606 species represent southern climatic and geographical influences; and that 238 species represent the boreal element in our flora, and are plants that are thoroughly at home only in the north of Scotland, and are found in England and Wales only in mountainous tracts. In any county, or other tract of land, the great mass of the flora always consists of the 532 generally-diffused plants, and the climatic difference between one county and another is shown by the extent to which the characteristically northern and southern types are represented. It adds very much to the interest which any book on local botany has for the non-resident general reader, if the writers keep these three climatic groups distinct in their minds, and give as complete an idea as possible of the way in which, and the extent to which, the austral and boreal types are represented in the area of which they treat. The writers of the present "Flora" have not attempted to give any general summary worked out upon this basis, and they are quite mistaken in supposing that their county includes three out of Watson's six climatic zones. Watson's infer-agrarian zone includes the low-level country south of the Humber and the Dee. Its characteristic types are such plants as *Clematis Vitalba*, *Rubia peregrina*, *Geranium rotundifolium*, *Trifolium subterraneum*, *T. suffocatum*, *Lathyrus Nissolia* and *L. Aphaca*, and *Centaurea Calcitrapa*. Watson's mid-agrarian zone inclu des the low levels of the north of England, up to a height of 900 feet above sea-level on the mountains of Yorkshire and the Lake District. Its upper limit is marked by the cessation (essential from climatic causes, not accidental) of fruticose Rubi, *Rosa arvensis*, *Pyrus Malus*, *Viburnum Opulus*, and *Alnus glutinosa*. Above this, up to the line of possible arable cultivation, extends the super-agrarian zone, with an average annual temperature of 42° to 45° F. The only county south of the Humber and Trent in which it is represented is Derbyshire. There do not appear to be in Leicestershire more than ten or a dozen out of the 238 boreal plants, such as *Lycopodium Selago*, *Empetrum nigrum*, and *Drosera anglica*, and these are either very rare or quite extinct. There is no saxifrage except *granulata* or *tridactylites*, no wild bird-cherry, no *Andræa*, no *Polypodium Phegopteris* or *Dryopteris*. To understand their county and its flora in their proper relation to the rest of England, Mr. Mott and his colleagues must revise completely their ideas on this subject. The county would appear to be essentially a mid-agrarian outpost, pushed out from the Pennine Chain into the centre of England; for, out of the 600 austral types, not more than about 150 enter into it, which is fewer than there are either in North Yorkshire or at the Lakes. The limestone types, the occurrence of which is regulated more by soil than climate, appear to be well represented.

For the way in which the details of the flora are worked out, we have nothing to give but commendation. In the identification of the Phanerogamia, great pains has evidently been taken by the Committee. No doubt some of the species, which they admit on the authority of their predecessors, will prove to be blunders, as, for instance, *Tofieldia palustris*, *Carduus heterophyllus*, and *Asplenium viride*. When the members of the county society make their excursions into the different districts, they will be able to see at a glance what plants have been gathered there by their predecessors. The flora includes, not only the Phanerogamia and ferns, but also the mosses, Hepaticæ, lichens, Algæ, and fungi. It is not likely that there are many fresh Phanerogamia or ferns still to find; but as only 4 Characeæ, 179 mosses, 49 Hepaticæ, 177 lichens, and 446 fungi are known, there is ample scope for further work in all these orders. The portion of the book devoted to Algæ, which is ably edited by Mr. F. Bates, of Leicester, contains descriptive notes on many of the less known species. There is an interesting note on p. 344, on the species which have become extinct. They are 30 in number, and are nearly all plants of swamps and heaths, amongst them being *Lycopodium Selago*, *Osmunda regalis*, *Pinguicula vulgaris*, *Drosera anglica*, and *D. rotundifolia*.

The book will be still more interesting when we have good floras of Warwickshire, Nottinghamshire, Derbyshire, and Cheshire to compare it with, and for all these counties "Floras" are in course of preparation.

J. G. BAKER

GEOLOGY OF JERSEY

Géologie de Jersey. Par Le P. Ch. Noury, S.J. (Paris: F. Savy; Jersey: Le Feuvre, 1886.)

CONSIDERING that Jersey became subject to the Crown of England at the time of the Norman Conquest, English geologists may agree with M. de Lapparent's complaint as to the neglect the island has hitherto received. Although the Geological Society of London made it their earliest care to publish in 1811 (not 1817, as quoted in the opening of this little volume) MacCulloch's paper on the Channel Isles, although at the present time more than one worker is engaged in further removing the reproach, M. Noury is even now well to the front in providing in a handy form an account of the structure of Jersey serviceable to inhabitants and visitors alike. The character of this well-printed *brochure* presupposes, however, some general knowledge of geology, and the author is perhaps not so uniformly happy as, let us say, the Rev. W. S. Symonds in placing his facts before the intelligence of the untrained tourist. Some controverted matters, moreover, of purely speculative value are introduced, such as the construction of the primitive crust (p. 126), the succession in time of granite, syenite, and diorite, and the formation from these of schists and gneisses by disintegration in a heated ocean. The description of the prevailing rocks is the work of a close observer in the field; and the careful mention of such materials as have been artificially introduced ("cultivated rocks," one might almost call them) cannot be too highly praised. Future geologists will thus be spared the description of gneissic fragments (p. 6) imported as ballast from Brazil.

The suggested derivation of "pyromeride" (p. 29)—

"*partagée dans le feu*"—is not historic, Haüy's and Monteiro's name referring to the different fusibilities of the two constituents of the spheroids. We doubt also the primary origin assigned to the chalcedony with which the hollows of these old rhyolites are so often filled. Here, as is so frequently the case among Continental writers, the immense importance of secondary changes appears to be overlooked. In one of these lavas M. Noury has found a spherulite measuring 18 inches in diameter. The "sphérolithes," however, of certain diabase veins (p. 41) would [illegible] to correspond to the spheroidal structure of [illegible]ed basalt rather than to the contemporaneous [illegible]nic bombs suggested by the author.

The account of the connection between open fissures and the decomposition of dykes, and of the origin of the numerous bays, as well as of the larger inland features, is full of interest to the visitor. In the review of the history of the island the discussion of recent elevation and depression is too lengthy to allow of justice being done to the evidence relied on for the ages assigned to the various types of rock—evidence derived solely from comparison with the mainland of France. The scanty preservation, moreover, of Secondary deposits in the Hebrides makes one cautious in accepting the conclusion (p. 139) that Jersey has remained above water since Permian times. M. de Lapparent has, indeed, recently stated that the final conglomerate may be of Triassic age.

The book is written in the lucid and attractive style that French men of science have taught us to expect. A coloured geological map forms a handsome and valuable addition.

G. C.

OUR BOOK SHELF

General Biology. By William T. Sedgwick, Ph.D., and Edmund B. Wilson, Ph.D. Part I. Introductory. (New York: Henry Holt and Co., 1886.)

THIS work has been planned by the authors as an "introductory study" to biological science, after digesting which the learner may proceed to Huxley and Martin's "Practical Biology," Brooks's "Hand-book of Invertebrate Zoology," or to a second part of the present book, which is promised to be ready some time this year.

In the first four chapters of the introductory portion, Messrs. Sedgwick and Wilson deal with the generalities of biology—that is, with the nature and properties of protoplasm and the origin and modification of cellular tissues. In the remaining chapters they discuss at full length the two types selected to illustrate the two principal modifications of life. These are, the common brake (*Pteris*) and the earthworm (*Lumbricus*). The embryology and physiology of the selected types are as fully dealt with as the pure morphology. At the end of each chapter a scheme of practical work is given, which may in some cases be of much value.

On p. 123 it is stated that "all the organs of the body are originally developed from the walls of these chambers"—that is, the chambers of the body-cavity formed by the dissepiments. But it is a well known fact that, as has been previously stated by the authors themselves (p. 152), the nerve-cords and ganglia are developed from the epiblast, or, as Messrs. Sedgwick and Wilson prefer to call it, the "ectoblast." Such being the case, it is obvious that the nerve-cords are not developed from the mesoblastic chambers.

Another and more serious error will be found on p. 143, where the *vesiculæ seminales* of the earthworm are described as the *testes*. It has been conclusively shown by Bloomfield that the large white bodies which fill up the tenth and eleventh somites of *Lumbricus* are really the *vesiculæ seminales*. The true *testes* are very small bodies, only present at certain periods of the year. There are two pairs of them, in the eleventh and twelfth somites. The *spermatozoa* are not fully matured in the *testes*, but pass into the *vesiculæ seminales* to complete their development.

Notwithstanding these few errors, Messrs. Sedgwick and Wilson's introductory essay is well adapted for the use of junior students in biology. Moreover, it is adequately illustrated by well-drawn woodcuts, far exceeding in clearness of execution the average of those found in American text-books.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Industrial Studentships

I AM directed to request that you will be so good as to allow me, through the medium of your columns, to inform manufacturers and others engaged in industries in which art is more or less concerned, that the Lords of the Committee of Council on Education have decided to make arrangements for the admission of a limited number of persons employed in those industries to study in the South Kensington Museum, Library, and Schools, without the payment of any fees, for periods of from two to nine months according to circumstances.

Detailed rules with regard to these working studentships will be sent on application to the Department. Briefly, the conditions may be stated to be that the designer or workman for whom admission is sought shall show that he has sufficient power of drawing and sketching to be able to profit by the opportunities afforded; that he is actually engaged in some art industry; and that the proprietors of the works in which he is engaged undertake to maintain him while he is studying at South Kensington. When admitted, the working student will be set, under direction, to study in the Museum and Art Library from examples relating to the industry in which he is employed, and he will also receive instruction in drawing and designing in the Art School, suited as far as may be to his special case.

My Lords have taken this step with a view to render the Museum of more speci l and direct use to the country, and they trust that the valuable collection of examples of applied art which has now been brought together may thus be more fully appreciated and taken advantage of by the directors of industry in the country.

J. F. D. DONNELLY

Science and Art Department, February 28

Top-shaped Hailstones

IN connection with the abnormal fall of rain which is taking place this cold weather in the North-West Provinces of India, and which has clothed the outer ranges of the Himalaya with snow down to the 5000-feet level, I should like to mention a fall of hailstones which occurred on January 21 near Ramnagar, in the Terai. The hailstones were not very remarkable for size, being generally one-third of an inch across, with here and there a larger one half an inch in diameter. Some peculiarities of shape and structure, however, arrested my attention. Nearly every one that was not deformed by collision was top- or pear-shaped. Owing to their rebounding from the ground, it was impossible to see whether the broad or pointed end fell foremost; but in every case the broad end was composed of perfectly hyaline, amorphous ice, whilst the pointed end was banded crosswise by alternate layers of clear and white ice. In every case this distinction was perfectly well marked.

In some few instances I found hailstones of another, but pro-

bably derived form. Instead of being circular in section at right angles to the long axis, they were triangular, so that they bore a strong resemblance to the kernels of a beech nut. The



broad end in this case also was perfectly transparent, and the sharper end banded as before.

I append three diagrams representing typical forms.

Ramnagar, Terai, January 25 C. S. MIDDLEMISS

Snowflakes

IN your issue of January 20 (p. 271) is an interesting sketch of the snowstorm of January 7, 1887, with mention of snowflakes 3½ inches long. Without vouching for the exact details I send you some statements from a letter in the *New York World* of to-day's issue. The letter is dated Fort Keogh, Montana, U.S., February 13. "The winter of 1886–87 will be long remembered throughout the north-west for the extreme severity of the temperature and the unusual depth of snow. From January 6 to 11 the degree of cold was something frightful. Mercury thermometers were often congealed, and spirit thermometers were kept jumping from 40° to 60° below zero. Half a dozen times has the 60° notch been touched, and once this season 62½° below zero has been scored on the Saskatchewan plains. But the authorities in weather in this country are the Indians. The oldest members of the Crow tribe say there have been few such winters as the present since they settled in the Yellowstone Valley. Curious phenomena sometimes attend a snowstorm. Near Matt. Coleman's ranch on January 28 the flakes were tremendous, some were larger than milk-pans. Some flakes measured 15 inches square and 8 inches thick. For miles the ground was covered with such bunches, and they made a remarkable spectacle while falling. A mail-carrier was caught in the same storm and verifies it." The narrative is one of great suffering, and loss of human lives and cattle. "Miss Maggie Bunn, school-teacher at Highmore, while going from the school to her house was frozen to death. The bodies of three Indians who belonged to Berthold Agency were found frozen near Ashland." And so on, in harrowing detail, for a number of whites perished. SAMUEL LOCKWOOD

Freehold, New Jersey, U.S.A., February 14

"Invisible at Greenwich"

I WRITE to note an apparent oversight which I have detected in the *Nautical Almanac* for 1888. The partial solar eclipse of August 7 is stated to be "invisible at Greenwich," but on applying a rigorous calculation I find that it will be visible there to a small extent, the times of contact being as follows:—

	G.M.T. h.	m.	Angle from N. pt.	Angle from vertex
First contact	6	53	... 11° to E.	... 26° to W.
Greatest phase ...	7	3	... ·013 (sun's diam. 1)	
Last contact	7	13	... 30° to E.	... 7° to W.

the angles being for the direct image.

I am aware that this is a very insignificant eclipse, but the greatest attainable accuracy is desirable in our national ephemeris, which, indeed, inserts eclipses much slighter than the above, *e.g.* the lunar eclipse of November 26, 1890, whose magnitude is only ·002. A. C. CROMMELIN

Trinity College, Cambridge, February 15

Lunar Halos

LAST evening (February 8), about a quarter-past eight o'clock (75th meridian time), I saw around the moon a series of coloured rings lying close together. The inner one was two or three diameters of the moon from the moon and *red*, the next was violet, then red, and finally violet again, this last one being very faint. From their proximity to the moon these rings seem to constitute the coronal, but I am puzzled by the fact that the inner ring was red. Do halos ever occur so close to the moon and without an interval between the two pairs of red and violet rings?

February 12.—Since writing to you on the 9th inst. I have found that my colleague here, Prof. W. G. Brown, noticed the rings around the moon about half an hour before I saw them. He says the colour nearest the moon was *yellow*, passing into red outwards, and that immediately following the red was violet, then the colours of the solar spectrum in order from violet to red on the outside. This indicates that the first red was really outside a violet ring which for some reason was invisible, and brings the phenomenon properly under diffraction: in fact, we had a good example of the coronal with the innermost rings wanting. S. T. MORELAND

Washington and Lea University, Lexington, Va., U.S.A.

The Beetle in Motion

IF it can interest Prof. Lloyd Morgan I am in a position to communicate that I have many times observed the progressive movements of insects, spiders, and myriapods. I have also noticed the retardation of hind-legs; it seems to me that this occurs only in the case of bulky and slow-moving beetles, like the larger Melasomata. In general, I find that the mode of progression in articulates does not differ essentially from what we see in vertebrates; the process is only, at first sight, a little obscured by the plurality of the legs. If we consider only the prothoracic ring of a beetle, we find that it walks like all bipeds, alternating one leg with another. Two segments walk in the manner of quadrupeds, which are not amblers. Now the legs of the third segment must necessarily repeat the movements of the legs of the first segment, for the sake of equilibrium. The fourth ring would repeat the movements of the second, and so on.

Tashkend A. WILKINS

A Recently-Discovered Deposit of Celestine

WITH reference to Mr. Madan's letter (p. 391), on "A Recently-Discovered Deposit of Celestine," I beg to inform him that a note was read by me at the last meeting of the Mineralogical Society, describing these crystals as exhibiting a habit and size unknown till then to occur with such crystals of celestine in England. I obtained the crystals at Christmas, from Mr. Henson, of the Strand, and am expecting to receive more material, which I hope to work on at the end of Term; but, unlike Mr. Madan, I have at present been unable to visit the locality where they are found. R. H. SOLLY

Mineralogical Museum, Cambridge, February 28

The Vitality of Seeds

MAY I ask, through the columns of your widely-circulated paper, whether there is any really trustworthy evidence for the following statement made by Prof. Judd in his address to the Geological Association (p. 393 in your last issue): "The botanist cites the germination of seeds, taken from ancient Egyptian tombs, as a striking illustration of how long life may remain dormant in the vegetable world." I know that this is a popular belief, but should like to learn upon what foundation it rests. Probably it would interest other botanists besides.

February 26 N. E. P.

THE RELATIONS BETWEEN GEOLOGY AND THE MINERALOGICAL SCIENCES[1]

II.

LET us now turn from the statical aspect of minerals, their morphology, to the dynamical aspects, their physiology.

Minerals are not fixed and unchangeable entities, as they are sometimes regarded. On the contrary, they exhibit varying degrees of instability, and pass through very definite series of metamorphoses.

We have already seen that every alteration in the temperature or other conditions which surround a crystal leads to striking modifications of molecular structure, which are at once revealed by the delicate tests of optical analysis. So sensitive, indeed, are some crystals to the action of external forces, that even the passage of the

[1] Address to the Geological Society at the Anniversary Meeting on February 18, by the President, Prof. John W. Judd, F.R.S. Continued from p. 396.

light-waves through their substance leads to permanent molecular rearrangements which are evidenced by marked changes in colour, translucency, and other properties.

Many minerals have their atoms so arranged that the action of external forces causes them to fall readily into new combinations. In this way there are brought about such paramorphic changes as that of aragonite into calcite, and augite into hornblende. Excessively slight manifestations of force are sometimes sufficient to induce such paramorphic changes.

But the most significant fact of all is that every crystal possesses certain peculiarities of molecular structure, and as the result of this internal "organisation," it responds definite manner to the action of various external , undergoing in this way well-marked series of sical and chemical changes without losing its identity. s the final result of such successive changes, however, the bonds which hold the "organised" structures together are gradually weakened, and at last break down altogether. In this way the separate existence of the mineral comes to an end; but the materials of which it was composed, resolving themselves into new compounds, may go to build up the substance of other "organised" structures. Need I point out that in all these respects minerals behave exactly like plants and animals?

But in the case of plants and animals changes such as these, which are the direct outcome of external forces acting on a special organisation, are called *physiological*, and I know of no valid reason why the same term should not be employed in the case of minerals. It is true that the accomplishment of the cycles of change in minerals often requires periods of time of enormous duration, and that during incalculable intervals they may appear to be wholly suspended; but in these respects the "life" of a mineral differs from that of a plant in just the same manner as the latter does from the life of an animal.

I must ask your attention for a few moments to these peculiarities of internal organisation in minerals, and to the way in which the various physical and chemical forces act and react upon them in consequence of their special organisation.

Recent researches have shown that every crystal possesses a number of planes, all of which are related to its peculiar symmetry, along which the several physical forces operate in a marked manner to produce changes in the physical and chemical properties of the crystal. These planes have been called the "structure-planes" of the crystal.

By far the most obvious of these structure-planes of crystals are those of cleavage. When crystals are subjected to the action of mechanical force they break up along one, two, or three definite planes, with varying degrees of ease. In some cases when this separation cannot be readily effected by percussion or pressure, it may be brought about by the unequal expansion and contraction in a crystal resulting from alternate heating and cooling. We cannot arrive at the limit of this liability of a crystal to separate along its cleavage-planes; if we powder a calcite-crystal and examine the fine dust under a microscope, each minute grain will be seen to have the form of a cleavage-rhomb of the material.

Now the exquisite molecular structure of a crystal, of which this wonderful property of cleavage is the outcome, is borne witness to, not only by the perfection of the cleavage-surfaces—presenting, as they do, a lustre which no artificial polish can imitate—but by the fact that each particular set of cleavage-surfaces presents definite characteristics, analogous to those seen in the actual faces of crystals. Each exhibits striking peculiarities in its mode of reflecting light; each yields in varying degrees to a hard point drawn across it in different directions; and each, when treated with appropriate solvents, is attacked in a characteristic fashion, giving rise to the geometrical forms known as the etching-figures. Wonderful as these cleavage-surfaces are, however, it must be remembered that the power of cleavage is one that, under ordinary circumstances, remains altogether *latent* in crystals.

Cleavage-planes, however, are not the only latent structure-planes in crystals. Long ago it was shown by Brewster, Reusch, and Pfaff, that when minerals are subjected to pressure in certain directions, their molecules appear to glide over one another along certain definite planes within the crystal; and, if we examine optically a crystal which has been treated in this manner, it is actually found to exhibit a series of twin-lamellæ arranged parallel to the so-called "gliding-planes." It thus appears that in the movements set up within a crystal by the application of force from without, certain of the molecules of which the crystal is built up, lying in bands parallel to the gliding-plane, are actually made to rotate through an angle of 180°.

At one time these "gliding-planes" were regarded as being peculiar to a few minerals, such as calcite and rock-salt; but the investigations of Frankenheim, Baumhauer, Foerstner, and especially of Mügge, have shown that they exist in crystals belonging to every group in the mineral kingdom, including all those minerals which occur as common rock-forming constituents, such as the feldspars and pyroxenes.

As is the case with the cleavage-planes, so with the gliding-planes, there may exist one, two, or three in the same crystal. One of these is usually a principal gliding-plane—the slipping movement with its accompanying twin-lamellæ being produced parallel to it with the greatest facility—while the others are subordinate ones.

Strange to say, however, the particular gliding-plane along which a crystal yields appears to be determined, not only by the direction in which the force is applied, but to some extent also by the nature of that force, whether percussive, or a sustained pressure, or a violent stress; in some cases where the application of external force fails to produce the gliding movement with its accompanying lamellar twinning, it may be induced by the strains which result from unequal expansion and contraction during the heating and cooling of a crystal. Some mineralogists have, indeed, proposed to apply distinctive names to the results which follow from the application of different kinds of force—whether a blow (*Schlagfiguren*), pressure (*Reissflachen*), or the effect of heating and cooling (*Contractionrisse*).

The gliding-planes of crystals are quite distinct from the cleavage-planes, though some very curious and interesting relations have in certain cases been shown to exist between them. That the artificial formation of twin-lamellæ, like the production of cleavage, is rendered possible by complicated molecular structures, it is scarcely necessary to point out. The application of external force to such crystals is like the putting of a spark to a train of gunpowder: the molecules lying in parallel bands are in unstable equilibrium, ready, so soon as set in motion, to roll through an angle of 180°.

There is still a third and even more subtle set of structure-planes in crystals to which I must now allude, those, namely, for which the name of *solution-planes* has been proposed.

It was long ago shown by Daniell that when crystals are exposed to the action of solvents they are attacked in such a manner as to give rise to peculiar geometrical forms. The subject has been followed up by Baumhauer, Leydolt, Becke, and others, who have shown what a wonderful variety of "etching-figures" may be produced by operating upon the various faces and cleavage-surfaces of different crystals.

Quite recently, however, it has been shown by Von Ebner, as the result of his studies of calcite and aragonite, that all the complicated phenomena of the etched figures arise from the existence of planes along which solvent or chemical action takes place most readily within

a crystal. It thus appears that the complicated etched figures, with their curved and striated surfaces, are indications of the combination or oscillation of tendencies to chemical action along the different solvent-planes of the crystal.

My own experiments have enabled me to show that the chemical action taking place along the solution-planes of crystals leads to the development of cavities, often assuming the forms of negative crystals, which may become wholly or partially filled with the product of the chemical action.

Although the solution-planes are quite distinct, both from the gliding-planes and the cleavage-planes of crystals, I have been able to show that some curious and interesting relations exist between them. If lamellar twinning has been already developed in a crystal, then chemical action takes place along the gliding-planes in preference to the normal solution-planes.

It is only when we study the minerals building up the rock-masses of the globe that we fully realise the importance of these molecular structures, and the wonderful changes which crystals are capable of undergoing, as a consequence of their internal "organisation." Then, and then only, do we begin to understand the significance and the far-reaching consequences of the physiological changes of which minerals are susceptible.

The crystals forming the rock-masses of the globe have been subjected to every variety of mechanical force —violent fracture, long-continued strain, steady but enormous pressure—prolonged over vast intervals of time, to which must be added the potent effects of alternate heating and cooling. Such crystals, moreover, are transfused through their whole substance by various liquids and gases acting under tremendous, and sometimes varying, pressures.

Under such circumstances it is not surprising to find that the crystals have often yielded along their cleavage-planes, and that cleavage-cracks have been produced. These, by affording a ready channel for the passage of solvents, not unfrequently determine the course of various chemical operations going on within the crystal.

Not unfrequently, too, the rock-forming minerals have yielded along their gliding-planes, and the development in them of twin-lamellæ is the result. Every crystal of calcite in an ordinary metamorphic limestone, and many of the plagioclase feldspars in igneous rocks, exhibit the secondary lamellar twinning which has arisen from the action of mechanical forces upon the mass.[1] The microcline structure in orthoclases, with many other similar structures in other minerals, must almost certainly be ascribed to the same cause.

Still more remarkable are the consequences which follow from the existence of the solution-planes in crystals. By the action of various solvents under pressure, augite is made to assume the forms known as diallage and pseudo-hypersthene, the ferriferous enstatite of bronzite or hypersthene, while the feldspars acquire their avanturine, schiller, and chatoyant phenomena. When, in addition to the statical pressures due to thousands of feet of superincumbent rocks, these solvent agencies work with those tremendous dynamical aids afforded by deforming stresses, such as make the rocks to flow during mountain-making, it is not surprising to find the molecules of the original crystals breaking from their old allegiances, and the liberated atoms uniting to form new minerals, the position of which is determined by the lines of flow in the mass.

Not a few of our gems owe their exquisite beauties to these physiological changes which have taken place in them since their first formation. The ardent glow of the sunstone and the pale watery gleam of the moonstone, no less than the lovely play of the azure tints in Labrador-spar and the bronzy sheen of Paulite, are the result of physiological processes taking place in crystals which were originally clear and translucent. In the profound laboratories of our earth's crust slow physical and chem[illegible] operations, resulting from the interaction betwe[illegible] crystal, with its wonderful molecular structure, and [illegible] external agencies which environ it, have given rise [illegible] new structures, too minute, it may be, to be traced by our microscopes, but capable of so playing with the light-waves as to startle us with new beauties, and to add another to

"The fairy tales of science, and the long results of time."

Yes! minerals all have a *life-history*, one which is in part determined by their original constitution, and in part by the long series of slowly-varying conditions to which they have since been subjected. In spite of the circumstance that their cycles of change have extended over periods measured by millions of years, the nature of their metamorphoses and the processes by which these have been brought about are, in all essential respects, analogous to those which take place in a *Sequoia* or a butterfly. In spite, too, of the limitations placed upon us by our brief existence on the globe, it is ours to follow in all its complicated sequence this procession of events, to discover the delicate organisation in which they originate, to determine the varied conditions by which they have been controlled, and to assign to each of them the part which it has played in the wonderful history of our globe during the countless ages of the past.

The subject of distribution, or chorology, is one of no less importance in the study of the mineral than in that of the vegetable and animal kingdoms. The relations of minerals to one another, and the manner in which they make their appearance in respect both to time and place, constitute a most instructive and suggestive field of research.

The older mineralogists paid some attention to the question of the mode of association of minerals with one another, which they described under the term "paragenesis." But this was at a time when only large and freely crystallised specimens received much attention. At the present day this question of the varied distribution of minerals in space and time, and the manner in which they are associated with one another to build up rock-masses, constitutes a most important branch of our science, that to which the name of petrology is given.

Under the name of "petrography" an attempt has been made to establish a branch of natural-history science which shall bear the same relation to mineralogy as that science does to chemistry. As minerals are formed by the union of certain chemical compounds, so rocks, it is argued, may be regarded as being built up of different minerals. But it must be remembered that while minerals possess a distinct individuality—the result of their different chemical constitution and their characteristic crystallographic form—we are quite unable to point to anything analogous to these in the case of rocks.

How is a rock-"species" to be defined? It is not enough to state its ultimate chemical composition; for rocks of the most varied character and origin may agree in this respect. Equally futile is it to take mineralogical constitution as the basis of our classification; for, in the

[1] It has often been asserted that the "striation" on the faces or cleavage-surfaces of crystals is an indication of the existence of polysynthetic twinning. But in the oligoclase of Ytterby and other localities, I have found that many crystals which exhibit striation do not affect polarised light differently in the alternate striæ. But on submitting the crystals to alternate heating and cooling, and sometimes by percussive force, the twinning may be easily developed in them. It appears from these observations that the crystals are built up of lamellæ, in which the molecules are alternately in stable and unstable equilibrium. I have in some cases found that the stresses upon a slice of feldspar which is being heated and cooled and then ground into a thin section, while cemented to a glass plate during the preparation of a microscopic slide, are sufficient to cause the rotation of the molecules in the alternate lamellæ. In some cases, I have no doubt that twin-lamellation, like cleavage-cracks, may be induced in the crystals of our rock-sections during the processes to which they are submitted in their preparation.

same rock-mass, the species of minerals which are present and their proportions to one another may, and, indeed, often do, vary from point to point. Nor does minute structure, though affording admirable criteria for distinguishing certain *types* of rock, supply a sufficiently definite means of diagnosis for all the different varieties which occur. A system of "lithology" may, indeed, be devised, if we confine our attention to the hand-specimens in our museums; but it breaks down the moment that we attempt to apply it in our researches in the field.

I have long felt assured that all attempts at a nomenclature and classification of rocks must, for the reasons just stated, be regarded as tentative and provisional only; but the careful study of rock-types is nevertheless bringing to light a number of facts calculated to profoundly modify mineralogical no less than geological thought and speculation.

Petrology forms the link between mineralogy and geology, just as palæontology does between biology and geology. Mineralogy has justly been styled the alphabet of petrology; but if the orthography and etymology of the language of rocks lie in the province of the mineralogist, its syntax and prosody belong to the realm of the geologist. In that language, of which the letters are mineral species and the words are rock-types, I am persuaded that there is written for us the whole story of terrestrial evolution.

Petrology, it is clear, could make but little progress until the improvement of microscopic methods enabled us to make accurate determinations of the minerals in a rock, even when these are present as the most minute particles. The characteristic peculiarities of the different rock-forming minerals, so carefully studied by Zirkel, their accurate optical diagnosis, at which Rosenbusch has laboured with so much success, these with the micro-chemical methods of Knop, Bořický, Streng, and Behrens, and the pyro-chemical method of Szabó, have already done much to render exact our methods of recognising the minerals in a rock. The contrivances, for which we are principally indebted to the French petrographers, for effecting the isolation of the minerals in rocks, so that they may be submitted to accurate chemical analysis, enable us in cases of difficulty or doubt to confirm or check the results of our microscopical studies.

But there is at present, perhaps, a tendency to confound the end with the means in such researches as these. When all the varieties of minerals in a rock have been correctly identified, the work of the petrologist is not ended; on the contrary, it is only just begun.

The relationship of the several minerals in a rock to one another, the discrimination between such as are original and those of secondary origin, and the recognition among the former of the essential, as distinguished from those that are accessory or accidental,—these are problems of even greater importance than the exact determination of the species or varieties to which each belongs. In not a few rocks it can be demonstrated that every one of its present mineral constituents is different from those of which it was originally made up; in some cases, indeed, it may be shown that the recombination of the elements of the rock into fresh mineral aggregates has taken place again and again. As well might we try to give a rational account of our English speech without taking into account the series of changes through which it has passed in its evolution from the Anglo-Saxon dialects, as to explain the nature of a rock without studying the influence upon it of the forces by which it has gradually acquired its present characters.

With respect to the geographical distribution of the different mineral species, many suggestive observations have been made. Some, like the feldspars, the pyroxenes and the olivines, appear to be ubiquitous in our earth's crust, and even make their appearance again in those bodies of extra-terrestrial origin—the meteorites. Others, like leucite, nepheline, hauyn, sodalite, and melilite, are exceedingly abundant in certain areas of the earth's surface, while they appear to be wholly wanting in others.

Still more remarkable are the relations which are found to exist between the types of rocks occurring in different geographical areas. The study of this subject is leading us to the recognition of the fact that there are distinct petrological provinces. In closely adjoining areas—such as Hungary and Bohemia, for example—widely different types of rock have been erupted during the same geological period; and this is a fact not less striking and significant than that of the meeting of two perfectly distinct biological provinces along a line which traverses the Malayan archipelago. It cannot be doubted that the prosecution of this hopeful branch of study—the geographical distribution of minerals and rocks—will lead us to results of the highest interest and value.

That there will be shown to be a distribution of rocks in time, as well as in space, I am perfectly prepared to believe. I cannot but think, however, that some of the generalisations on this subject which have been hazarded are somewhat premature. To a geologist (especially one belonging to the school of Lyell) it is equally difficult to conceive that there should be a broad distinction between the metamorphic rocks of Archæan and post-Archæan age respectively, as that the pre-Tertiary volcanic rocks should be altogether different from those of Tertiary and recent times.

The great object of all our studies—concerning the morphology, the physiology, and the chorology—of the mineral kingdom, ought to be to arrive at definite ideas concerning its ætiology; the causes by which the existing forms, capabilities, and positions of minerals and rocks have been determined.

While the *fossils* contained in rock-masses afford us the means for determining the date of their origin, the careful study of the minerals which they include may enable us to unravel the complicated series of changes through which they have passed since their first formation.

Eighteen years ago, when seeking to show how the origin of a particular rock might be elucidated by a combination of studies in the field, in the chemical laboratory, and by the aid of the microscope, I ventured to offer to this Society some general remarks on this subject. As it has been my constant endeavour since that time to apply the principles then enunciated in the case of rocks of more complicated character and more recondite origin, I may perhaps be forgiven for repeating the words I then used. Every rock since its first formation "has undergone and it still is undergoing a constant series of internal changes, the result of the action of different causes, as heat, pressure, solution, the play of many chemical affinities, and of crystallographic and other molecular forces, causes insignificant perhaps in themselves, but capable under the factor *time* of producing the most wonderful transformations. The geologist is called upon to unravel the complicated results, to pronounce what portion of the phenomena presented by a rock is due to the forces by which it was originally formed, and what must be referred to subsequent change; to discriminate the successive stages of the latter and to detect their various causes; in short, to trace the history of a rock from its deposition to the present moment."

Dr. Wadsworth has well characterised the changes which take place in rock-masses as due to the tendency of unstable mineral combinations to pass into stable ones. It must be remembered, however, that stability is a relative term, and that the arrangement of molecules which is stable under one set of conditions becomes unstable under another set. As by the internal movements and the external denudation of the earth's crust, the conditions under which rock-masses exist are undergoing slow but

continual change, new adjustments of the molecular structure of the rocks are at once necessitated and brought about.

In attempting to reason as to the *original* conditions under which a rock-mass must have been formed, it is of great importance to avoid those sources of error which exist in rocks that have undergone much secondary alteration. Such rocks abound in, though they are not necessarily confined to, the older geological formations; and it is among the younger and fresher rocks, therefore, that we may most hopefully seek the key to many petrological problems.

If, for example, we concentrate our attention upon the more recent and less altered igneous rocks, it becomes clear that the degree of crystallisation displayed by them has depended on the slowness with which consolidation has taken place, and that this has in turn been determined by the depth from the surface at which they have been formed. In this way, by the study of igneous rock-masses in Scotland and in Hungary, I was able to show that there is a perfect gradation from highly crystalline rocks—granites, diorites, and gabbros—into the ordinary volcanic types—rhyolites, andesites, and basalts, respectively—and from the latter into the various kinds of volcanic glass. These conclusions have been confirmed by subsequent investigations like those of Hague and Iddings in the Comstock region, and of Lotto in Elba. Further and more recent researches have enabled me to show that certain types of structure have been determined in rocks, according to the more or less perfect absence of all movement within them during their consolidation.

Very remarkable, indeed, are the internal changes which take place in rock-masses when they are submitted to those powerful stresses which result from the movements that occur during mountain-making; and the full explanation of these is perhaps the most difficult problem which still confronts the geologist.

It was long ago asserted by Scrope and Darwin that the solid rock-masses of the globe, under such conditions as these, must have actually *flowed*, like the viscous lavas of the rhyolitic series. These geologists were even able to show that the separation and disposition of the crystalline elements in such lavas present the closest analogy with what is seen in the crystalline schists and gneisses of greatly disturbed areas.

Since these early researches, which were principally based on the study of rocks in the field, aided only by the pocket-lens, three classes of researches have served to deepen our insight into the methods by which the schistose and gneissose rocks must have been produced.

In the first place, the experiments of MM. Tresca and Daubreé have shown that solid matter under enormous pressure behaves like a viscous substance, its whole internal structure exhibiting evidence of the flowing movements to which it has been subjected.

In the second place, the studies of M. Spring have established the fact that both paramorphic change and direct chemical reaction may result from simple pressure. Thus the unstable monoclinic form of sulphur, by a pressure of 5000 atmospheres, was at ordinary temperatures converted instantly into the stable rhombic form, a transformation accompanied by change of density and of many other physical properties. Still more striking is the case of the unstable, yellow, rhombic, mercuric-iodide, which, by simple rubbing with a hard substance, passes into its stable, red, tetragonal allomorph. It is instructive to notice that the same change in both instances appears to take place "spontaneously" after a sufficient interval of time; or, in other words, small variations in temperature, pressure, and other surrounding conditions are capable, if sufficient time be allowed, of bringing about the same result as more intense pressure applied suddenly. That the similar paramorphic change of pyroxene into hornblende, which is so frequently exemplified in the earth's crust, is sometimes the result of intense pressure, and at other times follows from the repeated slight alteration of conditions during long periods of time, we have, I believe, abundant evidence.

But the experiments of M. Spring that prove that chemical reactions can result directly from pressure are of even greater interest to the geologist. By submitting mixed powders to intense pressure, he succeeded in producing metallic alloys and various binary compounds, and also in bringing about double decomposition between many salts. That similar reactions between the complicated silicates which form the minerals of rocks have resulted from the enormous pressures to which they have been subjected, we have the most ample proof. Thus in rocks where such pressure has just begun to act, such as the "flaser-gabbros," wherever the unstable olivine is in contact with the almost equally unstable anorthite chemical reactions have been set up by the pressure, and these have resulted in the formation of zones of enstatite and anthophyllite, hornblende and biotite, which have been so well described by Törneböhm, Bonney, Adams, and Williams. Provided with the clue supplied by these results, we find little difficulty in going one step further. When the pressure has been still more intense, as in mountain-making movements, reactions are set up among all the minerals of the rock-mass; the elements of which it is composed, set free from their old engagements, enter into new alliances, and the result is the formation of a completely new set of crystallised minerals.

The third class of researches, destined, as I believe, to remove our difficulties in explaining the origin of the schistose and gneissose rocks, are those already alluded to as having been undertaken with the microscope. As yet the details of such changes have only been explained in the case of some of the simpler examples; but I am convinced that the persevering application of the same methods in the field and the laboratory will result in the removal of difficulties that now seem to be absolutely insurmountable.

Some observers in this country have been led to infer that the recrystallisation of rock-masses under pressure has in all cases been preceded by their pulverisation. Of this, I confess that I can find no evidence. That near great faults of all kinds, this reduction of rocks to powder does take place, we find abundant proof; but the evidence also points to the conclusion that such *rock-crushing*, as distinct from *rock-flowing*, is in every case local and exceptional.

There is another and totally different series of changes which takes place in rocks, when, brought near to the surface by denudation, they are exposed to the action of water, oxygen, carbonic acid, and other atmospheric agents. The breaking-up of the alkaline silicates and the deposition of secondary silica, the formation of the zeolites, the epidotes, the chlorites, and serpentine, the resolution of crystallised minerals into the isotropic mixtures, and the recrystallisation of these in new forms, all offer problems of the highest interest to the geologist.

I may venture, in drawing these remarks to a close, to indicate another point of analogy between the three natural-history sciences. It is found in the circumstance that experimental verifications of our conclusions are often difficult, if not actually impossible.

We must be content to reason from the proved variability of the existing forms of plants and animals as to the possibility of the production in time of new species. And in the same way, with our limited command of heat, pressure, and especially of time, we can scarcely hope to originate the exact counterparts of the various minerals and rocks of our earth's crust.

We may nevertheless point with satisfaction to what, in spite of such difficulty, has already been accomplished in this interesting field of research. The honour of having

pushed these researches to such successful issues belongs chiefly to the chemists, mineralogists, and geologists of France. To the labours of Senarmont, Daubrée, and a host of other workers, we owe the artificial production of a very large number of the minerals of our globe; while the ingenious experiments of Fouqué and Michel Lévy have resulted in the formation of many rocks differing in no essential particulars from those which have been produced by natural agencies.

In the prosecution of his various researches the importance and value of exact mineralogical knowledge to the geologist is becoming every day more apparent. The temporary estrangement between the cultivators of mineralogy and geology is now, we may hope, for ever at an end; very heartily, indeed, do geologists recognise and welcome the aid of their brethren the mineralogists.

But if it be confessed that the benefits, past and prospective, conferred on geological science by mineralogy are vast and even incalculable, it must also be admitted that the debt is amply repaid by the beneficial influence which is being exercised in turn upon mineralogy by geology.

Some time ago a distinguished mineralogist asked me if I did not find the ordinary text-books of his science but little calculated to arouse the interest or excite the enthusiasm of students. I am sure that the energy of my assent must at least have assured my friend of the strength of my convictions on the subject.

Too long, indeed, has the accumulated mass of mineral lore recalled the grim vision of the seer of Chebar. In that gruesome valley the wail of the student, "the bones are very dry," has mingled with the sigh of the teacher, "Can these bones live?" But now from the four winds of heaven come the constructive ideas of many minds—from Scandinavia and from France, from Germany and from the United States—and in obedience to this influence behold "a great shaking" in the formless mass. Scattered facts, isolated observations, imperfect generalisations, and tentative hypotheses are falling together "bone to his bone," and are building up a sound body of mineralogical knowledge; and into this the spirit of geological thought entering, mineralogy shall stand forth a living science.

DR. WILLIAM TRAILL, OF WOODWICK[1]

THE death of this assiduous student of natural history merits more than a passing notice, since there are few surgeons who did more for the advancement of Eastern conchology than he; while his researches on the antiquities of his native county (Orkney) also claim attention. His whole career, indeed, as in the case of many an Eastern surgeon, illustrates the wisdom of placing both natural history and botany on the curriculum of every medical student.

Dr. Traill was the eldest son of Mr. Traill, of Westness, Rousay, Orkney, and he was born in Kirkwall on September 8, 1818. He proceeded to the University of Edinburgh to study medicine at the age of sixteen, and while there he had the advantage of the direction and advice of his uncle, the late Prof. Traill, who held the Chair of Medical Jurisprudence. Young Traill proved an apt student, and showed from the first a strong liking for natural history. This was fostered by his uncle (whose collection of snakes, now in the Museum of Science and Art, was well known to naturalists), as well as by his pursuits during the holidays at the family seat at Westness, in the Island of Rousay. Amongst his fellow-students were Dr. Cleghorn, of Stranthie, late Conservator of Forests in India, Sir Lyon Playfair, and Dr. Halliday Douglas.

After graduating in 1841, he proceeded to India as a surgeon in the East India Company's service. The splendid field thus opened up to the young naturalist stirred all his energies into activity, and he studied and collected various groups, but especially the land-shells of Madras. His early studies on the shores of Orkney had given him a predilection for this department, and he remained faithful to it throughout life. Thus, when shortly afterwards called to serve in China, he began the collection of those beautiful specimens of Eastern shells now so well known in many collections. His opportunities were further extended by a residence of some years at Singapore, and afterwards at Malacca and other stations. He returned to England in 1854, and his collections were much admired, both as regards the beauty of the specimens and the number of examples of each species. His acquaintance with Dr. Knapp, a retired army surgeon, and also well known as a malacologist, gave a great impetus to his studies, as also did his association with Andrew Murray, Robert Gray, Dr. Howden, Wyville Thomson, Foster Heddle, James Cunningham, Patrick Dalnahoy, and R. Greville.

His return-voyage to India in 1856 gave him an opportunity of examining the pteropods and other pelagic mollusks, and his observations, with four plates and a chart, were communicated by Sir Walter Elliott to the *Madras Journal*, then edited by his friend Dr. Cleghorn. His preparations of the delicate glassy shells of the Thecosomatous forms was remarkable. He also described some rare species, observed certain peculiarities in their structure, and made comparisons between the velum of the young Cypræa and the epipodia of the pteropods. His collection of Eastern mollusks was largely increased during his second period of duty, so that it became celebrated for certain rare types, such as *Rostellaria rectirostris*, *Trochus guilfordii*, *Trochus imperialis*, &c. He also added largely to Prof. Traill's collection of snakes formerly alluded to.

On retiring from active duty he settled at St. Andrews, and at once took an active interest in the University Museum and Literary and Philosophical Society, of which latter he was a Vice-President at his death. He spent much of his time in arranging the Mollusca in the Museum, and he enriched the collection by many interesting and rare types. In his annual trips to his estate in Orkney he also made researches on the antiquities and geology of the district, and these he embodied in papers communicated to the Edinburgh Antiquarian Society, and to the Society at St. Andrews. Amongst these papers are the following:—"Results of Excavations at the Broch of Burrian, Orkney," two plates and woodcuts; "Notice of Excavations at Stenabeck, Orkney," with woodcuts; "On Submarine Forests in Orkney"; "On the Picts' Houses of Skerra Broc"; "On the Recurrence of Boulder-Clay in Orkney"; "Notice of the Boulders in North Ronaldshay," &c.

His knowledge of botany also enabled him to acclimatise various plants in Orkney, such as *Phormium tenax*, various Veronicas, the Manuka (Capt. Cook's sea-plant), the Japanese *Euonymus*, and others.

Dr. Traill was a man of refined and cultivated mind, genial but unobtrusive, and had a large circle of friends. He enjoyed good health till eighteen months ago, when the first symptoms of the disease which ultimately proved fatal appeared. W. C. M.

[1] Abstract of Paper read at the Literary and Philosophical Society, St. Andrews, January 21, 1887.

THE EARTHQUAKE

A SERIES of shocks of earthquake has caused much havoc in the Riviera during the last week. Although it is too early to attempt to give a complete account of what has happened, the leading facts, so far as they are of scientific interest, are well summed up in the following report, issued by Father Denza, of the Montcalieri Observatory:—

"(1) The earthquake in our region has had nearly the

same effect as those on November 28, 1884, and September 5, 1886. In length it extended to the east along a line leaving the plains of Lombardy at Lomellina, and passing by the district of Alessandria to the Riviera di Levanto, and westward over all the Western Alps, proceeding towards Switzerland as far as Geneva and beyond, and to Paris and Corsica. The telluric movement proceeded from the Lepontine Alps on the north to the Gulfs of Lyons and Genoa on the south, extending, but more feebly, through Tuscany to Rome.

"(2) The movement had its greatest intensity in Liguria, in Southern France, and in Piedmont, where it shook the whole of our plain, and penetrated into all the Maritime, Cottian, Graian, Pennine, and Lepontine Alps.

"(3) This time the centre of the strongest intensity was in the Gulf of Genoa, along the line dividing the place where the Apennines join the Alps, and extending from Savona to Mentone. It was within this space that people lost their lives in several localities, such as Savona, Noli, and Mentone, and everywhere as far as Marseilles there were numerous disasters and buildings thrown down. The movement of the soil, not so violent, but equally disastrous, spread over the mountainous country which extends from the Altare Pass to Millesimo, Mondovi, and the neighbouring regions. The shock was severe, but it did no considerable damage, in a portion of the province of Coni, as also in the provinces of Alessandria and Turin, it being very intense on Mont Cenis. It was slighter in the plains and in the valleys of the province of Novara.

"(4) In the places where the earthquake was most intense the principal shocks were three in number, and with a slight difference, depending probably on the difference of clocks, correspond to the times indicated by the seismic instruments of our Observatory—namely, the first at 6.22 a.m., the second at 6.31, and the third at 8.53. In the places near the centre of motion slight shocks occurred at intervals all through the day. The severest and most terrible shock was the first, which was undulatory in several places, oscillatory, and perhaps rotatory. It was several times prolonged and accentuated. Here at Montcalieri, as at Turin and elsewhere, it had three principal repetitions, plainly evidenced by the courses traced by our registering seismograph. These augmentations of intensity were mistakenly regarded by some as so many distinct shocks.

"(5) The dominant direction of the first undulatory shock was from west to east, with slight deviations at intervals from west and north-west to east and south-east, and with oscillatory and very slight vibrations. The two other shocks were also undulatory, and the last was rather more intense than the second, btt without reaching the intensity of the first. The second and third had about the same direction as the first.

"(6) The earthquake in places where it was severe and very severe was accompanied by rumblings. I may add, in conclusion, that about 2 o'clock this (Thursday) morning our most delicate seismic instruments signalled very slight fresh shocks, undulatory, and from north-west to south-west."

The fullest and most accurate details as to the successive shocks have come from the more important towns in the western Riviera. Mr. W. J. Lewis, writing to us from the Hôtel des Iles Britanniques, Mentone, on Saturday, the 26th of February, says that some slight vibrations seem to have been felt there about midnight and 3 a.m. before the great shock. "This last," he continues, "occurred apparently a few minutes before six, just as day was dawning." He was roused from sleep by being violently jolted in bed, which was being shaken with great violence. At the same instant he heard loud noises of apparently cracking walls and ceilings, and the rattle of falling plaster and breaking glasses. "I did not," says Mr. Lewis, "instantly realise my position, but had time to consider what was going on, and to conclude that, if the house collapsed under the shock, escape was hopeless, and that there was nothing to be done. This may possibly have taken ten seconds. Needless to say, that when the motion ceased and I found myself unharmed, I was up, seized my warmest clothing, and was down in the garden in less than a minute. The daily Press will have sufficiently described the scenes which have occurred throughout the Riviera. The second shock, of considerable, but much less, force, occurred about ten minutes later. I observed, within a few minutes of this that the hall clock marked 6.15, local time, corresponding to 5.54 a.m., so that I should be inclined to place the second shock at 6.10. A third shock of about the same intensity as the second occurred between 8.30 and 8.45. This last threw down [illegible] bricks, tiles, &c., which had been displaced by the [illegible] shock, and raised the panic to the greatest height."

According to Mr. Lewis, the early reports of the disaster at Mentone were much exaggerated, but the truth, he says, is bad enough. "The large hotels, especially those in high situations, seem to have suffered least. The whole of the East Bay and the old town have escaped practically unharmed. The greatest damage has occurred to two-storied buildings placed on the alluvial soil in the comparatively level part lying along the sea, and in the valleys of the Carrei and Borrigo, embracing the main portion of the modern town of the West Bay. Here the relation with the foundation is well marked in the case of two equally well-built houses not more than 300 yards apart, viz. St. John's Parsonage and the House of Rest. The former is in the valley, and the foundations were a source of great trouble at the time of building. It is very much shattered. The other is built on a rock, and has escaped uninjured. Within a radius of a quarter of a mile of the station the main destruction has occurred. But the houses most wrecked—some score or more—show most conclusively bad building. The large hotels in this injured area—the Iles Britanniques, National, Orient, Mediterranée, des Colonies, &c.,—most of which are four to five stories high, have suffered injury to lathe and plaster, but in few places are the main walls seriously damaged. In the case of these high buildings the intention of raising them to such a height necessitated a firm and solid foundation. I have noticed that the walls in a part of this hotel at a height of six stories have on the top floor suffered no visible damage. In the same way Monte Carlo, built on rocky ground, has escaped uninjured."

Writing from Nice, a correspondent of the *Times*, signing himself "Commander, R.N.," says that, on Wednesday morning, about six o'clock, he was awakened by an extraordinary commotion so unaccountable that for a moment he thought an escaped lunatic was shaking the bed in a maniacal outburst of fury. Running to the window, he saw that the shock must have been very severe, "for everywhere the streets were strewn with fragments of cornices, mouldings, chimney-pots; while many houses exhibited dangerous-looking cracks and rents in the walls of the upper stories. Another shock as violent as the first must inevitably have been followed by the downfall of many buildings. Fortunately, however, none of the succeeding shocks at all approached the first in violence." Another correspondent of the *Times*—"C. E. de M."—writes from Nice, that he was awakened shortly after 6 a.m. by "a tremendous vibration, which shook the whole house, a large hotel, from top to basement. The bed rocked and swayed violently to and fro like a hammock set swinging, and great masses of plaster fell from the ceiling and walls in every direction, strewing the room with *débris*, while the paper was literally stripped off the walls, and every second the whole hotel appeared as if it must topple over. . . . At 8.30 a.m. another shock, though of less violence, seemed to complete the reign of terror which had now set in."

At Cannes Sir Theodore Martin noted that the first of

a series of shocks began at five minutes after six (Cannes time). "No premonitory warning was given, and there was none of that rumbling noise which frequently accompanies earthquakes. The sky was without a cloud, and the first 'rose of dawn' had just begun to show itself in the east. The air was still and fresh, and not a leaf stirred on mimosa or eucalyptus. The trembling, beginning somewhat gently at first, like that produced by the passage of a heavy railway train, grew rapidly more and more marked. . . . The convulsion lasted for fully a minute, and the oscillation was from east to west. A second but slight shock, some minutes afterwards, did not tend to diminish the apprehension caused by the first. So far as [illegible]arm, few of the thousands who fill the hotels [illegible]ed in their rooms, the great majority finding their [illegible], some in the scantiest of raiment, into the adjoining gardens. The first alarm was beginning to pass off when, about half-past eight, a third shock was felt. This did not last above fifteen seconds, but while it lasted it was very severe, shaking the floors and moving the furniture in the same way, but in a less degree than the first shock. The air continued calm as before, and the whole sky was flooded with sunshine."

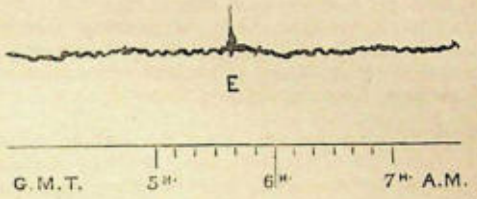
It will be observed that Sir Theodore Martin describes the direction of the oscillation at Cannes as from east to west. Another correspondent of the *Times* says that at Antibes the undulations were "undoubtedly from west to east." At Toulon, where there were two violent shocks about six o'clock, the undulations were also from west to east. On the other hand, at Turin, where there were three shocks in the space of seventeen seconds, the second shock, which was by far the strongest, had a direction from north-east to south-west.

At Marseilles two smart shocks were felt about 6 a.m., and a third at 8.30 a.m. They lasted about fifteen seconds each, and caused fissures in several houses. At Nimes some windows were shattered, and the clocks stopped; and like results were produced at Grenoble. At Avignon three shocks were felt between 6 and 8 o'clock a.m., and the first shock was violent enough to awake all the inhabitants. Slight shocks were felt at Lyons.

It was in the towns and villages of the Italian Riviera that the earthquake produced its most desolating effects. Diano Marina was utterly destroyed. At the first shock, about 6 o'clock, the inhabitants of this place rushed into the streets half dressed. Then came a more fearful shock. A frightful cracking noise was heard as far as the beach, and the houses fell in, burying the greater number of those who had lived in them. The results at Diano Castello, a mile and a half off, were also very appalling, and at Bajardo more than 200 persons were killed in the church. The full extent of the calamity which so suddenly overtook these and other places in the same district cannot even yet be accurately determined. The following is the official list of dead and wounded:—Alassio, 3 dead, 8 wounded; Albenga, 30 wounded; Albissola, 3 dead, 12 wounded; Bajardo, 230 dead, 30 wounded; Bussano, 80 dead, 27 wounded; Castellaro, 41 dead, 65 wounded; Ceriana, 5 dead, 12 wounded; Diano Castello, 35 dead, 10 wounded; Diano Marina, 180 dead, 65 wounded; Montalto Ligure, 1 dead, 3 wounded; Noli, 16 dead, 12 wounded; Oneglia, 23 dead, about 150 wounded; Pompeiana, 5 dead, 7 wounded; Porto Maurizio, 1 dead, 10 wounded; Savona, 11 dead; Taggia, 8 dead, 14 wounded; Triora, 4 dead, 9 wounded.

All over Switzerland the earthquake was felt, more or less, and the oscillations are said to have been from north to south. Dr. A. Riggenbach, Assistant Astronomer at the Basle Observatory, writes to us that some shocks occurred there. The two clocks of the Basle Observatory, and the two regulators of the public electric dials, the principal astronomical clock of Knoblich, keeping sidereal time, were stopped at 6h. 42m. 50s. a.m. local mean time, or 5h. 34m. 30s. a.m. Greenwich mean time.

Mr. G. M. Whipple, Superintendent of the Kew Observatory, has been good enough to send us a careful tracing, which we reproduce, of the curve given by the bifilar magnetograph at the Kew Observatory, showing that the instrument was affected by the earthquake about 5.40 a.m. Indications of the later shocks were shown on the original photograph, but not with sufficient clearness to enable them to be satisfactorily identified. In the Signal Office at Washington, the Government seismoscope was, on Wednesday morning, disturbed by accurately recorded shocks at 7.33 a.m. This is equivalent to 7.50 a.m. by the standard time of the 75th meridian. If, therefore, these shocks were connected with the earthquakes in Southern Europe, the velocity of their transmission from the Riviera was about 500 miles an hour.



Copy of trace of bifilar magnetograph at the Kew Observatory, Richmond, Surrey, 1887, February 23, 5–7 a.m. Movement produced by earthquake marked E.

The problems connected with the earthquake were discussed at the meeting of the French Academy of Sciences on Monday. M. Mascart stated the contents of a note from M. Fines, of Perpignan, who possesses a magnetometer. A little before the shock his magnetic instruments were shaken by a peculiar jolting motion. At 5.45 a.m. the magnetic registering instruments at the Observatory in the Parc de St. Maur, near Paris, exhibited the same motions. At the Lyons Observatory similar vibrations were observed at 5.55. M. Mascart remarked that these movements were simultaneous. It was not, therefore, an oscillatory movement passing from one point to another with which they had to deal, but a phenomenon which affected a large space simultaneously. He supposed there had been an electric current which had acted on all the instruments placed within its sphere of action. The form of the curves recorded was very distinct from those given by magnetic instruments when affected by storms or auroras. M. Mascart suggested that means might yet be found of predicting the approach of a seismic storm. He added that if the cause of the effects that had been observed was an electric flux, it was easy to understand why their intensity was everywhere nearly the same. A commission was appointed to examine documents which may be transmitted with reference to the earthquakes.

NOTES

A CIRCULAR to Great Britain and the other European States, and to the United States, has been forwarded by the Executive Commissioners of the Melbourne Centennial International Exhibition. The Exhibition will be opened on August 1, 1888, in order to celebrate the centenary of the founding of the colony of New South Wales, and will remain open for six months. The Commission invites the British, foreign, and colonial Governments to participate in the undertaking, and trusts that steps will promptly be taken by them for the completest possible representative display. It is pointed out that the population of Australasia is 3,500,000, that the imports of British goods annually amount in value to 32,000,000*l.*, and that 7700 miles of rail-

way are open for traffic, while over 2000 miles of line are in course of construction. Applications for space must be made before the end of August this year. The Commission desires to make the Exhibition specially interesting in manufacturing processes, machinery, &c., in motion, and objects of manual labour. There will also be a picture gallery lighted by electricity. Further information may be obtained from the Agent-General in London, or from the Executive Commissioners in Melbourne.

MR. ROBERT ETHERIDGE, JUN., of the Geological Department of the British Museum, has received the combined appointments of Palæontologist to the Department of Mines, and to the Australian Museum, Sydney, and will shortly proceed to Australia to take up the duties of the two offices. His extensive palæontological knowledge will be much missed in the British Museum.

SOME days ago the Medical School of Paris elected M. Brouardel as Dean, in the place of M. Béclard, recently deceased. M. Brouardel is Professor of Forensic Medicine.

ON Saturday last Mr. John Morley delivered, in the Egyptian Hall of the Mansion House, the annual address to the students of the London Society for the Extension of University Teaching. His subject was "The Study of Literature," and we need scarcely say that he set forth his ideas with his usual vigour and lucidity. But what did Mr. Morley mean by the following sentence: "I, for one, am not prepared to accept the rather enormous pretensions that are nowadays made sometimes for physical science as the be-all and end-all of education"? By whom are these "rather enormous pretensions" made? Men of science, no doubt, claim for the study of physical science a high place in education; but we have never heard that they feel disposed, on that account, to exclude the study of art and literature.

THE University of St. Petersburg lately celebrated its sixty-eighth anniversary. It has 64 professors, 47 fellows, 8 lecturers, and 39 laboratory assistants. There are 2627 students, who are grouped as follows:—For Oriental languages, 87; for law, 1170; for natural science, 426; for mathematics, 618; for history and philology, 224.

WE have received the four February sections of "Studies in Microscopical Science," edited by Mr. Arthur C. Cole. The text, which is finely illustrated, relates to Haustoria, the ovary and ova in birds, fatty degeneration of the kidney, and microbes.

PROF. OTTO STRUVE'S jubilee was celebrated some days ago at the Pulkowa Observatory. A great number of delegates from learned societies and scientific institutions were present.

THE new journal edited by Prof. Grancher is called the *Bulletin Médical*. It appears in Paris twice a week, on Thursdays and Sundays.

IN the February number of the Journal of the Anthropological Institute there is an interesting paper by Mr. Bloxam, describing eight specimens of Aroko or symbolic letters, which have actually been used by the tribe of Jebu in West Africa. These Aroko were sent to Mr. R. N. Cust by Mr. J. A. Otonba Payne, Registrar of the Supreme Court at Lagos, who himself belongs to the tribe of Jebu. The paper is carefully illustrated. One of the figures represents a message from a native prince of Jebu, Ode, to his brother residing abroad. It consists of six cowries, all turned in the same direction. The quill of a feather is passed through them from front to back, and the shaft is turned towards the end of the quill and fixed to the side of the cowries. The significance of this symbolic group of objects depends upon the facts that, in the Jebu language, six is "E-fà," from the verb "fà," to draw, and that Africans are in the habit of cleansing their ears with a feather, and look upon it as the only instrument by which this can be effectually done. The meaning is: "By these six cowries I do draw you to myself, and you should also draw closely to me; as by the feather only I can reach to your ears, so I am expecting you to come to me, and hoping to see you immediately."

IN the *Rendiconti* of the Reale Istituto Lombardo for January, Count Trevisan de Saint-Léon describes some experiments recently carried out by Dr. Bareggi in Milan, for th[illegible] of showing that it is possible to ascertain, from the state[illegible] blood, whether persons bitten by animals suspected of ra[illegible] or even undoubtedly mad, have really been infected.

THE Reports of the Botanist to the New York Agricultural Experiment Station, Geneva, N.Y., Mr. J. C. Arthur, for 1885 and 1886, furnish an admirable illustration of the value of such State appointments. A large portion of both Reports is occupied with an exhaustive history of the pear-blight (*Micrococcus amylovorus*), which is exceedingly destructive to pear-trees in the Northern United States; proofs that the mischief is caused by the specific Bacterium; and suggestions for a remedy. In addition to this, much information is given with regard to the following diseases, among others: the strawberry-mildew (*Sphærotheca Castagnei*), the plum-leaf fungus (*Septoria cerasina*), the lettuce-rust (*Septoria Lactucæ*), and the lettuce-mildew (*Peronospora gangliformis*). Woodcuts are given of these various fungoid parasites, and a very useful summary is appended of the literature of the pear-blight.

AN admirable lecture on "Wrought Iron" was delivered by Mr. J. Starkie Gardner at the Society of Arts on Tuesday, February 22. It is printed in the current number of the Journal of the Society of Arts, with illustrations of the exquisite ironwork in the cathedrals of York, Durham, and Winchester. The general artistic superiority of mediæval ironwork to that of later times Mr. Gardner attributes in part to the fact that in the Middle Ages important work of this kind was intrusted only to smiths who had a special aptitude for it. If such a workman was not forthcoming, the work was either not executed, or was made in the simplest form; whilst, if he were forthcoming, the details at least of the design were left to his own fancy. Mediæval smiths were not fettered by estimate or bound by time, but Mr. Gardner is of opinion that they did their work much more quickly than men do now. Otherwise, he thinks, the intricate designs used in Germany, Spain, and Portugal, for ordinary domestic purposes, could not have been produced at any price which would have suited the occupiers.

AT a durbar held at Shillong in connection with the Jubilee rejoicings, Mr. Ward, Chief Commissioner of Assam, reviewed the history of the province during the last fifty years. In that time, he said, its population and settled area had been nearly trebled. The first tea plantation had been started about fifty years ago. There were now nearly 200,000 acres under tea, while the land taken up by planters, although not yet actually planted, amounted to about 400,000 acres. Again, fifty years ago the land revenue of five districts, comprising Assam proper, had been about four and a half lakhs of rupees; it had grown to twenty-six lakhs. Then the journey from Gowhatty to Debrooghur had occupied a month or six weeks; now it took three days.

MUCH interest has been excited by the announcement that Capt. Conder, of the Palestine Exploration Expedition, has succeeded in deciphering and translating the Hittite inscriptions. Ten principal texts are known, and Capt. Conder claims to have

intepreted all of them. Three of his translations, which were published in the *Times* of Saturday last, are invocations to the sun and water gods, and, apparently, to the divinity of the moon. Capt. Conder says that not only the words, but the grammar of the inscriptions, can be shown to belong to a well-known tongue. What this tongue is, we are not to learn for some time.

WE regret to announce the death of Dr. Grothe, Professor at the Polytechnical School at Delft, author of "Mechanical Technology," and an excellent monograph on iron. He was born in Westphalia in 1806, and died on February 10 last.

PROF. HAECKEL, of Jena, has just started on a journey to the East, which will be of some months' duration. He will visit the coast of Asia Minor to continue his investigations of lower marine animals.

LIEUT. QUEDENFELDT has just returned from Morocco to Berlin, bringing with him some valuable collections: an ethnological one, which he has presented to the Anthropological Society, a collection of insects, and a large collection of the implements, tools, and instruments of torture of the Hamadjas tribe.

MESSRS. G. PHILIP AND SON have in the press a revised and enlarged edition of "The Geology of England and Wales," by Horace B. Woodward, F.G.S., of the Geological Survey of England. They will also have ready shortly "Philips' Planisphere of the Stars visible from the Countries situated about 35° south of the Equator" (uniform with "Philips' Planisphere for England"); "Rustic Walking Routes within the Twelve-mile Radius from Charing Cross," containing a field-path map of the district, with geographical description, charts, and directions, by W. R. Evans; and "Philips' Handy Volume Atlas of the World," consisting of sixty-four plates, containing upwards of one hundred maps, printed in colours, with statistical notes on each map.

MESSRS. WHITTAKER AND CO. will publish shortly a second and much enlarged edition of "Magnets and Dynamo-Electric Machines," being the first volume of their "Specialist's Series." For the new edition some revisions in the text have been made, and a preface and a chapter on the latest types of generators have been written by Mr. W. B. Esson.

A FRENCH translation has been published of Cæsar Lumbroso's "Uomo Delinquanti," with a fine series of figures to illustrate the learned author's lectures concerning the anthropological features of the professional criminal.

ADMIRAL TEISSERENC DE BORT has just published a map, showing the distribution of fog on the various parts of the earth. It is based upon observations made at 1600 land stations, and 112,000 marine ones.

IN a Report just issued, Mr. S. W. North, Medical Officer of Health, calls attention to the prevalence of typhoid fever in York during the year 1886. For many years York has been liable to outbreaks of this disease, and the fact will not surprise anyone who reads Mr. North's account of the sanitary conditions of the city.

IN a paper entitled "Ueber die Allgemeine Beugungsfigur in Fernröhren" (Mémoires de l'Académie Impériale des Sciences de St. Pétersbourg, viie. série, tome xxxiv., No. 5), Hermann Struve remarks that the old problem of the diffraction of light through a circular aperture, the source being in the axis, has been considered by Airy and others, who have given approximate solutions in special cases; but the general solution has only been made feasible by the discovery of Bessel's functions. He accordingly proceeds to develop it by the straightforward methods with which readers of modern analysis are familiar; showing how his solution accords with those previously given for the axis and for the edge of the geometrical shadow. In this latter case he remarks that the illumination is less than one-fourth that which would be obtained by removing the screen. His results are put into a useful numerical form in tables at the end of the paper.

THE last number of the *Bulletin* of the Belgian Natural History Museum contains a summary of ornithological observations made at various stations throughout Belgium during the year 1885. This is quite a novel feature, which, if carried out systematically, promises excellent results, especially as regards the many obscure questions connected with the migrations of birds of passage. The chief stations are Brussels, Hasselt, Carlsburg, and the Ostend and other lighthouses along the coast. The names of the naturalists who undertake to send in reports are given in all cases. These reports contain the name of the bird in three languages—Latin, French, and Flemish or Walloon according to the locality—followed by the dates of arrival and departure, and any other remarks tending to throw light on the habits and movements of the bird. Thus, under *Ciconia alba*, Bechst., *Cicogne blanche*, *Ooievaar* (white stork), we have, from the Nieuport Lighthouse: "Seven seen, June 18, flying westwards; rare on this coast, where they never nest.—Signed, A. Vermorke." The present summary contains 171 such entries, the value of which, when made by competent observers from year to year, ornithologists will not fail to appreciate.

THE latest advices from Honolulu report that the volcano of Mauna Loa is again in eruption, and that all the craters in the vicinity have become active.

IN the December number of the *Mineralogical Magazine*, Prof. Macadam gives the analysis of a sample of talc used in paper-making. This mineral is obtained from New Jersey. It is very largely employed for paper-making in place of China clay (kaolin), and gives, amongst other advantages, a much more pure effluent, fully 90 per cent. being retained in the paper. From its fibrous nature it appears to attach itself to the smaller paper particles, and retain these also. The very high and beautifully smooth glaze of the American papers is largely due to the use of this substance.

IN the *Mittheilungen* of the Zürich Antiquarian Society (Band xxii. Heft 1) will be found a detailed account of the recently-discovered lake-dwelling at Wallishafen, on the Lake of Zürich. The articles found were mainly bronze, but underneath the existing remains appear to be the charred fragments of an earlier dwelling, the remains of which clearly belong to the Stone Age.

A LARGE canoe, belonging to prehistoric times, was lately dragged from the bottom of the River Cher, near Vierzon, and is now in the Museum of the Society of Antiquaries at Bourges. A part of it had been visible for many years at low water, but no one understood what it was until it happened to be seen by M. Beauchard, who at once perceived its real character. When it was brought to land, fragments which had been torn or cut off by peasants were recovered and pieced together. The canoe is in the form of a trough, and is said to have a general resemblance to the ancient boat found some time ago at Brigg, in Lincolnshire. The present specimen has the special characteristic of being closed at both ends by pieces of wood fixed in vertical grooves. This device seems to have been adopted in consequence of the boat having been injured by some accident.

M. GUILMETH, the French traveller, while on a journey in Australia, discovered some bee-hives in a gigantic eucalyptus-tree, of 120 metres in height. The honey was strongly scented with the perfume of the flowers of the tree. Prof. Thomas Karaman has examined it, and believes it to have beneficial medicinal properties.

LIKE the authorities of the National Museum, Washington, the Curators of the Museum of the Academy of Natural Sciences, Philadelphia, complain that they have not nearly room enough for the display of the collections intrusted to their charge. "It is well within the truth," they state in their Report for 1886, "to say that the existing collections, if properly displayed, would completely fill a building of twice the dimensions of the present one. The large and very valuable collections of the Pennsylvania Geological Survey, contained in upwards of 200 cases, still remain in the cellar, boxed, for want of exhibition space. The types of the greater number of the fossil plants described by Lesquereux in his 'Coal Flora of the United States,' probably one of the most valuable collections of fossil plants in the world, have been added to this collection during the year, but, for similar reasons, still remain boxed. The report of the Professor of Ethnology and Archæology indicates that accessions to this department of the Academy's Museum could readily be had were proper exhibition space provided, but that under present conditions the same is impossible. In view of these facts the necessity for an extension to the Academy's building cannot be too strongly insisted upon." The Curators also urge that a fund should be raised for zoo-geographical exploration. The interest derived from 50,000 dollars would, they think, fairly equip an annual expedition to any of the largely-unexplored regions lying about the dominions of the United States, such as Mexico, Central America, the Bahamas, and Labrador.

MR. ARTHUR J. BETHELL has reprinted, with additions and corrections, three articles which lately appeared in the *Field*, on a ride to the Falls of Zambesi. He has added a number of notes which may be of considerable service to men who think of spending some time in hunting in South Africa.

IT was decided some time ago that a number of the Crown diamonds of France should be sold. Others were put aside for the collections of the Paris School of Mines and Museum of Natural History; and these gems were recently given to the delegates appointed by the two Schools. The Regent diamond, a very fine one, will be kept in the Louvre Gallery.

THE additions to the Zoological Society's Gardens during the past week include a Bonnet Monkey (*Macacus sinicus*), a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Miss E. James; a Three-striped Paradoxure (*Paradoxurus trivirgatus*) from India, presented by Mr. Gerald Callinder; a Common Squirrel (*Sciurus vulgaris*), British, presented by Miss May Honrott; a Scop's Owl (*Scops giu*), captured at sea near Aden, presented by Mr. W. M. Holland; a White-fronted Heron (*Ardea novæ-hollandiæ*) from Australia, presented by Mr. J. B. Dyas; a Stanley Parrakeet (*Platycercus icterotis*) from West Australia, a Burmeister's Cariama (*Chunga burmeisteri*) from South-East Brazil, a Black Sternothere (*Sternotherus niger*) from West Africa, received in exchange; two Smews (*Mergus albellus* ♂ ♀), European, purchased.

OUR ASTRONOMICAL COLUMN

COMET 1887 *b* (BROOKS, JANUARY 22).—The following ephemeris for this object is by Dr. R. Spitaler (*Astr. Nach.* No. 2773).

1887 Berlin midnight	R.A. h. m. s.	Decl. ° ′ ″	Brightness
March 4 ...	3 37 51 ...	51 48·5 N. ...	1·19
6 ...	3 43 32 ...	49 39·6 ...	1·15
8 ...	3 46 11 ...	47 35·1 ...	1·12
10 ...	3 53 33 ...	45 35·2 ...	1·08
12 ...	3 58 3 ...	43 39·9 ...	1·04
14 ...	4 2 17 ...	41 49·3 N. ...	1·00

The brightness on January 25 is taken as unity.

COMET 1887 *c* (BARNARD, JANUARY 23).—Dr. H. Oppenheim gives (*Astr. Nach.* No. 2773) the following ephemeris for Berlin midnight for this comet :—

1887	R.A. h. m. s.	Decl. ° ′	log *r*	log Δ	Brightness
March 10	21 36 44	51 59·4 N.	0·3182	0·3700	0·6
14	21 52 56	53 51·0	0·3259	0·3775	0·6
18	22 9 39	55 34·6	0·3335	0·3855	0·5
22	22 26 51	57 10·3	0·3411	0·3938	0·5
26	22 44 30	58 37·8	0·3486	0·4025	0·4
30	23 2 32	59 57·2 N.	0·3560	0·4113	0·4

The brightness at discovery is taken as unity.

COMET 1887 *d* (BARNARD, FEBRUARY 15).—Prof. Boss supplies the following elements and ephemeris for this object from observations made on February 16, 18, and 20 :—

T = 1887 April 6·77 G.M.T.

π = 203 13
Ω = 139 16 } Mean Eq. 1887·0
i = 126 2
log *q* = 9·8892

Ephemeris for Greenwich Midnight

1887	R.A. h. m.	Decl. ° ′	Brightness
March 2 ...	3 56·7 ...	29 21 N. ...	0·38
4 ...	3 40·0 ...	31 18 ...	
6 ...	3 26·5 ...	32 48 N. ...	0·32

The brightness at discovery is taken as unity.

A METHOD FOR THE DETERMINATION OF THE CONSTANT OF ABERRATION.—M. Lœwy, in reply to M. Houzeau's claim to be considered the originator of the method for determination of aberration by measurement of the relative positions of two stars situated in distant parts of the sky (NATURE, vol. xxxv. p. 377) points out, in the *Comptes rendus*, tome civ. No. 7, that the invention of a new method for the determination of the constant of aberration does not consist in a general indication of the effect of aberration on a certain observation or combination of observations, but in furnishing definite rules the following out of which will lead to results of the accuracy demanded by the exigencies of modern science. M. Lœwy maintains that M. Houzeau's researches on the subject come under the former category, whilst his own are entitled to be ranked under the latter.

The same number of the *Comptes rendus* contains a note by M. Trépied pointing out how photography can be applied for the purpose of practically carrying out M. Lœwy's method.

THE HARVARD COLLEGE OBSERVATORY.—From Prof. Pickering's Report, presented on December 7, 1886, we learn that during the past year the east equatorial has been used for the photometric observation of the eclipses of Jupiter's satellites upon the system adopted in 1878. The total number of eclipses thus observed is 358, of which 39 have occurred since the end of October 1885. With the same equatorial the observation of comparison stars for variables with the wedge photometer has been continued, and has formed the principal work of the instrument. The "new" stars in Orion and Andromeda, and comets, have also been observed with the east equatorial throughout the year. The reduction and publication of work already done with the meridian-circle is at present, in Prof. Pickering's opinion, more desirable than the prosecution of new series of observations. This department of the Observatory has sustained a heavy loss in the resignation of Prof. Rogers, who has devoted many years to laborious astronomical work at Harvard College. During the year ending November 1, 1886, 209 series of measures have been made with the meridian-photometer. The total number of separate photometric comparisons is 59,800. The instrument continues to give entire satisfaction as a means of measuring the brightness of stars of the ninth magnitude or brighter. The average deviation of 100 circumpolar stars used as standards, which, with the smaller instrument of the same kind employed in the Harvard photometry, was 0·16 of a magnitude, has been reduced to 0·12 with the present instrument; whilst the average deviation of stars from the fifth to the ninth magnitude but little exceeds 0·1 of a magnitude. And a comparison between the results obtained by Dr. Lindemann, at Pulkowa, with a Zöllner photometer, and at Harvard College, with the meridian-photometer, shows that the average deviation of a measurement of the difference in brightness between two stars observed at both places does not exceed 0·1 of a magnitude. For an account of the interesting and import-

ant researches in stellar photography which have recently been carried out at the Harvard College Observatory, see NATURE, vol. xxxv. p. 37.

NEW MINOR PLANET.—A new minor planet, No. 265, was discovered on February 27, by Herr Palisa, at Vienna. This is the fifty-eighth that Herr Palisa has discovered.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1887 MARCH 6–12

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on March 6

Sun rises, 6h. 37m.; souths, 12h. 11m. 28·1s.; sets, 17h. 46m.; decl. on meridian, 5° 40′ S.: Sidereal Time at Sunset, 4h. 43m.

Moon {Full on March 9} rises, 13h. 39m.; souths, 21h. 29m.; *sets*, 5h. 10m.*; decl. on meridian, 17° 4′ N.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury ...	6 54	13 15	19 36	3 22 N.
Venus	7 20	13 35	19 50	2 16 N.
Mars	7 0	12 54	18 48	1 58 S.
Jupiter... ...	22 19*	3 21	8 23	12 2 S.
Saturn... ...	12 2	20 11	4 20*	22 28 N.

* Indicates that the rising is that of the preceding evening and the setting that of the following morning.

Occultations of Stars by the Moon (visible at Greenwich)

March	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image ° °
6 ...	*f* Geminorum ...	6 ...	0 41 ...	1 40 ...	131 289
8 ...	18 Leonis... ...	6 ...	4 1 ...	4 39 ...	67 337
8 ...	45 Leonis... ...	6 ...	18 24 ...	19 14 ...	68 185
8 ...	49 Leonis	4 ...	20 50 ...	21 54 ...	61 111
8 ...	49 Leonis... ...	6 ...	22 53	near approach	332 —
11 ...	γ Virginis... ...	2½ ...	3 7 ...	3 40 ...	145 210
11 ...	B.A.C. 4277 ...	6 ...	4 22	near approach	186 —

March	h	
12 ...	3 ...	Mercury stationary.
12 ...	20 ...	Jupiter in conjunction with and 3° 34′ south of the Moon.

Saturn, March 6.—Outer major axis of outer ring = 44″·0; outer minor axis of outer ring = 18″·3; southern surface visible.

Variable Stars

Star	R.A. h. m.	Decl. ° ′		h. m.	
U Cephei	0 52·3	81 16 N.	Mar. 7,	19 36	*m*
S Arietis	1 58·6	11 59 N.	,, 6,		*M*
T Cancri	8 50·2	20 17 N.	,, 9,		*m*
R Ursæ Majoris ...	10 36·7	69 22 N.	,, 11,		*M*
T Virginis	12 8·8	5 24 S.	,, 7,		*M*
S Ursæ Majoris ...	12 39·0	61 43 N.	,, 10,		*M*
W Virginis	13 20·2	2 48 S.	,, 12,	5 0	*M*
δ-Libræ	14 54·9	8 4 S.	,, 9,	23 39	*m*
U Coronæ	15 13·6	32 4 N.	,, 6,	18 46	*m*
R Scorpii	16 10·9	22 40 S.	,, 11,		*M*
U Ophiuchi... ...	17 10·8	1 20 N.	,, 7,	5 46	*m*
		and at intervals of		20 8	
Sagittarii... ...	18 25·2	19 12 S.	Mar. 9,	3 0	*m*
β Lyræ...	18 45·9	33 14 N.	,, 9,	1 0	*m*
S Vulpeculæ ...	19 43·8	27 0 N.	,, 12,		*M*
η Aquilæ	19 46·7	0 43 N.	,, 9,	5 0	*m*
δ Cephei	22 25·0	57 50 N.	,, 12,	0 0	*m*

M signifies maximum; *m* minimum.

ON RADIANT-MATTER SPECTROSCOPY:—EXAMINATION OF THE RESIDUAL GLOW[1]

I.

THE duration of phosphorescence after cessation of the exciting cause is known to vary within wide limits of time, from several hours in the case of the phosphorescent sulphides to a minute fraction of a second with uranium glass and sulphate of quinine. In my examinations of the phosphorescent earths glowing under the excitement of the induction discharge *in vacuo*, I have found very great differences in the duration of the residual glow. Some earths continue to phosphoresce for an hour or more after the current is turned off, while others cease to give out the light the moment the current stops. Having succeeded in splitting up yttria into several simpler forms of matter differing in basic power (Roy. Soc. Proc. vol. xl. pp. 502-509, June 10, 1886), and always seeking for further evidence of the separate identity of these bodies, I noticed occasionally that the residual glow was of a somewhat different colour to that it exhibited while the current was passing, and also that the spectrum of this residual glow seemed to show, as far as the faint light enabled me to make out, that some of the lines were missing. This pointed to another difference between the yttrium components, and with a view to examine the question more closely I devised an instrument similar to Becquerel's phosphoroscope, but acting electrically instead of by means of direct light.

The instrument, shown in Fig. 1, A and B, consists of an opaque disk, *a b c*, 20 inches in diameter, and pierced with twelve openings near the edge as shown. By means of a multiplying wheel, *d*, and band, *e f*, the disk can be set in rapid rotation. At each revolution a stationary object behind one of the apertures is alternately exposed and hidden twelve times. A commutator, *g* (shown enlarged at Fig. 1, B), forms part of the axis of the disk. The commutator is formed of a hollow cylinder of brass round a solid wooden cylinder. The brass is cut into two halves by a saw cut running diagonally to and fro round it, so as to form on each half of the cylinder twelve deeply cut teeth interlocking, and insulated from those on the opposing half cylinder by an air space about 2 mm. across. Only one half, *h h h*, of the cylinder is used, the other, *i i i*, being idle; it might have been cut away altogether were it not for some little use that it is in saving the rubbing-spring, *j*, from too great friction when passing rapidly over the serrated edge. To a block beneath the commutator are attached two springs, one, *k*, rubbing permanently against the continuous base of the serrated hemicylinder *h h*, and the other, *j*, rubbing over the points of the teeth of *h h*. By connecting these springs with the wires from a battery it will be seen that rotation of the commutator produces alternate makes and breaks in the current. The spring, *j*, rubbing against the teeth is made with a little adjustment sideways, so that it can be said to touch the points of the teeth only, when the breaks will be much longer than the makes, or it can be set to rub near the base of the teeth, when the current will remain on for a much longer time and the intervals of no current will be very short. By means of a screw, *l l*, attached to the spring, any desired ratio between the makes and the breaks can be obtained. The intermittent primary current is then carried to an induction coil, *m*, the secondary current from which passes through the vacuum tube, *n*, containing the earth under examination. When the commutator, the coil-break, and the position of the vacuum tube are in proper adjustment, no light is seen when looked at from the front if the wheel is turned slowly (supposing a substance like yttria is being examined), as the current does not begin till the tube is obscured by an intercepting segment, and it ends before the earth comes into view. When, however, the wheel is turned more quickly, the residual phosphorescence lasts long enough to bridge over the brief interval of time elapsing between the cessation of the spark and the entry of the earth into the field of view, and the yttria is seen to glow with a faint light, which becomes brighter as the speed of the wheel increases.

To count the revolutions, a projecting stud, *o*, is fastened to the rotating axis, and a piece of quill, *p*, is attached to the fixed support, so that at every revolution a click is produced. With a chronograph watch it is easy in this way to tell the time, to the tenth of a second, occupied in ten revolutions of the wheel.

Under ordinary circumstances it is almost impossible to detect any phosphorescence in an earth until the vacuum is so high that the line spectrum of the residual gas begins to get faint; otherwise the feeble glow of the phosphorescence is drowned by the greater brightness of the glowing gas. In this phosphoroscope, however, the light of glowing gas does not last an appreciable time, whilst that from the phosphorescent earth endures long enough for it to be caught in the instrument. By this means, therefore, I have been able to see the phosphorescence of yttria, for example, when the barometer gauge was 5 or 6 mm. below the barometer.

When the earth under examination in the phosphoroscope is yttria free from samaria, and the residual emitted light is ex-

[1] Paper read before the Royal Society by Mr. William Crookes, F.R.S., on Feb. 17.

amined in the spectroscope, not all the bands appear at the same speed of rotation. At a slow speed the double greenish-blue band of Gβ (545) first comes into view, closely followed by the deep blue band of Gα (482). This is followed, on increasing the speed, by the bright citron band of Gδ (574), and at the highest speed the red band of Gζ (619) is with difficulty seen.

The following are measurements of the time of duration of the phosphorescences of the different constituents of yttrium. The wheel was first rotated slowly, until the first line visible in the spectroscope attached to the phosphoroscope appeared; the speed was counted, and it was then increased until the line next visible was seen. In this way the minimum speed of revolution necessary to bring each line into view was obtained, and from these data the duration of phosphorescence for each constituent

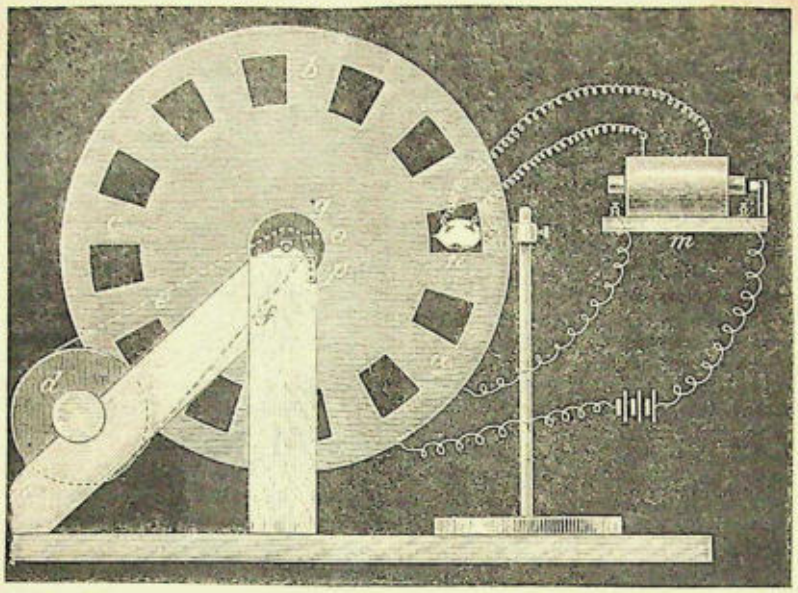


FIG. 1, A.

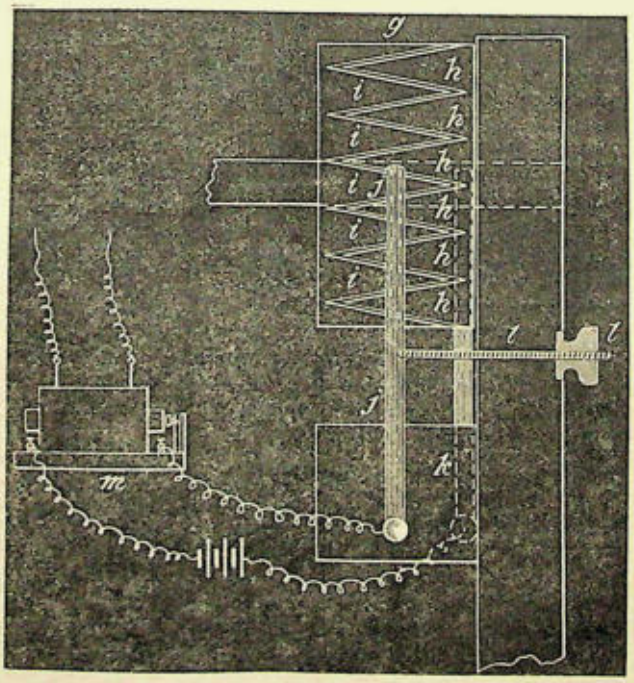


FIG. 1, B.

of yttria was calculated. The time in the following table represents in decimals of a second the time elapsing between the cessation of the induction discharge and the visibility of the residual glow of the earth :—

At 0·0015 sec. interval the green and blue lines of Gβ and Gα begin to be visible.

At 0·0032 sec. interval the citron line of Gδ begins to be visible.

At 0·00175 ,, the deep red line of Gζ (647) is just visible.

At 0·00125 ,, the line of Gδ is almost as bright as that of Gβ, and the red line of Gη is visible.

At 0·000875 sec. interval the highest speed the instrument could be revolved with accuracy, the whole of the lines usually seen in the yttria spectrum could be seen of nearly their usual brightness.

I have already recorded (Phil. Trans., 1883, Part III. pp. 914-16), that phosphate of yttria, when phosphoresced *in vacuo*, gives the green lines very strongly whilst the citron band is hazy and faint. The same tube of yttric phosphate was now examined in the phosphoroscope. The green lines of Gβ soon showed themselves on setting the wheel into rapid rotation, but I was unable to detect the citron band of Gδ even at a very high speed.

The effect of calcium on the phosphorescence of yttria and samaria has been frequently referred to in my previous papers. It may save time if I summarise the results here. About 1 per cent. of lime added to a badly phosphorescing body containing yttrium or samarium always causes it to phosphoresce well. It diminishes the sharpness of the citron line of Gδ but increases its brightness. It also renders the deep blue line of Gα extremely bright. The green lines of Gβ are diminished in brightness. Lime also brings out the phosphorescence of samarium, although by itself, or in the presence of a small quantity of yttrium, samarium scarcely phosphoresces at all.

In the phosphoroscope the action of lime on yttrium is seen to entirely alter the order of visibility of the constituents of yttrium. In a mixture of equal parts yttrium and calcium, the citron Gδ line is the first to be seen, then comes the Gα blue line, then the Gβ green line, and finally the Gγ red line. This may, I think, be explained somewhat as follows:—Calcium sulphate has a long residual phosphorescence, whilst yttrium sulphate has a comparatively short residual phosphorescence. Now with yttrium, although the green phosphorescence of Gβ lasts longest, it does not last nearly so long as that of calcium sulphate. The long residual vibrations of the calcium compound induce, in a mixture of calcium and yttrium, phosphorescence in those yttric molecules (Gδ) whose vibrations it can assist, in advance of those (Gβ) to which it is antagonistic; the line of Gδ therefore appears earlier in the phosphoroscope than that of Gβ, although were calcium not present the line of Gβ would appear first.

Experiments were now tried with different mixtures of yttria and lime as ignited sulphates, to see where the special influence of lime on Gδ ceased.

Yttrium	Calcium	
Per cent.	Per cent.	
97½	2½	Order of appearance in the phosphoroscope.—Gβ, Gα, Gδ, and Gγ. The citron line of Gδ is only to be seen at a high speed, and is then very faint.
95	5	Order of appearance in the phosphoroscope.—Gα, Gβ, and Gδ (citron and blue) together, and lastly Gγ (red). At a very high speed the green lines of Gβ become far more luminous than any other line.
90	10	Order of appearance.—Gδ and Gα together, then Gβ, and lastly Gγ.
80	20	Order of appearance.—Gδ and Gα simultaneously, then Gβ, and lastly Gγ. The residual phosphorescence lasts for 30 seconds after the current stops. The light of this residual glow is entirely that of Gδ. The line of Gβ comes into view at an interval of 0·0045 second. At 0·00175 second the line of Gγ is just visible.
60	40	Order of appearance.—Gδ and Gα together, then Gβ and Gγ together.
50	50	
40	60	
30	70	Order of appearance.—Gδ, Gα, Gβ.
10	90	
5	95	
1	99	Order of appearance.—Gδ, Gα. The green lines of Gβ could not be seen in the phosphoroscope; they would probably be obliterated by the stronger green of the continuous spectrum given by the calcium.

The action of barium on yttrium was now tried. The following mixtures (as ignited sulphates) were made:—

Yttrium	Barium	
Per cent.	Per cent.	
95	5	In the phosphoroscope the Gβ line appears earliest, but the blue Gα line is the next to be seen, whilst the red line of Gγ is the latest in appearing. As the percentage of yttrium increases the blue line more and more overtakes the red and increases in brightness.
90	10	
80	20	
70	30	Spectrum similar to the above. As the percentage of yttrium increases the spectrum grows brighter. In the phosphoroscope the earliest line to appear is the Gβ green, then the Gγ red, and next closely following it the Gα blue.
60	40	
50	50	
40	60	
30	70	
25	75	
20	80	In the radiant-matter tube all these mixtures give similar spectra. The Gβ green is a little brighter and the Gδ citron is a little fainter than in the corresponding mixtures of yttrium and calcium, but the whole of the yttrium lines are seen. In the phosphoroscope the Gβ green is the first to appear, then the Gγ red. The Gδ citron is not visible at any speed.
15	85	
10	90	
5	95	
1	99	Red line of Gγ is much brighter; Gδ is very faint, and the green of Gβ is stronger. In the phosphoroscope the order of appearance is,—first the line of Gβ, then the red line of Gγ.
0·5	99·5	Phosphoresces with difficulty, of a light blue colour, but turns brick-red in the focus of the pole. Spectrum very faint. Order of appearance to phosphoroscope,—Gβ first, the others too faint to be seen.

The next experiments were tried with strontium, to see what modification the addition of this body to yttrium would produce. The following mixtures of ignited sulphates were experimented with:—

Yttrium	Strontium	
Per cent.	Per cent.	
95	5	A very good yttrium spectrum. In the phosphoroscope the order of appearance is,—first the green of Gβ, then the Gα blue, lastly the Gγ red. No Gδ citron line could be seen.
80	20	In the phosphoroscope the green of Gβ is very prominent at a low speed, standing out sharply against a black background. With a higher velocity the Gα and Gγ lines come into view.
60	40	The ordinary spectrum of this and the neighbouring mixtures is very rich in the citron line of Gδ, but I entirely fail to see a trace of this line in the phosphoroscope at any speed. The line of Gβ is the first to come, then the blue line of Gα.
40	60	
35	65	At about this point a change comes over the appearance in the phosphoroscope. The blue line of Gα is now the earliest to appear, and it is followed by the Gγ red and Gβ green. No Gδ line is seen.
25	75	These mixtures are very similar to each other in the phosphoroscope. The line of Gα comes first, next the Gγ line, then Gβ line. No Gδ citron line has been seen in any of these mixtures.
15	85	
5	95	
0·5	99·5	

In a paper read before the Royal Society, June 18, 1885 (Phil. Trans., 1885, Part II., p. 716), I described the phos-

phorescence spectrum given by a mixture of 61 parts yttrium and 39 parts of samarium, and illustrated it by a coloured lithograph. Also in a paper read before the Royal Society, February 25, 1886 (Roy. Soc. Proc. vol. xl. p. 236), I described and figured the phosphorescent spectrum of an earth obtained in the fractionation of yttria which was identical, chemically and spectroscopically, with an earth discovered by M. de Marignac, and provisionally called by him Yα. I repeat here these spectra, and the spectrum of yttrium added for comparison. Omitting minor details, it is seen that the Yα spectrum is identical with

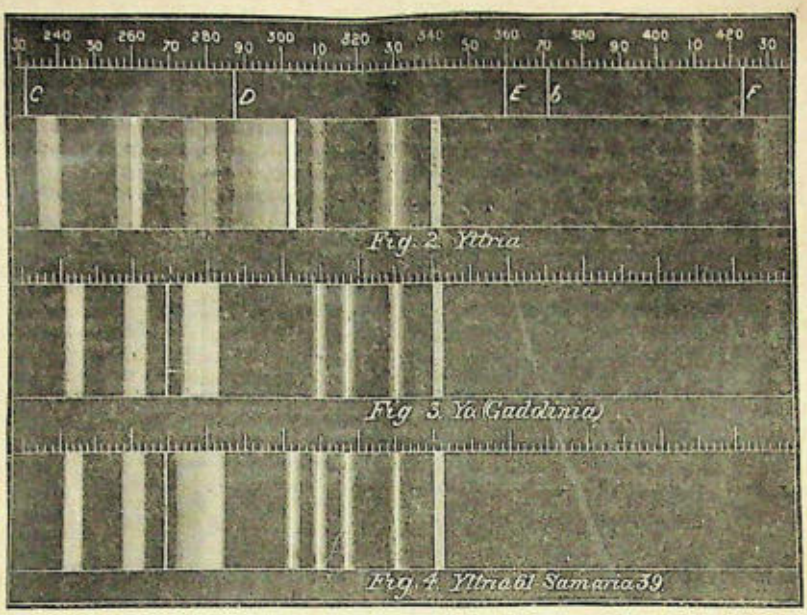


Fig. 2. Yttria.

Fig. 3. Yα (Gaddinia).

Fig. 4. Yttria 61 Samaria 39.

that of the mixture yttrium 61, samarium 39, with one important exception—the citron line of Gδ in the former spectrum is absent in the latter. Could I by any means remove Gδ from the mixture of yttrium and samarium the residue would be Yα. I have little doubt that this will soon be accomplished, but in the meantime the phosphoroscope enables us to remove the line of Gδ from the mixture. It is only necessary to add strontium to a suitable mixture of yttrium and samarium and view the phosphorescing mixture in the instrument when the wheel is rotating rapidly, to obtain a spectrum which is indistinguishable from that of Yα.

(To be continued.)

PRE-SCIENTIFIC THEORIES OF THE CAUSES OF EARTHQUAKES

IN the course of a lecture delivered recently before the Rigaku Kyôkai, or Science Society of Tokio, on the causes of earthquakes, Prof. Milne classified the theories as to the cause of these phenomena into three kinds—unscientific, *quasi*-scientific, and scientific. In the former class he included the explanations of the Negro preachers at Charleston after the late earthquakes there, that they occurred in consequence of the wickedness of the population. The Mussulmans in Java recently prayed to the volcanoes there to cease their shakings, at the same time promising reformation of life. That earthquakes are the direct result of man's wickedness is an idea that has always been common. About 1750 earthquakes were felt in many parts of Europe, which were widely attributed to this cause, and innumerable sermons were preached inculcating the lesson that if mankind would live better lives there would be no more earthquakes. In 1786, after a shock at Palermo, the people are recorded to have gone about scourging themselves, and looking extremely humble and penitent. An English poem called "The Earthquake," published in 1750, alleged, in somewhat halting verse, that the disturbances were not due to an unknown force, nor to the groanings of the imprisoned vapours, nor yet to the shaking of the shores with fabled Tridents :—

"Ah no! the tread of impious feet
The conscious earth impatient bears
And shuddering with the guilty weight,
One common grave for her bad race prepares."

From this theory, which can scarcely have satisfied the poet himself, Prof. Milne passed on to the myths which attribute earthquakes to a creature living underground. In Japan it is an "earthquake-insect" covered with scales, and having eight legs, or a great fish having a certain rock on his head which helped to keep him quiet. In Mongolia the animal was said to be a frog, in India the world-bearing elephant, in the Celebes a world-supporting hog, in North America a tortoise. In Siberia there was a myth, connected with the great bones found there, that these were the remains of animals that lived underground, the trampling of which made the ground shake. In Kamchatka the legend was connected with a god, Tuil, who went out hunting with his dogs. When these latter stopped to scratch themselves, their movements produced earthquakes. In Scandinavian mythology, Loki, having killed his brother Baldwin, was bound to a rock face upwards, so that the poison of a serpent should drop on his face. Loki's wife, however, intercepted the poison in a vessel, and it was only when she had to go away to empty the dish that a few drops reached him and caused him to writhe and shake the earth. The lecturer had no means of collecting the fables of the southern hemisphere; but they would obviously be worth knowing for purposes of comparison. As to *quasi*-scientific theories, these endeavoured to account for earthquakes as parts of the ordinary operations of Nature. It was supposed, for instance, that they were produced by the action of wind confined inside the earth. The Chinese philosophers said that Yang, the male element, entered the earth and caused it to expand, and to shake the ground in its efforts to escape. Its effects would be more violent beneath the mountains than in the plains, and therefore earthquakes in the north of China, which was mountainous, were said to be more violent than those in the south. It was supposed that when the wind was blowing strongly on the surface of the earth, there was calm beneath, and *vice versâ*. Aristotle and many other classical writers attributed earthquakes to wind in the earth. Shakespeare, in "Henry IV.," speaks of the teeming earth being pinched and vexed with a kind of colic by the imprisoning of unruly wind within her womb. Then came the theory of electrical discharges, which was advocated in 1760 by Dr. Stukely, as well as by Percival and Priestley. They are strongly held in California at the present day, where it was believed that the network of rails

protected the State against any dangerous accumulation of electricity. But Prof. Milne showed that the laying down of rails in Japan had no such effect. He thought the electric phenomena which sometimes attended earthquakes were their consequences, not their causes. He had himself experimented with dynamite placed in a hole; an earth-plate was fixed about thirty yards away from the dynamite, and from it a wire was carried some distance to another earth-plate. When the dynamite charge was exploded there was certainly a current produced, as was indicated by a strong deflection of a galvanometer-needle at the end of the wire. He attributed this to chemical action. When the ground was shaken there was always a greater or less action by increase or decrease of pressure in connection with the earth-plate. Earth currents unquestionably accompany earthquakes, but, as has been said, they appear to be the consequences, not the causes, of the latter. Next came the chemical theories, which were very strong in Europe up to the beginning of the present century. It was imagined that underground there were various substances, such as sulphur, nitre, vitriol, which, by their action on each other, resulted in violent changes, giving rise to vapour, the sudden production of which, in certain cases, would shake the ground. It was only in 1760 that Dr. Mitchell, who wrote a good deal on the subject, first threw out the theory that earthquakes were connected in some way with volcanoes, because they were most frequent in volcanic countries. He observed that large quantities of steam were given off from volcanoes, and came to the conclusion that an earthquake was produced at the time that an attempt was made to form a volcano, that steam got in between certain strata, and, as it ran between them, caused pulsations. Prof. Rogers, about the same time, in North America, endeavoured to show that it was not steam, but really lava, that ran along underneath the ground, causing it to rise and fall, thus producing an earthquake. Prof. Milne having thus dealt with unscientific and *quasi*-scientific theories, passed on to those of modern science. It is unnecessary here to follow him into this portion of his subject, although it occupied the main part of the lecture.

ON THE EFFECT OF CERTAIN STIMULI ON VEGETABLE TISSUES[1]

THE object of our paper is to describe the behaviour of turgescent pith when placed in water and treated with certain reagents. If from a growing shoot the external tissues be removed, a well-known result is seen: the pith suddenly lengthens, becoming longer than the specimen was at first. This experiment shows that turgescent pith is normally in a compressed condition—it is always trying to get longer—and when it is freed from the coercion of the unyielding external tissues, it at once does become longer. This tendency to become longer is further manifested by allowing turgescent pith to remain in damp air, or in water, for some time, when a great increase in length takes place. In such a piece of pith we have the essential, active factor in growth, freed from interference, and at liberty to perform its function rapidly and freely. The tendency in turgescent pith to get longer is the very power which calls forth that increase in length which we call growth; so that in studying turgescent pith we are studying the active agent in the production of growth. We do not suppose that our results are necessarily directly applicable to normal growth,[2] but we think that they have a bearing on normal growth sufficiently close to give interest to our experiments.

The pith,[3] after being cut into pieces about 6 inches in length and ¼ inch in thickness, was ready for use. The lower end of the pith was fixed to a hook at the bottom of a narrow jar, the upper end was attached by a silk thread to the short arm of an auxanometer lever. The jar was then filled with water, and as the pith elongates the short arm of the lever ascends and the long arm rapidly descends. Its movement, read off on a millimetre scale, gives an index of the rate of "growth" of the pith. The lengthening of the pith is, in fact, observed like the normal growth of a plant, the only difference being that the "growth" of the pith is so rapid that the descent of the long arm is clearly visible to the naked eye and is correspondingly easy to measure. It is most striking to see the index travelling down thus quickly and traversing (it may be) 10 mm. (⅜ inch) in a minute. We used a stop-watch to determine the time in which the point of the long arm of the lever travelled over a certain distance, and we could thus estimate the changes in the rate of growth from minute to minute.

The first thing needful to know is the ordinary course of growth of the pith in water. It was found that an interesting phenomenon—an apparent *grand period*—takes place. That is to say, the growth is at first slow, then more rapid, and ultimately becomes slow again, the whole period taking perhaps twenty minutes to complete. This is precisely the series of changes which a growing organ exhibits in the course of days instead of minutes. We do not suppose that our grand period is necessarily of a kindred nature to the grand period of normal growth. For we are aware that purely mechanical processes, such as the moistening of a hygroscopic awn, exhibit the same thing—the awn at first untwists slowly, then more quickly, and then again slowly. But the knowledge of the fact is of great importance to us, since unless we know the normal course of growth we cannot study the effect of reagents.

Warmth.—Before going on to consider the action of reagents, we will say a few words as to the stimulation caused by an increase in the surrounding temperature. If the water in the jar is gradually warmed, the growth of the pith increases in speed in the most striking manner. The increase is fairly steady from, say, 17° C. to about 35°, the rate at this latter temperature being perhaps four times as high as it was at first. It then usually becomes irregular, with some diminution; and, just before a temperature is reached which kills the tissues, a sudden and rapid fall in the rate of growth sets in. This we found usually to occur at about 55° C. This is, no doubt, an unusually high temperature, but not higher than plants are known to be able to survive.

The chief interest in these temperature experiments is this: they show that the phenomena we are considering is a truly vital one. We have always been on our guard in this matter, and have wished to make certain that the observed phenomena are not in some mysterious way mechanical, instead of, as we believe, the response of living tissues *as* living tissues. Therefore, when we find that heat has a normal effect on our material, we are encouraged to believe that our other results—to which we now pass on—are also vital phenomena.

Alcohol.—The pith was attached to the auxanometer, and the jar filled with water. As soon as the rate of growth was found to be steadily diminishing, a small quantity of alcohol was added. The result was an immediate and striking increase in the rate of growth. For instance, when 2 per cent. of spirit was added, the growth was accelerated within two minutes by 50 per cent.

The result is temporary, so that in the course of another two minutes the rate of growth sinks to what it was before stimulation. Similar results were obtained with ether, and here the pith was allowed to grow in damp air, and was subjected to ether in the form of vapour. When the vapour was present in the proportion of 0·27 per cent., the acceleration was 56 per cent.; with 0·4 per cent., the acceleration was 100 per cent. Here, as in the case of alcohol, the result was temporary, the rate falling in a few minutes to what it was before stimulation.

When the ether amounts to 3 per cent. of the atmosphere, the pith is killed, and shows no increase, but, on the contrary, a decrease[1] in length. Elfving has shown that ether has a stimulating effect on respiration, and on the sensitiveness of swarm-spores to light. He also tested its effect on the growth of phycomyces. His results differ from ours, inasmuch as he found no stimulating effect: the ether produced either no effect whatever, or else it retarded, or even stopped, growth.

Ammonia.—We employed the *Liquor Ammoniæ fortior* of the "British Pharmacopœia" for the preparation of our solutions, and we found that various strengths ranging between 0·5 and 2·4 per cent. produced acceleration of growth. Here again, as with ether and alcohol, the acceleration was very temporary.

Acids.—As a rule, acids produced no acceleration, but caused either retardation, or flaccidity and death. Thus, for instance, acetic acid (0·5 and 1 per cent.) produced retardation; 5·4 per cent. produced death.

Hydrocyanic Acid did not cause flaccidity such as we have described in the case of acetic acid. The action of this reagent is comparable rather to that of alcohol, but is not

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identically the same. It produces either a temporary acceleration, such as is due to alcohol, or else a remarkably steady and high rate of growth. On the action of this reagent we hope to make further observations.

Quinine Chloride.—Extremely dilute solutions acted poisonously, and produced a shortening of the tissues. When contraction took place it was manifested within a remarkably short time. In one case contraction seemed to begin simultaneously with the exposure to the poison, and was certainly well marked in less than one minute.

Conclusion.—The most interesting fact which we have established is the possibility of stimulating turgescent tissues to increased elongation by such reagents as alcohol, ether, and hydrocyanic acid. And we incline to think that our results may help to direct attention to a factor in the problem of cell-mechanism—namely, the protoplasmic element, rather than the purely osmotic side of the question.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, February 24.—"On the Relation between Tropical and Extra-Tropical Cyclones." By the Hon. Ralph Abercromby. Communicated by Mr. R. H. Scott, F.R.S.

All cyclones have a tendency to assume an oval form; the longer diameter may lie in any direction, but has a decided tendency to range itself nearly in a line with the direction of propagation. Tropical cyclones have less tendency to split into two, or to develop secondaries than those in higher latitudes. A typhoon which has come from the tropics can combine with a cyclone that has been formed outside the tropics, and form a single new, and perhaps more intense, depression. There is much less difference in the temperature and humidity before and after a tropical cyclone than in higher latitudes. The quality of the heat in front is always distressing in every part of the world.

The wind rotates counter-clockwise round every cyclone in the northern hemisphere, and everywhere as an ingoing spiral. The amount of incurvature for the same quadrant may vary during the course of the same cyclone; but in most tropical hurricanes the incurvature is least in front, and greatest in rear; whereas in England the greatest incurvature is usually found in the right front. Some observers think that broadly speaking the incurvature of the wind decreases as we recede from the equator. The velocity of the wind always increases as we approach the centre in a tropical cyclone; whereas in higher latitudes the strongest winds and steepest gradients are often some way from the centre. In this peculiarity tropical cyclones approximate more to the type of a tornado; but the author does not think that a cyclone is only a highly developed whirlwind, as there are no transitional forms of rotating air.

The general circulation of a cyclone, as shown by the motion of the clouds, appears to be the same everywhere. All over the world, unusual coloration of the sky at sunrise and sunset is observed, not only before the barometer has begun to fall at any place, but before the existence of any depression can be traced in the neighbourhood. Cirrus appears all round the cloud area of a tropical cyclone, instead of only round the front semicircle, as in higher latitudes. The alignments of the stripes of cirrus appear to be more radial from the centre in the tropics, than tangential, as indicated by the researches of Ley and Hildebrandsson in England and Sweden respectively. Everywhere the rain of a cyclone extends farther in front than in rear. Cyclone rain has a specific character, quite different from that of showers or thunderstorms; and this character is more pronounced in tropical than in extra-tropical cyclones.

Squalls are one of the most characteristic features of a tropical cyclone, where they surround the centre on all sides; whereas in Great Britain, squalls are almost exclusively formed along that portion of the line of the trough which is south of the centre, and in the right rear of the depression. As, however, we find that the front of a British cyclone tends to form squalls when the intensity is very great, the inference seems justifiable that this feature of tropical hurricanes is simply due to their exceptional intensity.

A patch of blue sky, commonly known as the "bull's-eye," is almost universal in the tropics, and apparently unknown in higher latitudes. The author's researches show that in middle latitudes the formation of a "bull's-eye" does not take place when the motion of translation is rapid; but as this blue space is not observed in British cyclones when they are moving slowly, it would appear that a certain intensity of rotation is necessary to develop this phenomenon.

The trough phenomena,—such as a squall, a sudden shift of wind, and change of cloud character and temperature, just as the barometer turns to rise, even far from the centre—which are such a prominent feature in British cyclones,—have not been even noticed by many meteorologists in the tropics. The author, however, shows that there are slight indications of these phenomena everywhere; and he has collated their existence and intensity with the velocity of propagation of the whole mass of the cyclone.

Every cyclone has a double symmetry. One set of phenomena, such as the oval shape, the general rotation of the wind, the cloud ring, rain area, and central blue space, are more or less related to a central point. Another set, such as temperature, humidity, the general character of the clouds, certain shifts of wind, and a particular line of squalls, are more or less related to the front and rear of the line of the trough of a cyclone. The author's researches show that the first set are strongly marked in the tropics, where the circulating energy of the air is great, and the velocity of propagation small; while the second set are most prominent in extra-tropical cyclones, where the rotational energy is moderate, and the translational velocity great. The first set of characteristics may conveniently be classed together as the rotational, the second set as the translational, phenomena of a cyclone.

Tropical and extra-tropical cyclones are identical in general character, but differ in certain details, due to latitude, surrounding pressure, and to the relative intensity of rotation or translation.

Linnean Society, February 17.—Mr. W. Carruthers, F.R.S., President, in the chair.—The Rev. A. Johnson exhibited drawings of an abnormal *Begonia Veitchii* grown by him the preceding autumn. The peculiarity consisted in the flower having a single, large, flask-shaped, ovarian-like organ (?) placed centrally, and surmounted by a single, simple, straight style; thus, though doubtless a male, indicating an hermaphrodite condition, while presenting resemblances to the normal female organs of *Laurus nobilis*.—Mr. E. M. Holmes exhibited some irregularly-developed lemons, in which the carpels were more or less separated at the apex; the arrest of the normal union of the carpel being attributed to the bite of an insect in the early stage of the growth of the fruit.—There were exhibited, for Mr. J. G. Otto Tepper, a new *Stylidium* (*S. Tepperiana*, F. Muell.), collected in November 1886 on Mount Taylor, Kangaroo Island, Victoria, Australia. It was found in the interstices of a Tertiary limestone. Other trees which grew in the neighbourhood were stunted Eucalypts, Hawkeas, and an Acacia somewhat resembling *A. pycnantha*.—Sir J. Lubbock drew attention to examples of *Peziza coccinea* from Ilfracombe.—A dried specimen of *Primula imperialis*, Jungh., collected by Dr. Sydney Hickson in Java, was exhibited from the Royal Gardens, Kew. This species is a giant form of *Primula*, being over 3 feet in height. Plants of this Himalayan and Malayan species are now under cultivation at Kew, and form an interesting addition to this popular group of garden plants.—Mr. G. Maw showed two rare Narcissi, both known under the name of *N. cernuus*. The daffodil discovered by Mr. Buxton in the Pyrenees at 7000 feet altitude is interesting as the only white form known in a wild habitat. A diminutive, orange-coloured species, flowered by the Rev. C. Wolley Dod from bulbs collected by Dr. Henriques, of Coimbra, appears to be allied to *N. triandrus*.—Sir J. Lubbock read the second part of his paper on phytobiological observations, and on the leaf of *Liriodendron*. In *Œnothera biennis* the seed-leaves are linear, terminating in a large round expansion. There is nothing to account for it in the seed, nor does it appear to be of any advantage to the young plant. On watching the growth, however, and comparing it with that of other allied species, the explanation appears to be as follows: the cotyledons are at first round, but a growth takes place at the base of the cotyledon, which closely resembles that of the subsequent leaves, hence their peculiar figure in this species. In allied species the seed-leaves consist of two parts, a terminal portion—the true or original cotyledon—and a subsequent growth resembling in each species their true leaves. With reference to seed-leaves in which the stalks are connate, *e.g. Smyrnium*, the union seems clearly advantageous as giving additional strength. Other characters in various species, *Plantago*, *Tilia*, *Heliophila*, *Cardamine*, &c., were instanced. As to the tulip-tree (*Lirio-*

dendron), for long a puzzle by the peculiar saddle shape of the leaves, after testing various other suggestions which had proved untenable, Sir John described the structure of the bud and the manner in which the young leaves were packed in it, and showed that the peculiar manner in which the young leaves are arranged, satisfactorily accounts for the well-known and very remarkable form of the leaf.—A paper was read on *Dichelaspis pellucida*, by Dr. Hoek, of Leyden. The cirripede in question was got from the scales of a water-snake in the Mergui Archipelago by Dr. J. Anderson, and this is believed to be the first record of the species since Charles Darwin wrote his classic monograph on the group thirty-five years ago.

Zoological Society, February 15.—Prof. W. H. Flower, F.R.S., President, in the chair.—The Secretary read a report on the additions that had been made to the Society's Menagerie during the month of January 1887, and called special attention to two Blakiston's Owls (*Bubo blackistoni*) from Japan, presented by Mr. J. H. Leech; three Hooker's Sea-Lions (*Otaria hookeri*), presented by the Hon. W. J. M. Larnach, Minister of Marine of New Zealand; and a Blue Penguin (*Eudyptula minor*) from Cook's Straits, New Zealand, presented by Mr. Bernard Lawson.—Prof. F. Jeffrey Bell read a report on a collection of Echinodermata made in the Andaman Islands by Colonel Cadell. The collection was stated to contain 100 examples referable to 50 species.—Mr. G. A. Boulenger read a paper on a collection of Reptiles and Batrachians made by Mr. H. Pryer in the Loo Choo Islands. The author observed that exceptional interest attached to this collection, seeing that it was the first herpetological collection that had reached Europe from that group of islands. Two new species were described, viz. *Tachydromus smaragdinus* and *Tropidonotus pryeri*.—Mr. Oldfield Thomas read a paper on the small Mammals collected in British Guiana by Mr. W. L. Sclater. The collection contained thirteen specimens belonging to eight species, of which one was new; this the author proposed to describe as *Hesperomys* (*Rhipidomys*) *sclateri*.—Mr. G. A. Boulenger pointed out the characters of a new Geckoid Lizard from British Guiana. The specimen in question was contained in a small collection of Reptiles made by Mr. W. L. Sclater on the Pomeroon River. The author described it as *Gonatodes annularis*.—A communication was read from Mr. Charles O. Waterhouse, containing an account of a new parasitic Dipterous Insect of the family Hipposcidæ. The author stated that this insect had been found on a species of Swift (*Cypselus melanoleucus*), by Dr. R. W. Shufeldt, at Fort Wingate, New Mexico. It was closely allied to *Anapera pallida*, a European dipterous parasite found on *C. apus*, and was proposed to be named *Anapera fimbriata*.—Mr. John H. Ponsonby communicated, on behalf of Mr. Andrew Garrett, the first part of a paper on the Terrestrial Mollusks of the Viti or Fiji Islands.—Mr. F. E. Beddard read a paper on the structure of a new genus of Lumbricidæ (*Thamnodrilus*) discovered by Mr. W. L. Sclater in British Guiana, which he proposed to characterise as *Thamnodrilus gulielmi*.

Anthropological Institute, Feb. 8.—Mr. Francis Galton, F.R.S., President, in the chair.—A paper was read by Sir Charles Wilson on the tribes of the Nile Valley north of Khartoum. Sir Charles Wilson opened his paper by remarking on the extraordinary way in which the various races inhabiting the Nile Valley—with many of whom he had come in contact in the course of the Nile Expedition—had become mixed up, and how completely the indigenous population had in certain cases lost its nationality while absorbing its Arab conquerors. The tribes of the Nile Valley north of Khartoum might be divided into three groups, the Hamitic, the Semitic, and the Nuba, all alike claiming descent from the Koreish of Mecca. Sir C. Wilson then proceeded to give briefly a history of the different tribes from the earliest times, describing in detail the peculiarities and physical characteristics of each race. A number of Soudanese weapons, lent by Sir Allen Young, were exhibited.

PARIS

Academy of Sciences, February 21.—M. Gosselin, President, in the chair.—Determination of the constant of aberration: first method of observation, by M. Loewy. In this paper the author proceeds to explain successively the geometrical properties on which depend the various methods of estimating the constant of aberration. The first of the two processes is here dealt with, which, although somewhat less rigorous than the general method, practically yield results of the greatest precision, while also enabling the observer to determine two other physical constants—the variation of refraction caused by change either of temperature or of atmospheric pressure.—Note on M. Faye's recent communication regarding waterspouts, by M. Mascart. M. Faye having again raised this question in connection with M. Weyher's experiments, the author returns to his original contention that the great body of observed phenomena are directly opposed to M. Faye's theory of cyclones.—On the development of the Pennatulæ (*Pennatula grisea*), and on the favourable biological conditions presented by the Arago Laboratory for zoological studies, by M. H. de Lacaze-Duthiers. A visit paid to the Arago station last October suggests some remarks on the flourishing condition of the Alcyonaria and Pennatulæ, which have become thoroughly acclimatised in this district. A general description is given of the laboratory and reservoir at the Fontaulé headland, which has been enlarged to a capacity of 130 cubic metres, offering every facility for the study of sponges, star-fish, tritons, and many other lower forms of marine life.—On the Alpine flora surviving in the Paris district, by M. A. Chatin. The author discusses the various hypotheses which trace this already described flora either to the Scandinavian or Swiss Alps or to the Pyrenees, and concludes generally that the Parisian highland flora is independent of all, and truly aboriginal. It is also contended that most of the present European vegetation goes no further back than the Quaternary formations, and that for plants there has been independent succession and plurality of centres of creation rather than widespread diffusion from a single centre.—On the orthobutyrate and isobutyrate of lime, by MM. G. Chancel and F. Parmentier. An exhaustive study of these substances shows that M. le Chatelier's approximate relation—

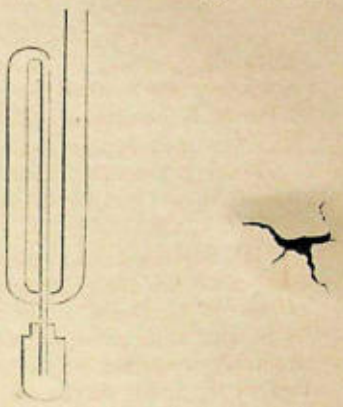
$$\frac{dx}{x} : \frac{k}{\delta} Q \frac{dt}{T^2},$$

giving the variation of solubility of different bodies, with their heat of solution at saturation, cannot be regarded as the expression of a general law from which fresh deductions may be safely drawn.—On the red fluorescence of alumina (second notice), by M. Lecoq de Boisbaudran. Here are treated two highly calcined aluminas + Cr_2O_3 and + Bi_2O_3, and a moderately calcined alumina + Bi_2O_3.—On the incubation of Phylloxera during the winter season, by M. A. L. Donnadieu. In reply to M. Balbiani, who holds that the Phylloxera of the oak completes the entire cycle of its evolution in a single year, the fertilised eggs hibernating during the ensuing winter, the author's researches lead to the conclusion that the activity of this organism is not interrupted during the period of suspended vegetation of the plant on which it lives. A like conclusion is arrived at as regards the Phylloxera of the vine, which on this plant continues without interruption, but with a somewhat diminished intensity, the biological evolutions of its summer life throughout the winter season.—Observations of Brooks's comet made at the Observatory of Toulouse, by M. Baillaud.—On Gauss's quadrature formula, and on Hermite's formula of interpolation, by M. P. Mansion.—On the orthogonal systems formed by the θ functions, by M. F. Caspary.—On the movements of the air, by M. Ch. Weyher. A series of experiments are described which have been carried out by means of a jet of air or vapour a demi-millimetre in diameter and inclined 45° to the horizon, holding in suspense two spheres, one of cork with a diameter of 20 mm., the other of caoutchouc inflated with air. The centre of gravity of the spheres is below the axis of the jet, which thus causes them to revolve round each other, while their weight is balanced by the attraction produced by the series of little eddies developed along the sides of the jet.—On a method of determining the induction flux traversing an electro-magnetic system, by M. R. Arnoux. A simple method is described, by means of which this quantity may be accurately determined without the aid of the ballistic galvanometer, which is not available for practical purposes.—On the causes determining the phosphorescence of the sulphuret of calcium, by M. A. Verneuil. From the author's researches, which are still in progress, it appears that the violet sulphuret of calcium prepared from shells owes its bright phosphorescence to the salt of bismuth, the carbonate of soda, the sea-salt, and the sulphate of lime formed during the reaction.—Action of some metals on weak solutions of the nitrate of silver, by M. J. B. Senderens. It is shown that by acting on such solutions lead reduces the nitric acid while the silver is precipitated; also that analogous phenomena are presented by zinc,

iron, tin, cadmium, antimony, and aluminium.—Action of sulphuric acid on the solubility of the sulphates, by M. R. Engel. Sulphuric acid, acting on solutions of sulphates incapable of combining with it to form acid sulphates, determines a diminution of the solubility of the salt. But this is shown to take place according to a law different from that observed for the chlorides in presence of hydrochloric acid.—On the reproduction of the micas, by MM. P. Hautefeuille and L. Péan de Saint-Gilles. In this preliminary paper the authors confine themselves to some of their researches on the fusion of the elements of the micas with the fluosilicate of potassa.—Remarks on M. Boutroux's note regarding the action of nitric acid on sugar, by M. E. Maumené. M. Boutroux's statement that by the action of sugar and nitric acid he obtained saccharic acid and oxalic acid, but not hexepic acid, is shown to be erroneous.—On the treatment of new wines with sugar, by MM. D. Klein and E. Fréchou. The authors' experiments show the possibility of obtaining with alcohol of about the theoretic quantity right fermentations by means of which poor vintages may henceforth be converted into good wines capable of preservation.—A contribution to the study of the alkaloids, by M. Oechsner de Coninck.—Researches on the mode of action of colchicine taken as a therapeutic, and on the mechanism of this action, by MM. A. Mairet and Combemale. The authors' experiments show that this substance has the same diuretic or purgative action on men as on animals, but the former are three times more sensitive to its action than the latter.—Fresh studies on the embryogeny of the Nematodes, by M. Paul Hallez.—On the development of the Nematodes of the beetroot during the years 1885 and 1886, and on their modes of propagation, by M. Aimé Girard.—On the oscillations produced during the Eocene period in the Laval basin, by M. D. Œhlert.—On the geological constitution of la Montagne-Noire, Castelnaudary district, by M. J. Bergeron.

BERLIN

Physical Society, January 21.—Prof. von Bezold in the chair.—Dr. König spoke of the disadvantages of the hydro-oxygen lamps, and demonstrated a new lamp constructed by Herr Linnemann, in which the unsteadiness in the light, arising from the fact that in the common lamp the flame burned now in the burning tube and now outside of it, was avoided. In the new lamp the coal-gas or the hydrogen issued from a ring-shaped opening in the burner, while the oxygen in the centre was admitted through a capillary tube and did not come into contact with the burning gas till outside of the burner. In the middle of the blue flame was seen a bright point which gave the heat-maximum. Instead of the lime cylinder, Herr Linnemann used in his lamp zircon plates, which, at the place of the bright point, gave a highly intense constant light. The speaker made use of this light in order, with the aid of the optical bench of Prof. Paalzow, to demonstrate by projection a long series of phenomena in connection with the doctrine of the polarisation of light. For all teaching purposes and demonstrations this method of representing the most important optical phenomena could not be surpassed by any other.—Dr. Lummer described the experiments of M. Macé de Lepinay, who by a new method had determined the wave-length of the ray of light D_2, ascertaining, as he had done, by weighing, the volume of a quartz cube, the size of which was determined in units of the wave-lengths, and from the volume of the cube finding the length of the light-wave. The speaker showed a series of inaccuracies in the measurements of M. de Lepinay, and, in view of the fact that the wave-lengths of the rays of light were now measured with a precision of 1/60,000, whereas the determination of the centimetre was affected with an uncertainty of 1/4000, he purposed inversely ascertaining the length of the centimetre from the wave-length. The mode of procedure should be the same as that made use of by M. de Lepinay, yet several improvements in the measuring and weighing were stated, such as the speaker hoped to be able to effect later on.—Dr. Dieterici showed an apparatus designed by Prof. Koppen which enabled one to fill a barometer free of air very rapidly. An upright standing communicating-tube open at one end for the admission of the quicksilver issued at the other end in a capillary tube passing at the bottom into a vessel. The open leg of the siphon was longer than the other. On pouring in the quicksilver it rose uniformly in both legs, forced up the air in the closed leg and through the capillary outwards. When the closed leg was entirely filled with quicksilver, and yet more continued to be poured in, it drained itself off through the capillary, bearing along with it all the air, in the same manner as did the Sprengel pump. The quicksilver became collected in the lower vessel and closed the lower opening of the capillary. The vacuum was thus established, and in the closed leg of the communicating-tube the quicksilver sank to barometer height.—Prof. H. W. Vogel presented photographs of coloured objects which in the distinctness of their *nuances* perfectly corresponded with the impression conveyed by the objects themselves to the eye. The speaker had, in conjunction with Herr Oberneth, succeeded in finding in eosin-silver a substance rendering the photographic plates most highly sensitive for the yellow-green rays, corresponding with the utmost sensitiveness of the retina for those rays. The photographs of solar spectra and different landscapes attested the excellence of this "sensibilisator."



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THURSDAY, MARCH 10, 1887

THE AURORA BOREALIS

L'Aurore Boréale. Étude générale des Phénomènes produits par les Courants électriques de l'Atmosphère. Par M. S. Lemström. (Paris: Gauthier-Villars, 1886.)

Resultate der Polarlicht-Beobachtungen angestellt im Winter 1882 und 1883 auf den Stationen Kingua Fjord und Nain. Von Dr. K. R. Koch. (Berlin: A. Asher and Co., 1886.)

THE organised and obstinate scientific curiosity of our time has not neglected the beautiful phenomenon of the "Polar Dawn." Yet its investigation is attended by peculiar difficulties and discouragements. It can be profitably conducted only amid scenes of frozen desolation, in the grisly depths of Arctic winter nights, under conditions taxing man's energy and resource to live, to say nothing of observing. The appearances in question are, moreover, as elusive as they are surprising. They promptly kindle the imagination, but leave the understanding, unless prepared by special study to apprehend something of their causes, baffled and helpless. Nevertheless, auroral research, though Nature seem to frown upon it, has been pursued with indefatigable energy during the last half century. It has formed the principal object of some, it has occupied a prominent place in the programmes of all recent Polar expeditions; besides being furthered, with less heroic zeal, by writers and thinkers unequal or averse to the company of thermometers normally below the zero of Fahrenheit. Nor have these labours been thrown away. Much of the mystery long attaching to the evanescent splendours of Arctic skies has been dissipated. There is no longer any doubt as to the *kind* of explanation appropriate to them. Their laws and relationships have been, to a great extent, elucidated; a satisfactory theory of their origin is at hand; some circumstances of their occurrence, long in debate, have been attested on unquestionable authority.

An excellent specimen of the patient laboriousness by which these results have been brought about is afforded in the work of Dr. Koch, cited as one of our authorities. He was in sole charge of the German station of Nain, on the coast of Labrador, during the International Polar term 1882–83, and now presents us with the record of observations there, together with those made simultaneously at the still more northerly post of Kingua Fjord. Although situated in about the latitude of Dundee—56° 33'—Nain appears to be, in point of climate, one of the grimmest localities accounted habitable on the face of the globe. Frost-bites were a quite common incident of Dr. Koch's daily experience; and furious winds, rendering the use of his meteoroscope impossible, often left him dependent upon the natural features of the solemn but forbidding landscape, for determining the azimuths of auroral bands and arches. As regards these phenomena, indeed, the station is admirably located. It lies close to the southern edge of, if not actually within, the zone of maximum frequency; auroræ are consequently numerous and intense, and appear almost indifferently above the northern or southern horizon. Their varying forms are beautifully delineated in the drawings which lend a greatly increased value to Dr. Koch's publication. Multiple arches, up to the number of eight, were frequently seen; and the incessant movements affecting them, both as a whole and in their parts, the transverse flashing of the rays set side by side to compose some of them, the torrential rushing of light along the paths others seemed to prepare for it, as well as the restless wanderings of the entire luminous structure up and down the sky, gave continual variety and animation to these strange exhibitions, while accentuating their baffling recalcitrance to exact measurement. No estimates of height were attempted at either Nain or Kingua Fjord; but there was a total absence of auroral appearances below the clouds, or otherwise unmistakably very near the earth, such as have been noted by M. Lemström and other observers in high latitudes. Luminous mists were, however, common. At times they suffused the whole sky; and shapeless masses of them constantly succeeded, and (at Kingua Fjord) were often the substitutes for the organised and definite forms of a perfect aurora. A sudden and wide-spread development of cirrus clouds was another curious secondary feature of the Nain polar lights. These were, at both stations, completely mute; not a suspicion of audibility attended their movements.

A no less intrepid observer than Dr. Koch is the author of the work with which we have coupled his in the heading of this article. M. Lemström's auroral researches began in 1868, when he was attached to the Swedish Polar Expedition commanded by Baron Nordenskjöld. They were continued during a sojourn of six weeks in Finnish Lapland in 1871, and were brought to a highly successful issue at Sodankylä in 1882-84. Finland held an honourable place among the eleven nations lately combined for a simultaneous attack upon the secrets of the Arctic circle; and the Professor of Physics in the University of Helsingfors was, by an almost inevitable choice, appointed chief of the Finnish meteorological station established in compliance with the terms of international agreement. Our readers are not unacquainted with the original line of work struck out by him in that capacity. Its upshot was to secure demonstrative evidence as to the *proximate* cause of the aurora borealis.

The book under review derives, then, a particular interest from its authorship. It is the production of a man who has devoted thought and labour without stint to the subject of which it treats, and has pushed the associated problems visibly nearer to solution. He now sums up the present state of knowledge as regards them in a well-arranged, concisely written, and copiously illustrated volume, recapitulating the most significant and surely established facts, fitting them, with the critical judgment bought by long experience, into their proper places, and expounding the theory best adapted to interpret and harmonise them.

Remarkably, as time went on, Halley's conjecture of a magnetic origin for auroræ gathered round it confirmatory circumstances entirely unknown to its author. Celsius and Hiorter noticed, in 1741, spasmodic disturbances of the magnetic needle coincident with the darting movements of northern lights. Wilcke, Ussher, and Dalton ascertained, towards the end of the century, the close geometrical relations between the terrestrial magnetic

system and all the various parts composing a fully developed auroral display: the corona forming in the magnetic zenith, the streamers flitting parallel to the line of the dip, the arch erecting its summit in the magnetic meridian. When Faraday succeeded in obtaining luminous effects through magnetic action, and Rudolf Wolf demonstrated the subjection of aurorae to an identical periodicity with magnetic variations, the case might have appeared complete.

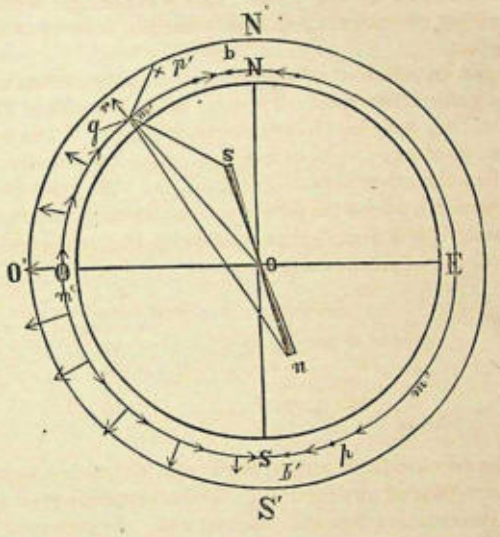
Yet the pure and simple magnetic theory of the aurora borealis, when attempted to be realised, either eluded the grasp of thought, or was found to involve admissions not very easy to make. Dalton, whose propensity towards forming distinct conceptions was a primary quality of his mind, had the courage to give it definite shape in 1793 (in his "Meteorological Observations and Essays"). Compelled, as he supposed, by the exigencies of observation, he conceived an envelope of an elastic fluid partaking of the nature of steel to replace atmospheric air at a height of about a hundred miles, and to supply the material alike of arches and streamers, shown, by their disposition in space, to be of a ferruginous character. It can scarcely be wondered at that the idea, in spite of Biot's adoption and development of it, failed to strike root. More vitality was in Canton's interrogative suggestion forty years earlier: "Is not the aurora borealis the flashing of electrical fire from positive towards negative clouds at a great distance, through the upper part of the atmosphere, where the resistance is least?" (Phil. Trans., vol. xlviii. p. 357.)

It was not, however, until the electrical illumination of rarefied gases came to be studied with detailed attention that the full effect of the visual identity of the two kinds of phenomenon became sensible. The analogy was defined and completed by some experiments made by De la Rive in 1853. They showed that a luminous discharge in an exhausted vessel, when influenced by a powerful electro-magnet, condenses into a ring of light encircling its pole, endowed, moreover, with a rotatory movement such as has frequently been observed to affect a system of auroral streamers. Here, for the first time, their true part in such displays was assigned to the forces emanating from the earth's magnetic poles. It is a directive, not a formative one. The structure, not the occurrence, of aurorae is conditioned by them.

A marked change in scientific opinion resulted, accordingly, from these investigations. The "magnetic effluvium" theory of the aurora borealis finally disappeared, and what we may call the "illuminated vacuum" theory took its place. The change was accompanied by a shifting of the ground of inquiry. What was urgently needed in order to render intelligible the mode of action producing the gorgeous flame-vesture of northern skies, was, perceived to be, not so much improved knowledge (however desirable) of the laws of terrestrial magnetism, as a sound doctrine of atmospheric electricity. Here De la Rive broke down. His hypothesis of a polar accumulation, through the agency of the winds, of the positive charge of the air, was obviously untenable.

Nothing better was, however, proposed until 1878, when Prof. Edlund, of Stockholm, applied the principle of "unipolar induction," discovered by Weber in 1841, to explain the phenomena of atmospheric electricity (*Phil. Mag.*, vol. vi. p. 360). The effects thus designated are really derived, as a particular case (in M. Edlund's probable view), from the well-established laws of magnetic action upon electric currents.

Each element of the system of currents formed by the electrified particles of the rotating terrestrial crust and atmosphere is thus urged, by the powerful magnet which the earth may legitimately be regarded as inclosing within it, along a path at right angles to the line drawn from each of its poles to the current-element. The direction and relative strength of the impelling forces are indicated in the accompanying figure, copied from the work before



us (p. 166), where the particle m' is solicited towards × by the south pole (pointing north) of the magnet Sn, and towards g by its south pole. The combined result is to drive the particle upward and poleward along a line everywhere perpendicular to the swing of the dipping-needle. The vertical component, accordingly (represented by the arrows standing erect on the circle $m'\ m''\ m'''$), attains a maximum at the magnetic equator, where the dip vanishes; the tangential component is there = 0, and attains its highest value in middle latitudes.

Several remarkable effects ensue: first, that atmospheric electricity gains potential with elevation—an observed fact; next, that it is constantly travelling away from the equator towards either pole. The circulatory process, however, thus set on foot, must be carried further; and in its continuance and completion M. Edlund finds the key to the auroral mystery.

At and near the equator, recomposition of the positive electricity of the air with the negative electricity of the earth is opposed by the whole strength of magnetic inductive repulsion, there acting vertically. When effected at all, it can only then be by sudden, violent, disruptive discharges, apparent to our senses as lightning. But the increasing inclination of the magnetic needle in higher latitudes renders the line of no resistance marked by it continually more practicable as an avenue of descent for the accumulating positive fluid. Hence, when it has attained a certain potential, gradual discharges take place over two polar zones, *along the line of the dipping-*

needle. These constitute what we are accustomed in the northern hemisphere to call the aurora borealis.

Auroræ are, in this view, the polar equivalents of lightning. The same office of relieving the electrical tension of the air is fulfilled by them with innocuous tranquillity. Not indeed in absolute silence, though the "eerie din" of their rustling streamers has been caught by very few ears. Major Dawson, however, was fortunate enough to hear once, and once only, during his sojourn at Fort Rae, 1882-83, a sound "like the swishing of a whip, or the noise produced by a sharp squall of wind in the upper rigging of a ship," which accompanied, with its *crescendo* and *diminuendo*, the brightening and fading of an aurora visible at the time. This was the first official confirmation of innumerable less authentic reports to the same effect.

The mutual relations of auroræ and thunderstorms are full of significant interest. In point of geographical distribution, they may be termed complementary. The one kind of phenomenon is not more characteristically of polar than the other is of tropical origin. We take from M. Lemström's pages the following concise table, strongly corroborative of Edlund's theory, showing the dependence upon latitude of storm-frequency:—

Latitude	Mean annual number of storms
Between 0° and 30°	52
,, 30° ,, 50°	20
,, 50° ,, 60°	15
,, 60° ,, 70°	10
About 70°	0

Yet the two kinds of atmospheric luminosity are separated by profound distinctions. Thunderstorms give no sign of systematic magnetic associations. Sometimes, it is true, the needle may be seen to quiver at the instant of a lightning-flash, but by what seems a casual disturbance, quite different from the tumultuous agitation which accompanies or even betrays the darting of northern lights.

Storms are, moreover (so far as is known), completely exempt from the complicated periodicity by which auroral appearances are regulated. Now this, as M. Tromholt discovered in 1882, is exactly inverted in the far north. His discussion of M. Kleinsmidt's observations (1864-80) at Godthaab in North Greenland made it apparent that, on the polar side of the great auroral zone, a sunspot maximum brings with it an auroral minimum, and *vice versâ*; that the two equinoctial peaks of the auroral curve in middle latitudes there coalesce into a single elevation at the winter solstice; and that the evening maximum noted further south is there shifted to the morning. Nor are these curious inversions peculiar to Godthaab.

Their immediate cause is easily understood. The auroral zone swings to and fro in several superposed periods, over the surface of the earth. As the sun's activity augments, it travels slowly towards the equator, and retreats towards the pole as it diminishes, diversifying its progress with minor oscillations, daily, bi-annual, and (perhaps) monthly. The analogy of the closing-in of the solar spot-zones with approach to maximum is striking, but unexplained. Auroral periodicity is thus seen to depend, not upon cessation, but upon removal, and the observed reciprocal relation between auroral frequency in middle and very high latitudes is completely accounted for.

We can even go a step further. By Edlund's theory an increase of atmospheric electricity must be attended by a lowering of the latitude in which recomposition takes place. That is to say, the observed shifting in space of the auroral zone implies, and is explained by, a rise and fall of potential in the upper conducting strata of the air, synchronising with the rise and fall of solar disturbance. This is probably in part an indirect effect of the fluctuations in the sun's activity.

Electricity, in M. Edlund's view, is simply the ether of space, a certain share of which belongs naturally to every ponderable substance. When this normal store is by any means augmented, the body on which the accumulation takes place is positively electrified; when it is diminished, negative electrification ensues. Hence, the expulsion of this so-called "fluid" from the earth by magnetic inductive action leaves it, *ipso facto*, negatively charged, and produces a positive charge in the air.

All this M. Lemström, in the work before us, readily admits; but he supplements the magnetic forces at work in disturbing our planet's electrical equilibrium with evaporation, of which the enormous capabilities for producing high potentials have been indicated by Prof. Tait (NATURE, vol. xxix. p. 517). But evaporation doubtless proceeds most vigorously when the sun's radiative energy is strongest—that is (presumably), at epochs of spot-maximum, so that an obvious link is thus supplied between the solar and auroral periods. The sequence of cause and effect is as follows: the sun's increased power quickens the development of aqueous vapour; this, in its turn, gives rise to a more copious supply of atmospheric electricity; added tension insures more speedy neutralisation; the zone of gradual recomposition descends towards the equator, and auroræ are more frequently visible in middle latitudes.

Yet this is perhaps not the whole truth. Many circumstances speak in favour of a direct electrical inductive action of the sun upon the earth. M. Quet has lately shown (*Comptes rendus*, t. xcviii. p. 1038) that the existence of a magnetic fluctuation corresponding in period with the sun's rotation on its axis is otherwise inexplicable; and the instantaneous response of the terrestrial magnetic system to the solar outburst of September 1, 1859, almost compels the same inference, which is strengthened by the undoubted growth of magnetic intensity with solar activity. Hence, as sunspots become numerous, the circulatory process described by M. Edlund must be quickened and strengthened; atmospheric electrical tension will be heightened; and although the repellent magnetic power is proportionately reinforced, this is more than counterbalanced by the added mutual attraction between the opposite electricities of earth and air. Through this cause also, then, the auroral zone widens its distance from the pole once in eleven years.

The view that auroræ are due to currents of positive electricity illuminating the air on their passage to the earth, has been solidly established by M. Lemström's results at Sodankylä. His "discharging apparatus" served the precise purpose of Franklin's kite. The one

experiment was not more decisive than the other. Not only did luminous appearances accompany the setting-in of a current towards the earth from the network of insulated wires spread over the summit of Mount Oratunturi, but the light evoked was distinctively *auroral*. Examined with the spectroscope, it yielded the still enigmatical "citron-line" discovered by Ångström in 1867. This is the invariable and chief constituent of auroral radiations. Besides one fitfully present, detected by Zöllner in the red, it is the only vivid line its spectrum includes. Ten others, more or less dubiously enumerated, are faint, hazy, indeterminate. M. Lemström holds that there is a fair agreement between some of them and lines in the laboratory-spectrum of rarefied air. But this is perhaps a too sanguine opinion. These seeming coincidences are very loose, and have not been drawn closer by careful inquiry. Vogel's conclusion that the spectrum of the aurora is modified from that of atmospheric air is indeed highly probable, but its probability is derived far more from external than from internal evidence.

A. M. CLERKE

THE BUTTERFLIES OF INDIA

The Butterflies of India, Burmah, and Ceylon. A Descriptive Hand-book of all the Known Species of Diurnal Lepidoptera inhabiting that Region, with Notices of Allied Species occurring in the Neighbouring Countries along the Border. With Numerous Illustrations. By Lionel de Nicéville, F.E.S. Vol. II. Royal 8vo. (Calcutta. London: Bernard Quaritch, 1886.)

MORE than four years have elapsed since the first part of this book was published, and one of the authors has been obliged to resign his share in the work. The second volume, which has been written by Mr. de Nicéville alone, is in no way inferior to the first. When we remember that in the trying climate of Calcutta, and only in the leisure hours which can be spared from official work, Mr. de Nicéville has with but very trifling assistance from the Government of India completed a volume of nearly 300 pages, containing over 300 species of butterflies, we must allow that he deserves great praise; and though a volume produced under such difficulties must of necessity contain faults, yet it is in every respect very superior to Mr. Moore's work on the Lepidoptera of Ceylon, which was largely subsidised by Government. There is no doubt that the impetus given to the study of the butterflies of India by the publication of this work will have the best results, and we have every reason to hope and believe that it may be completed in three or four years more at latest. The present volume is devoted almost entirely to the family of Nymphalinæ, and brings up the number of Indian butterflies already described to over 600, all of which are treated in a thoroughly scientific, careful, and painstaking manner.

Though the author has gathered to his assistance a growing band of field workers in various parts of India, among whom Messrs. Möller, Knyvett, Graham-Young, Colonel Swinhoe, and others are conspicuous, and is rapidly accumulating a large quantity of specimens from all parts of the country, he still labours under the difficulty of being unable to see the types of many of the so-called species described by Messrs. Butler and Moore in Europe. Evidence is constantly being brought forward to confirm the opinion of most entomologists, that a large proportion of the names given by these authors represent no fixed or constant varieties, and that the characters described by them cannot be recognised in the insects themselves; but it is impossible to ignore them until this can be proved by comparison of these types with large series of specimens. Under these circumstances, Mr. de Nicéville has acted wisely in printing the descriptions of all these doubtful species, so that the attention of collectors may be called to them, and their existence proved or disproved. His remarks on them have the advantage of being intelligible, which is not always the case with the original descriptions of the authors in question, who have had for some years almost a monopoly in the description of Indian butterflies.

The kind of difficulty which occurs in many instances may be illustrated by the author's final remarks on the numerous varieties of the genus Abisara, described as species by Mr. Moore.

"*A. prunosa* is typically the darkest coloured, and in the male most brilliantly purple-shot, of this group of the genus, specimens from Travancore being particularly large and dark. Even among Ceylon specimens, however, I find considerable variation; in some males the inner discal band on the fore-wing is evenly convex, and in others distinctly angled in the middle, and the purple suffusion is also variable; the size and number of the black spots on both sides of the hind-wing is extremely inconstant. In one very abnormal specimen there are two sub-apical spots, only the anal ones being entirely wanting. From an island one would expect to find some distinguishing characters in a species supposed to be peculiar to it, but I have quite failed to discover any. I can only repeat that, in my opinion, the name *echerius* should apply to all the species of this group of the genus Abisara, except perhaps to the Andaman local race, which has been named *bifasciata*; that as, in this case, the geographical range of numerous slight local races is not segregated, and each local race must interbreed with the next on the boundary-line which is supposed to separate them, it can serve no good scientific purpose to pick out a few apparently different specimens from each local race and to describe them, at the same time ignoring the intergrade specimens which exist."

If this opinion had been more generally held, the study of the butterflies of India would have been much simplified, and it is to be hoped that a new edition of "The Butterflies of India," which will certainly be called for almost before the first is complete, will show a large reduction in the number of names. A fixed nomenclature is the first desideratum in this as in other branches of science, and tends more than anything to attract good workers, who are often disgusted by a long list of synonyms and by changes in well-known old names.

The keys to the genera and species have been worked out very carefully, and will be useful to beginners. The literature, geographical distribution, and variation of each species are also well and carefully done. The volume will be indispensable to lepidopterists generally, and ought to interest many in India, who have hitherto looked on the collection of butterflies as rather a pastime than a science.

H. J. ELWES

OUR BOOK SHELF

The Deviation of the Compass in Iron Ships considered Practically. By W. H. Rosser. Second Edition, with considerable additions. (London: James Imray and Son, 1887.)

REMEMBERING the number of books already published treating in a practical form of compasses, their deviations on board iron ships, and the consequent adjustments, some persons may be disposed to ask, "What purpose will be served by an addition to them?" In answer it may be said that this, the second edition of a useful work by an author who bases his knowledge on the teaching of the "Admiralty Manual," and knows from instructing others their many difficulties, can hardly fail to be welcome to those having neither time nor ability to assimilate the subject without a guide at every turn.

Whilst we hope that Mr. Rosser's later edition will be duly appreciated, there is a certain definition which, for the sake of simplicity and accuracy, we would fain see removed from it. At pp. 30 and 31, clear definitions are given of true, magnetic, and compass courses. Why not let well alone, and not complicate the matter by introducing the term "correct" magnetic course? A reference to the later editions of the Admiralty publications on the deviation of the compass shows that the word "correct" in connection with "magnetic course" has been entirely omitted, apparently as no longer serving any purpose.

The concluding paragraph of the preface on patent compasses is hardly fair to Sir William Thomson's. The principles involved in the construction of his compass are not in themselves novelties, but he has done world-wide good by showing in it how that enemy of compasses—friction—may be avoided, whilst at the same time he has produced a card which is almost free from oscillation when the ship rolls heavily.

Travels in the Wilds of Ecuador. By Alfred Simson. (London: Sampson Low, 1886.)

"NO one with the spirit of roaming within him," says the author of this book, "can live long in Ecuador without cherishing a growing desire to explore its unknown parts." Some time ago, accordingly (the exact date is not mentioned), he started with a companion from Guayaquil for Baños, and from Baños they went through the forest to the village of Aguano, on the River Napo, completing the road in eighteen days' actual walking, or forty-five days' foot journey, including necessary stoppages. At Aguano they were obliged to remain forty-two days, which they spent partly in collecting Lepidoptera, partly in making voyages of discovery by land and water in search of provisions. They then made their way in canoes down the Napo to the Amazon, which they reached after a voyage of twenty-five days. At Iquitos the two friends parted, Mr. Simson's companion setting out to explore the Ucayali, while Mr. Simson himself joined a Mr. Reyes in an expedition up the River Putumayo.

The story is very simply and pleasantly told, and those who like to read about distant lands of which little is generally known, will find much to interest them in the author's record of his adventures. The best parts of the book are those in which he describes the Indian tribes of Ecuador, whose habits and modes of thought and feeling he closely observed. He also notes some rather curious facts in natural history. Probably few persons have ever heard of "the roaring of an alligator." "I heard it myself," says Mr. Simson, "on one occasion in the case of a huge beast who appeared to be following a female of his species." The animal was swimming very rapidly, diving and rebounding up to the surface of the water. Mr. Simson was in a small Rob Roy canoe, and remained still to watch his manœuvres. Immediately the alligator saw the canoe, he "came towards it, roaring like a bull at each bound above water." As he was diving, Mr. Simson (who was unarmed) forced the canoe straight over him, and so escaped. "Curiously enough," we are told, "not half an hour after this episode, an alligator jumped from a steep bank over my canoe, and only just cleared it, as I was distractedly paddling along under the shore, and inadvertently startled the reptile above me."

LETTERS TO THE EDITOR

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.

[The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.]

Tabasheer

As I have occasionally found the curious stony plug of which Mr. Thiselton Dyer writes (NATURE, vol. xxxv. p. 396), in the joints of bamboos accidentally broken, and been much exercised as to the nature and origin of the phenomenon, I have been much interested by his paper. May I further suggest that it is to a certain extent pathological—due, that is, to *arrested growth*, either longitudinal or lateral, in the shoot next above the joint in which the stony secretion or sediment is found.

In the onrush of tropical growth in the young shoot, Nature, after flooring the knot, has poured in, as it were, sap and silica sufficient for a normal length and width of stem to the knot next above it. But by some check to the impulse, or irregularity of conditions, the portion of stem thus provided for is shorter or narrower than intended; and the unused silica is left behind as a sediment, compacted by the drying residuum of sap. It is a question only to be settled by close examination of a great number of examples.

Something like it occurs, however, in the case of our own wheat. Larger joints, that is, and stronger walls are commonly found where the length of stem between joint and joint is a short one. As in the bath for electroplating the same amount of silver is deposited in a given time on a single penny as on a tea service of many pieces, so in the case of quick-growing silicated stems it would seem as if the same average amount of material were provided by the mounting sap, and the constructive use actually made of it determined by many accidents. In the wheat stem the silica is differently placed; in the fiercely-growing bamboo shoot the mineral in excess is left behind in a crude form, and disregarded. That is what I should expect to find.

HENRY CECIL

Bregner, Bournemouth, March 1

Temperature and Pressure in Jamaica

THE following table of elevations and averages is not as perfect as might be wished, but as some years must pass before it can be greatly improved, it is here given as one of many results obtained by the Meteorological Service in Jamaica:—

Station	Elevation Feet	Pressure Inches	Max.	Mean	Min.	Range
Kingston	0	30·00	87·0	78·2	71·0	16·0
Kempshot	1773	28·20	80·5	72·7	68·0	12·5
Cinchona Plantation ...	4907	25·27	68·5	62·6	57·5	11·0
Portland Gap	5477	24·71	69·0	59·7	54·6	14·4
Blue Mountain Peak...	7423	23·14	71·1	55 7	46·3	24·8

In NATURE, vol. viii. p. 200, it was suggested that the fall of temperature, δT was connected with the fall of pressure δP by the equation

$$\delta T = \lambda . \delta P,$$

where λ was taken equal to 3°·23.

We can now correct this expression and take

$$\delta T = \lambda . \delta P + \mu (\delta P)^2,$$

where $\lambda = 2°{\cdot}92$, and $\mu = 0°{\cdot}08$. But these values relate to mean temperatures; for minimum temperatures $\lambda = 0°{\cdot}96$, and $\mu = 0°{\cdot}40$.

These expressions and their connection are important, and it

would be interesting to know whether similar results have been found in India and elsewhere within the tropics, or may yet be obtained.

Computing δT by means of these formulæ, and applying the results to the temperatures at Kingston, we have

	Mean	Min.
Kempshot	72·7	68·0
Cinchona Plantation ...	62·6	57·5
Portland Gap	60·5	54·7
Blue Mountain Peak ...	54·4	45·6

which are fairly satisfactory.

Putting δP = 30 inches, the minimum formula gives −311° as the temperature of space, the thermometer being shaded from the sun by any spherical body such as the earth or moon.

Putting δP = 30 inches, the mean formula gives −81° as the mean temperature of a body devoid of atmosphere, such as a meteorite pursuing its course in space, or the moon, at the mean distance of the earth from the sun.

An expression for maximum temperatures cannot be as easily deduced; but if the surface of the meteorite or the moon which is turned from the sun be −311°, and if the mean temperature be −81°, it follows that the maximum temperature of the surface turned towards the sun must be about +149°.

Jamaica, February 12 MAXWELL HALL

Electricity and Clocks

IN addition to the plan pointed out by Prof. Sylvanus Thompson (the correct way to repeat from a striking clock to electric bells), I believe I have seen an arrangement in Dublin whereby a single port or going train only is made to strike the hours on an indefinite number of electric bells. I believe this mechanism is a patent. HORLOGE

Sandymount, March 2

Top-shaped Hailstones

ON August 6, 1885, a hailstorm occurred in this neighbourhood, during which two waterspouts were seen. After one of these had burst, a fall of hailstones, almost exactly similar to those described by Mr. Middlemiss in your issue of March 3 (p. 413), commenced and lasted for some minutes. I do not remember to have noticed that there was a mass of clear ice at the base of the cone, but the banding was very distinct.

Beside the horizontal stratification there was another perpendicular one, giving the hailstone the appearance of being composed of alternate cylinders of clear and white ice. If the hailstones which Mr. Middlemiss saw at Ramnagar showed this peculiarity, he will perhaps be kind enough to communicate the fact through your columns. Sketches of the hailstones which fell in this district were published in the *Meteorological Record* soon after the occurrence, but I cannot give the precise date of the copy. T. SPENCER SMITHSON

Facit, Rochdale, March 7

The Present Southern Comet

EITHER the present brilliant southern comet is periodic, or one of a large family of comets, moving in similar orbits and possessing marked similarities of structure. Its orbit, as far as an orbit can be determined from the approximate positions of a very indefinite nucleus, is similar to those of the 1843 and 1880 comets. In Grant's "History of Astronomy" the following description of the 1668 comet occurs:—"It appeared a little above the western horizon. The tail measured 23° in length, and resembled a huge beam of light. The head was so small as to be scarcely visible. The observations will be represented with sufficient accuracy by the elements of the orbit of the comet of 1843." A fairly accurate description of the present comet. There are other comets—1618, 1689, 1702—which possess this strong family likeness. If these comets be not one and the same, they must all have had a common origin. I do not know if it has been noticed that the aphelia of their orbits lie within a few degrees of Sirius. It may be possible that they have all been ejected from that gigantic sun; at any rate, it is impossible that they could have been attracted from nebulous masses lying beyond Sirius. A. W. R.

Lovedale, South Africa, February 1

The Earthquake

I EXAMINED my magnetograms very carefully on the day of the earthquake in North Italy, and I find no trace of any special disturbance on the H.F. trace similar to that on the Kew curve. It may be well to place this on record, as it may aid in fixing the limits of the disturbance. S. J. PERRY

Stonyhurst College, Blackburn, March 7

CEREBRAL LOCALISATION[1]

I.

IT is rather more than ten years since the first edition of this book came under review in the pages of this journal. And it was intrusted to very able hands, for its reviewer was George Henry Lewes, himself an experimentalist in this branch of physiology, and of the highest distinction as a philosopher and psychologist. The review is courteously but unflinchingly hostile: exception is taken to some of the facts and to most of the deductions of the author; although the value of the work, from its richness in suggestions as well as in facts, is ungrudgingly admitted. Mr. Lewes especially complains that the book "is so deficient in the indispensable correctives of counter facts and arguments, that the reader must be cautioned against accepting any position unless elsewhere verified. . . . From one cause or another there is a disregard of counter evidence, which, in a second edition, I should seriously urge him to rectify. . . . This disregard arises from no unfairness, but simply from the one-sidedness which comes from preoccupation with certain views."

The increased size of the work (498 pages instead of 323) is, no doubt, in part due to an endeavour to carry out this suggestion, although the growth of the subject may of itself, in great measure, account for such increase. Indeed it must be confessed that the characteristic complained of by Mr. Lewes has not by any means entirely disappeared, and the student who may consult its pages must bear in mind that the book still remains the gospel of the functions of the brain "according to Ferrier."

The pervading idea of the work is expressed by the term "localisation of function." It was against this idea (and especially against certain applications of it) that Mr. Lewes brought to bear the full powers of his criticism.

One serious objection which was urged by him against many of Dr. Ferrier's results (those of localised extirpation) was that he was unable to keep the animals alive long enough to allow the effects of Disturbance of function to subside, so as to leave only the effects of Removal to be estimated. But the use of antiseptics has now permitted this objection to be removed, since there is no longer, in most instances, the same difficulty in preserving the animals, as was the case in Dr. Ferrier's first experiments.

It is further urged by the previous reviewer that "neither the effects of Disturbance nor the effects of Removal are to be taken as conclusive evidence that the function disturbed or removed is the function of the organ operated on." [But although not of themselves conclusive, yet if looked at in conjunction with other evidence they may furnish important indications regarding the function of the organ.] Mr. Lewes further affirms that "whenever a function persists or reappears after the destruction of an organ, this is absolutely conclusive against its being the function of *that* organ," meaning, of course, of that organ alone. That, in the case of recovery or reappearance, partial or complete, of a lost function, another organ previously possessed of a different function has vicariously taken its place, is a scarcely tenable hypothesis. And yet there are well-recorded instances of such reappearance: as in the case of Goltz's dogs, which recovered some of the lost power of voluntary movement; and in that of the visual disturbances which are caused by lesions of the occipital lobe, in which

[1] "The Functions of the Brain." By David Ferrier, M.D., LL.D., F.R.S. Second Edition, re-written and enlarged. (London: Smith, Elder, and Co., 1886.)

I have myself frequently observed recovery, to all appearance complete. It appears to me that the idea expressed by the term "concentration of function" harmonises much more fully with our existing knowledge of the facts relating to this question than the more inflexible phrase "localisation."

It is time, however, to turn to the edition which lies before us. Dr. Ferrier, in his preface, tells us that the book has been almost entirely re-written, and, in point of fact, so much has been added and modified as to constitute this edition, in many respects, a new book. But the principal teachings of the original—those to which the book from the first owed its chief interest—the doctrines, namely, therein advocated regarding the localisation of cerebral functions, are, it is claimed by the author, maintained in all essentials unchanged. Since it is to the exposition of these doctrines, and especially of the experimental facts upon which they rest, that the student of physiology or psychology would naturally first turn, in order to discover what that is new may have been adduced in support of the Ferrierian teachings, and in what manner the hostile attacks which have been directed against them are met by their author, no apology is needed if we devote our attention first and chiefly to those parts of the book which deal with this important question.

After it had been found impossible to deny the correctness of the facts regarding electrisation of the cortex of certain regions of the brain, a vigorous onslaught was made from various quarters upon the method of experimentation. It was especially contended (by Dupuy and others) that the movements produced by this method are really due, not to excitation of the cortex cerebri itself, but to conduction of the current to the basal ganglia (corpora striata). But a single new fact entirely overthrows the last remnant of this objection, since it has been shown (by Franck and Pitres) that similar movements may be caused by mere mechanical stimulation of the cortex (p. 228). Indeed, the same observers entirely deny that the basal ganglia respond at all to direct electrical excitation, a statement which we shall afterwards see is not, however, accepted by Dr. Ferrier.

In the review above alluded to, Mr. Lewes alleges two principal facts against the doctrine that the gray matter of the cerebral cortex is directly excitable, viz.: (1) the fact that only the electrical current causes an excitation,—mechanical and chemical stimuli have no such effects, because they cannot pass through the cortex to reach the white substance; (2) what he terms the "decisive experiment" of Dr. Burdon Sanderson. "If that part of the surface of the hemisphere which comprises the active spots is severed from the deeper parts by a nearly horizontal incision made with a thin-bladed knife, . . the result is the same as when the surface of the uninjured organ is acted upon" (Proceedings of the Royal Society, No. 153). But we have just seen that, under suitable conditions, the cerebral surface may be excited mechanically; and, with respect to the second fact, I imagine that Dr. Sanderson would now be the first to admit that his results were due either to imperfect severance or to the spreading of a current of too great intensity.

Moreover, the study of the characters of the contractions which result from excitation of the cortex has tended to show that its excitation is indeed a stimulation of centrifugally discharging nerve-centres, and in conformity with this view it is found that destruction of the cortex in the excitable regions is followed not only by immediate paralysis of the parts in which movement is evoked on excitation, but also by speedy degeneration of the efferent nerve-fibres. The arguments upon this point are set forth briefly, but clearly, by the author (pp. 231-33).

With regard to the results of localised excitation of the cortex (in the monkey), some modifications which are not wholly unimportant have been introduced; but to obtain these the author appears rather to have again consulted his original memoir (Proc. Roy. Soc., No. 161, 1875) than the results of any new experimental investigations. The facts that the excitable region extends over the margin of the hemisphere to include the marginal gyrus upon the mesial surface, and that this part of the excitable region is associated with movements of the leg and trunk, had not been definitely determined at the time of publication of the first edition, but are duly recorded here (p. 245).

The general correctness of Dr. Ferrier's statements regarding the results of localised excitation of the brain in the monkey (and, from its resemblance to the human brain, these will be those of chief interest to most readers) seems at the present time to be universally admitted. I have myself so frequently had the opportunity of verifying them as to have no doubt of their general applicability. But the *inferences* which he has drawn from the results of excitation have not, as we shall presently see, been allowed to remain unquestioned.

The method of localised ablation is of yet more importance for the determination of the functions of the cortex than that which we have just considered. In carrying out this method, the necessity of strict adherence to Listerian precautions is demonstrated when we compare the results which were obtained in the first instance by Dr. Ferrier himself, and recorded in the first edition of this book, with those which have been yielded by the antiseptic method in the hands of Prof. Yeo and himself, in a series of experiments undertaken with the express object of testing the applicability of that method to brain-surgery, several of which experiments are recorded in this edition. The path which their experiments indicated has since been trodden by my colleague Mr. Horsley and myself, and it is to-day a beaten track leading to previously undreamed-of possibilities in surgical science. The fact that the brain can be as effectually searched with a view to the discovery and removal of a tumour as any other part of the human body is an advance of vast extent—a boon to suffering humanity of incalculable value. And that this boon has been acquired, could have been acquired, solely as the result of experiments upon animals, is a fact which may well make the most frenzied of anti-vivisectors pause ere he would deny to his fellow-men the opportunity of acquiring benefits of such inestimable worth!

At the present time it is admitted, even by those physiologists who, like Goltz, have been hitherto accounted the most strenuous opponents of the doctrine of cerebral localisation, that the results of localised extirpation of the cortex vary with the part removed. These results consist of a loss or diminution in the power of voluntary action of different groups of muscles, or of a loss or defect in the appreciation of sensory impressions (but, according to some observers, both volition and sensibility may be at the same time affected by the destruction of certain parts): lastly, from experiments upon some parts of the hemisphere, it may happen that no effect appreciable to the observer is obtained. With respect both to these results and those obtained by excitation, Dr. Ferrier, in the first edition of this work, took up certain positions which have in the meanwhile been vigorously assailed from various quarters. These positions are, in the present edition, for the most part defended by the author with no less vigour, although one or two have been somewhat shifted, and one, at least, altogether abandoned.

In order to make clear these positions to those readers of NATURE who may not have followed closely the controversies which have been carried on during the past fifteen years regarding this subject of cerebral localisation, it will be necessary briefly to describe, with the aid of a diagram, the main features of the external configuration of the monkey's brain (every fissure and convolution in which is represented in the human brain). It will then be easy to indicate the regions to which special functions were originally ascribed by Dr. Ferrier, the modifications

which he has since seen reason to introduce in the original scheme, and the results which have been arrived at by certain other workers in this field of research.

Fig. 1 is a diagram of the outer surface of the left hemisphere of the monkey's brain: in it the fissures are represented by black lines. It is seen to be crossed obliquely by six prominent fissures (besides less important

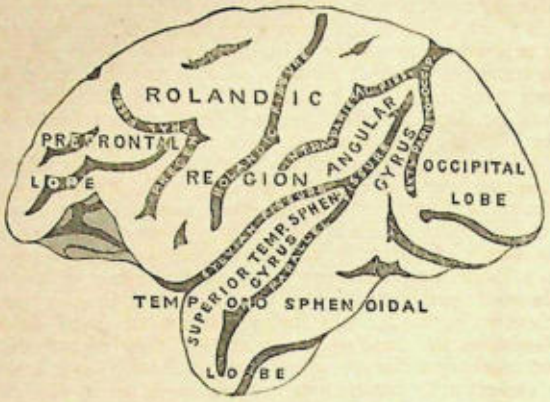


Fig. 1.

depressions). These, enumerated from before back, are the pre-central, Rolandic, intra-parietal, Sylvian, parallel, and parieto-occipital fissures. The anterior portion of the hemisphere in front of the pre-central fissure is termed the pre-frontal lobe. The part of the brain behind this, and bounded behind by the intra-parietal and Sylvian fissures, may be designated the Rolandic region, since it includes the Rolandic fissure. The next part, posteriorly, lies in the angle between the intra-parietal and parieto-occipital fissures, and has the end of the parallel fissure running up into it: it is known as the angular gyrus. Behind the parieto-occipital fissure is the occipital lobe. The rest of this surface of the hemisphere below and behind the Sylvian fissure is the temporo-sphenoidal lobe: the convolution in this which lies between the Sylvian and the parallel fissures, and which is thus very well marked off from the rest of the lobe, is the superior temporo-sphenoidal gyrus.

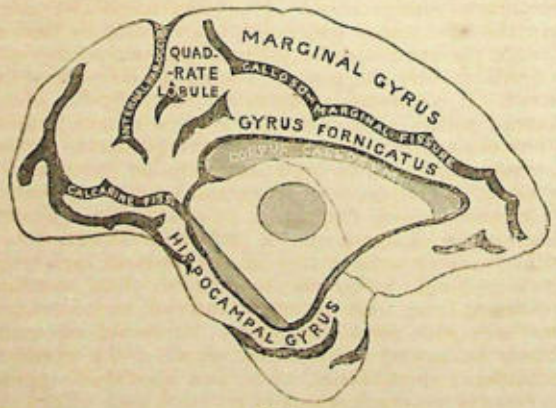


Fig. 2.

Fig. 2 represents the mesial and under surface of the left hemisphere. We here see, above the cut corpus callosum and the other parts which unite the two hemispheres, two convolutions running longitudinally, and separated by a well-marked fissure, the calloso-marginal. The upper one is termed the marginal gyrus, the lower the gyrus fornicatus. The latter expands posteriorly into the quadrate lobule, and is then continued around the posterior end of the corpus callosum on to the under surface of the temporo-sphenoidal lobe, where it becomes continuous with the hippocampal gyrus. The internal parieto-occipital fissure, continuous above with the external one of the same denomination, cuts off, like that, the occipital lobe from the rest of the brain.

Briefly stated, the positions taken up by Dr. Ferrier in the first edition of this work were as follows:—

(1) The Rolandic region is motor. This is the part of the hemisphere from which all volitional impulses (at least for the limbs, head, and face,—about the trunk-muscles nothing was ascertained) issue. It is not connected with sensory perceptions of any kind, not even with those of the muscular sense.

Evidence.—Electric excitation in this region in animals produces definite and co-ordinated movements of muscles of the limbs, neck, and face, similar to those which occur in voluntary efforts. Extirpation is followed by immediate and permanent paralysis of those muscles without the occurrence of any loss or impairment of sensation in the corresponding parts.

(2) The angular gyrus is the centre for vision with the opposite eye.

Evidence.—Electric excitation of this convolution produces movements of the eyes towards the opposite side, contraction of the pupils, and closure of the eyelids as if under the stimulus of a strong light. Movement of the head to the opposite side is also frequently produced. Extirpation of the angular gyrus on one side causes complete blindness in the opposite eye, but this is not permanent if the angular gyrus of the other hemisphere be intact. If this also be removed the loss of vision is complete and permanent.

(3) The superior temporo-sphenoidal convolution is the centre for hearing with the opposite ear.

Evidence.—Electrical excitation of this convolution produces sudden retraction or pricking up of the opposite ear, opening of the eyes, dilatation of the pupils, and turning of the head and eyes to the opposite side. "These phenomena resemble the sudden start and look of surprise which are caused when a loud sound is made in the opposite ear." Lesions of the temporo-sphenoidal lobe of one side which involve the superior convolution produce deafness of the opposite ear, as evidenced by the fact that the animal becomes deaf to ordinary sounds when the ear upon the same side as the lesion is stopped with cotton-wool. When the lesion is established bilaterally, so as to cause destruction of the superior temporo-sphenoidal convolution on both sides, the animal fails to respond to auditory stimuli.

(4) The hippocampal region is concerned with the appreciation of tactile sensation, if not of other forms of sensibility.

Evidence.—Unilateral destruction of this region is followed by complete absence of response to cutaneous stimulation on the opposite side of the body (without any true motor paralysis, although there may be disturbance of voluntary movements, "due to the loss of tactile sensation, by which movements are guided") "the effects being of a persistent character."

(5) The subiculum, or tip of the temporo-sphenoidal lobe, (under surface) is specially related to the sense of smell (in the nostril of the same side).

Evidence.—Electrical irritation of this part of the brain causes phenomena (torsion of the lip and partial closure of the nostril of the same side) such as are "produced by the direct application to the nostril of a powerful or disagreeable odour." Destruction of this region upon one side is accompanied, when the nostril of the opposite side is plugged, by impairment or loss of the olfactory sense: bilateral destruction by complete absence of reaction to olfactory sensations. "The comparative development of this region in animals in which the sense of smell is

largely developed, as in the dog, cat, and rabbit, strongly bears out this view."

(6) The lower part of the temporo-sphenoidal lobe, close to the subiculum, is probably to be regarded as the centre of taste.

Evidence.—Electrical excitation of this region produces movements of the lips, tongue, and cheek-pouches, which "may be taken as reflex movements consequent on the excitation of gustatory sensation." And the abolition of taste coincides with (bilateral) destruction of this region.

(7) The pre-frontal region is probably related to the reflective and intellectual faculties.

(8) The occipital lobe is related to the visceral sensations, such as hunger and thirst. The evidence in favour of this opinion was regarded even by its author at the time as very inconclusive, and since the subject is entirely ignored in the later edition we need not further consider it.

E. A. SCHÄFER

(*To be continued.*)

THE UNIVERSITY COLLEGES

THE other day (March 3) the *Times* printed a letter from Prof. Jowett containing a powerful appeal to the State on behalf of the University Colleges which have recently been established in large towns by the exertions of private individuals. On Monday evening last, Mr. Mundella, having asked the Chancellor of the Exchequer whether his attention had been called to this letter, proceeded to inquire whether the Government "would introduce or facilitate the passing of a measure authorising local authorities to contribute towards the establishment and maintenance of schools and colleges adapted to the wants of their several localities, and would recommend to Parliament annual grants in aid of the same." That Mr. Goschen, so far as his personal sympathies are concerned, would have liked to give an affirmative answer to this question there can be no doubt; but, speaking as a member of the Government, he adopted a very discouraging tone. He was not in a position, he said, to recommend to Parliament annual grants in aid of local colleges. He admitted that it was an open question whether local authorities should not be empowered to aid such institutions, but the Government could not undertake to introduce or facilitate the passing of a measure dealing with the matter.

This decision is greatly to be regretted, and we must hope that the Government will soon be compelled by the pressure of public opinion to reconsider the subject. No one disputes that the University Colleges have done, and are doing, most valuable service to the communities in the midst of which they are placed. Until they were established, what is called a University education was accessible only to very well-off persons. The University Colleges have brought a high intellectual training within reach not only of the middle classes, but of working men, and large numbers of eager and intelligent students have taken advantage of the opportunities provided for them. Even, therefore, if no material benefit were derived by the nation directly from the University Colleges, it would be the clear duty of the State to afford them the help they need. But from the point of view of industry and commerce, as well as from the purely intellectual point of view, it is hardly possible to overrate the importance of these colleges. That our traders are being driven by German and other competitors from important markets is, unfortunately, only too certain; and it is not less certain that they will never recover the ground they have lost until English industry in all its branches is carried on in accordance with strictly scientific methods. This is beginning to be pretty generally understood, and it will be strange if the country does not insist that justice shall be done to institutions in which a serious attempt is being made to impart the kind of knowledge without which it is impossible for manufacturers to adapt their work to the rigid conditions of the present age.

No doubt it would be very satisfactory if the University Colleges could be made self-supporting, but this they cannot be. If those of them which do not possess any considerable endowment receive no aid from the Government, they will soon be placed in a position of grave difficulty; and the question will have to be faced, whether it is worth while to maintain them at all unless they can be maintained in a state of high efficiency. After all, it is no very great sacrifice that the State is asked to make for their benefit. What is claimed is simply that not less shall be done for the English colleges than is done for like institutions in Scotland, Ireland, and Wales.

An aspect of the question which does not always receive adequate attention was well brought out in Prof. Jowett's admirable letter. "Among other benefits," he wrote, "the influence which is exercised by these institutions on the society of a place is not to be forgotten. The residence in a large manufacturing town of a number of highly educated persons, having a variety of literary and scientific interests, is a social element of great value. They raise the tone of conversation; they create ideas and aspirations which would not ordinarily have arisen in a mercantile community. They break in on the dull monotony of wealth. The posts which they occupy, though poorly paid, afford leisure for study and opportunities for research. Among the holders of them are to be found some of the most promising young men of the country. Many of them are known by their writings, and a large proportion of the papers published in English scientific periodicals is a record of the work done in University Colleges."

The *Times*, we are glad to say, cordially supports the cause advocated by the Master of Balliol. "The good," it says (March 3), "which the local colleges do is not exaggerated by Prof. Jowett. They form centres of instruction for all the young men and young women of a town who desire to improve themselves. They foster the love of study, and teach the art of making use of time. 'They may have even kindled in the minds of one or two the spark of genius.' To put the matter on a lower but not less practical level, they have done much, by means of their technical schools, to provide that very instruction of which, as everyone admits, our artisans are so much in need to enable them to carry on the struggle for existence against foreign rivals. Nor does the Master overstate the advantages which the town indirectly derives from the presence of these colleges, whose teaching staff do much to raise the tone of social life throughout the district. It is a sound argument of the defenders of the Church Establishment that it is a great gain to English society to have at least one educated gentleman settled in every parish. The argument may be extended in favour of the University Colleges, and we may say that in a large town, where the pursuit of wealth through commerce is the characteristic of the whole society, it is a great advantage to have four or five men of high intellectual training, whose aims are different, whose standard is different, and who represent science and literature sometimes with great distinction. It would on many grounds be matter for extreme regret if the excellent institutions which foster such men should disappear. Yet there is too much reason to fear that such will be the fate of most of them, unless help more permanent and certain than any that can be derived from voluntary sources is at once forthcoming. Neither Leeds, Newcastle, Sheffield, Nottingham, nor Bristol is in a satisfactory financial condition. The fees cannot pay even the very modest stipends of the professors, and the annual subscriptions are showing a lamentable tendency to diminish. It seems as though there was nothing for it but an appeal to the Exchequer, sorely tried as it now

is, and growing as is the need for economy. . . . The University Colleges during fifteen years have proved their value; and also, like every other educational institution, they have proved that they cannot live without external help. The only help that is likely to be permanent and that will enable them to feel secure is help from the State; and, in a moderate degree, it will be worth the State's while to give it."

The opinions of men of science on the subject were expressed in a letter from Sir Henry Roscoe, which appeared in the *Times* on Saturday last. "It is unnecessary now," he wrote, "to enlarge on the important national work in which these colleges are engaged. That the higher scientific and technical training which these colleges are now giving to the best of their power is a necessity, indorsed as this opinion has been by two Royal Commissions, is now, I am glad to think, generally admitted. It is, however, perfectly clear that if these colleges are to do the work which the country demands they must receive pecuniary assistance. They cannot from their very nature be made self-supporting. Their object is to afford a thorough but also a cheap education, and the localities have in almost all cases now practically exhausted the power of raising funds from private sources. How, then, are the necessary means to be found? They must come either from Imperial or from municipal sources. As the Master has pointed out, the remedy must be a speedy one. We cannot afford to wait until public opinion has reached the point at which ratepayers generally are convinced that it is to their advantage to support such colleges. The only alternative, therefore, is that the nation as a whole shall, through the Government, acknowledge its obligation to supply the necessary funds, the amount required being comparatively small and not one likely largely to increase. It is satisfactory to know that the whole subject of the furtherance of scientific and technical education in the country is at the present moment under the serious consideration of Members of Parliament of all political parties, and I have good reason to hope that our efforts to bring this question, vital as it is to the industrial and commercial supremacy of the country, to a satisfactory issue may, even this Session, be crowned by some measure of success. Among the several important matters engaging our attention, I need scarcely say that this particular one, affecting as it does the higher technical education of those who are hereafter to take positions as leaders in our commerce and industries, is by no means the least important."

We trust that the new impetus now given to this question may lead to beneficial results. It is to be hoped, however, that we shall hear less of the word "*technical*" in connection with these colleges, for if they are technical only, we may be better without them.

THE EARTHQUAKE IN SWITZERLAND

PROF. FOREL, the meteorologist, of Morges, on the Lake of Geneva, has just issued a report on the earthquake of February 23. He classifies the shocks under three heads—namely, preparatory shocks, strong shocks, and consecutive shocks. It is difficult, in the absence of trustworthy data, to indicate the precise locality of the first-named, but Switzerland was undoubtedly the region of the second; but it was to the third—that is, the consecutive shocks—that all the mischief was due. The professor traces the course of the phenomenon in Switzerland over a radius of at least four hundred square miles. Its force was greater in the southern parts of the country than in the north, though the shocks were felt throughout Geneva, Berne, Neuchâtel, Fribourg, Vaud, Valais, and Tessin; and observations go to prove that these shocks travelled almost due north and south, although the direction of the oscillations does not coincide with this course. The oscillations in Switzerland were characterised by their number and repetitions. In some localities they were longitudinal; that is, running parallel to the meridian; in others they were transverse, running or flowing from east to west. The vertical movements were marked by their feebleness where indicated, but in the greater part of the territory affected vertical oscillations were entirely absent. One of the peculiarities of the oscillations generally was the length of duration, which is set down as varying from 10 to 30 seconds. But the collected reports prove that the mean of these figures more nearly represents the prevailing duration. The intensity of the shocks was greater in the central and southern areas of the disturbance, and it would seem as if the shocks only just failed to attain the necessary strength which would have produced disastrous effects. As it was, church bells were rung, in some places violently; windows were rattled, doors thrown open, ceilings slightly cracked, and morsels of plaster were brought down, and here and there stacks of wood were thrown over. One of the most striking features of the phenomenon was the extraordinarily large number of clocks that were instantly stopped, and this fact has afforded the best possible means of determining with something like perfect accuracy the time of the shocks, which varies from three to four minutes past six in the morning, Berne time. The large astronomical clock of the Observatory at Basle stopped exactly at 6h. 4m. 7s. This, taken as representing Berne time, corresponds with 5h. 43m. 35s. of Paris, 5h. 55m. 43s. of Marseilles, 6h. 3m. 2s. of Nice, and 6h. 24m. 3s. of Rome.

The consecutive shocks, which were responsible for all the loss of life and damage to property, were centralised in the region of the Riviera. The greatest damage was done by the two first shocks, which occurred with an interval of fifteen minutes between them. The reports from the Swiss observatories also show that a series of feebler shocks were experienced in Switzerland later on in the same day, and also on several succeeding days.

NOTES

SEVERAL schools of science and art in the colonies and dependencies of the United Kingdom have expressed a wish to be allied with the Department of Science and Art and to have the advantage of its examinations. It has therefore been decided that upon the application of the Colonial Government or Educational Department, or other public authority of the colony, the Department of Science and Art will arrange for the examination of their schools, on the results of which examination certificates and returns of awards will be issued. The entire cost of the examination of the papers and works, and of their carriage, clearing in London, and conveyance to and from South Kensington, will, of course, have to be defrayed by the local authority concerned. The personal examinations, the subjects of which are stated in the Science and Art Directory, must be held in the colonies and dependencies upon the earliest date possible after the receipt of the examination papers, and these examinations must be conducted by qualified and responsible persons not immediately interested in the results of the examinations, who should on the conclusion of each examination furnish a certificate that the examination has been fairly conducted. The examination of works is held at South Kensington, and works to be examined must be forwarded to reach South Kensington not later than the end of April in each year. The Department will send upon application copies of lists of examples and prizes, and will, as far as possible, advise the local authorities in reference to the conduct of science and art schools or classes. The Department will also present specimen examination papers or works—when there are such in stock disposable—with the view of indicating the style of drawings

and paintings done by students and candidates in the United Kingdom, and the standards of attainment for the various examinations.

CAPT. A. W. GREELY has been appointed to succeed the late General Hazen, as Chief Officer of the Signal Service in the United States, with rank of Brigadier-General. This announcement has been well received in America even by those who have hitherto wished to see the Signal Service separated from the army. Capt. Greely was next in rank to General Hazen in the bureau, and his eminent fitness for the duties of his new position is universally acknowledged.

THE Paris Geographical Society will shortly celebrate the centenary of the La Pérouse expedition round the world. The last news received from the unfortunate explorer and his companions was brought to France by an uncle of M. de Lesseps.

SEVERAL interesting speeches were delivered in the House of Commons, on Monday evening last, in connection with the supplementary vote of 10,560*l.* for the Science and Art Department. Mr. Mundella said the vote asked for was the result of an automatic increase in which every member who had spoken ought to rejoice. The increase had been large and rapid. In 1875 the total number of pupils in every branch of art instruction was 444,000, while in 1885 the number had increased to 883,000, or nearly double. There had been a large increase of art schools, where, he thought it would be admitted, the work was much better done than in art classes. He did not, however, profess to be satisfied with the position we have attained. It was true, he said, our Estimates were large as compared with twenty-five or thirty years ago; but, as compared with other countries similarly situated to ourselves, they were a disgrace to us. The expenditure on education in England was 5 per cent. of the whole expenditure of the country, but in some other countries the expenditure on education formed one-third of the whole expenditure of those countries—in Switzerland, for instance, it was rather more than one-third. While it was the duty of the Treasury to keep down expenditure, there would be no real good done in this country until the expenditure on education was largely increased. Prof. Stuart also insisted that England does not yet do nearly enough for scientific education. To illustrate this, he quoted the school statistics of New Zealand and Australia, showing the large proportion of children attending science teaching in those colonies. Prof. Stuart argued strongly in favour of technical instruction being carried on in evening classes, so that the minds of workmen might be concentrated on those branches of work which they might not so easily acquire in the workshop. An immense impulse had been given in the right direction when the examination in chemistry had been made one of a practical kind, instead of merely book-work and paper-work, and a similar step would have a good effect in the case of physics and mechanics. In conclusion, Prof. Stuart urged upon the Government the desirability of extending as far as possible the scholarships, local exhibitions, and prizes in connection with the science classes. Sir H. Roscoe gave it as his opinion that the money which the country voted for the purpose of science and art instruction was money well spent. The importance of the question could not be overrated, and the Science and Art Department was in a position to carry out in the main the requirements of the country in regard to such instruction. There was, however, one matter to which the Department had not yet given attention, and that was the question of manual instruction in the use of tools. In view of what was being done on the Continent in extending science and technical instruction, he trusted the Committee would pass the vote as only the beginning of what they might hope to get in time.

WE regret to announce the death of Dr. August Wilhelm Eichler, Professor of Botany at the Berlin University, and Director of the Royal Botanical Garden and Botanical Museum at Berlin. He died on Wednesday, the 2nd inst.

DURING the past month there have been several fine displays of the aurora borealis in Northern Sweden. The displays generally began about 8 o'clock p.m., and continued till towards midnight, the point of culmination being reached about 11 o'clock. The auroræ appeared in the form both of streamers and clouds, the colours being mostly white and yellow.

ON February 19, about midnight, a brilliant meteor was seen in Central Norway. It went in a direction north-east to south-west, and was observable for several seconds. The colour was at first brilliantly white, but changed during the passage into yellow and green. The greatest apparent size of the meteor was equal to that of the full moon. It left a trail a couple of yards in length, portions of which remained for some seconds after the meteor had been lost to view behind a mountain ridge. During its passage it lit up the country within a great area.

THIS year Prof. Du Bois-Reymond will celebrate the twentieth anniversary of his appointment as secretary of the Academy of Sciences of Berlin. He is the oldest member of the physico-mathematical class of the Academy.

IN a lecture delivered at the Society of Arts on Wednesday, the 2nd inst., Mr. E. J. Beale stated that last season's experiments in the cultivation of tobacco in England and Ireland resulted in a success satisfactory beyond the hopes of the most sanguine promoters of the experiments. While reasonable caution in the matter of area and extent of future operations was necessary, those results, he thought, more than justified further trials.

THE fifty-fifth annual meeting of the British Medical Association will be held at Dublin on Tuesday, August 2, and the three following days. Dr. Withers Moore, Senior Physician to the Sussex County Hospital, is President, the President-Elect being Dr. John T. Banks, Regius Professor of Physic in the University of Dublin. An address in Medicine will be delivered by Dr. W. T. Gairdner, Professor of Medicine in the University of Glasgow; one in Surgery by Dr. E. Hamilton, Fellow and Professor of Surgery in the Royal College of Surgeons in Ireland; and one in Public Medicine by the Rev. S. Haughton, M.D., Senior Fellow of Trinity College, Dublin. The scientific business will be conducted in eight sections and two subsections. Dr. G. F. Duffey, of 30 Fitzwilliam Place, Dublin, is local Honorary Secretary.

THE Exhibition of Marine Meteorological Instruments organised by the Royal Meteorological Society, which will be held at the Institution of Civil Engineers, 25 Great George Street, Westminster, from Tuesday to Friday next, the 15th to 18th inst., promises to be very interesting and instructive. Many of the instruments used in the *Challenger* and other expeditions will be exhibited. At the meeting of the Society on Wednesday evening, Dr. H. R. Mill will read a paper on "Marine Temperature Observations." Any persons, not Fellows, wishing to visit the Exhibition or to attend the meeting, can obtain tickets on application to the Assistant Secretary, Mr. W. Marriott, 30 Great George Street, S.W.

IN the State of New York there are at least fourteen distinct laws relating to the medical profession. The State Legislature is now considering a measure for the entire repeal of some of these laws, and for the abrogation of parts of others. *Science* is of opinion that the measure "should meet with the hearty support of the medical profession, and receive the vote of every member of the Legislature."

MESSRS. CASSELL AND CO. will have ready, shortly, "A Manual of Practical Solid Geometry, adapted to the Requirements of Military Students and Draughtsmen," compiled by Major William Gordon Ross, R.E., Professor of Geometrical Drawing and Fortification, Royal Military Academy, Woolwich.

MESSRS. GRIFFIN will publish, shortly, a work on pathology, by Prof. Julius Dreschfeld, of Owens College.

DR. THOMAS JONES, Lecturer on Surgery at Owens College, has a work on surgery in preparation. Messrs. Smith, Elder, and Co., will be the publishers.

MR. H. K. LEWIS will issue immediately "Photography of Bacteria," illustrated with eighty-six photographs reproduced in autotype, by Dr. Edgar M. Crookshank; also a second edition, revised and considerably enlarged, of "Manual of Bacteriology," by the same author.

WE have received the first number of the *Wesley Naturalist*, a monthly journal of the new Wesley Scientific Society, of which the Rev. Dr. Dallinger, F.R.S., is President. In an introductory paper, Dr. Dallinger says the Society does not hope to do important original work. Its aim will be "to direct, stimulate, and help, mostly the young and those engaged in daily work, in acquiring correct knowledge of the principles of a chosen branch of science."

MESSRS. GURNEY AND JACKSON, the successors to Mr. Van Voorst, are about to publish a List of British Birds, which has been revised by Mr. Howard Saunders. It will be printed so as to be available for the labelling of specimens. The use of varied type will enable the student to distinguish readily the rarer visitors and the species having a doubtful claim to be considered British.

AN extensive fish-culture establishment is being formed by Mr. William Burgess on his estate at Malvern Wells, Worcester, for the propagation of Salmonidæ and coarse fish. A series of breeding- and rearing-ponds has been made, and a hatchery capable of incubating four millions of ova is being constructed. The site selected for the purpose is said to be admirably adapted for fish-culture, as there is an abundance of pure water. Mr. Burgess has already turned into his waters a quantity of fish, including trout, salmon, and carp.

IN the spring the U.S. Fish Commission steamer *Albatross* will sail for her work on the Pacific. The fish-bearing properties of the Kiu Sawa, or Black Stream of Japan, will be investigated. The Kiu Sawa, crossing the Pacific in a high latitude, is said to modify the temperature and climate of Alaska and the Aleutian Archipelago in very much the same way as the Gulf Stream modifies the climate of the British Isles.

THE managers of the Royal Victoria Hall and Coffee Tavern show much discretion in the choice of subjects for their well-known "Penny Science Lectures." On Tuesday last a lecture on "Vesuvius and Ischia, a Volcano and an Earthquake," was delivered by the Rev. W. W. Edwards. On Tuesday next, Prof. George Forbes will describe "A Journey across Asia, through Siberia," and, on the 22nd inst., the Dean of Westminster will lecture on "Westminster Abbey."

A REPORT of the proceedings of the thirty-fifth meeting of the American Association for the Advancement of Science, held at Buffalo in August last, has lately been published. It contains, besides many short papers and abstracts, the address of Mr. H. A. Newton, the retiring President, and the addresses of the Vice-Presidents in the Sections of Mathematics and Astronomy, Physics, Chemistry, Mechanical Science and Engineering, Geology and Geography, Biology, Anthropology, and Economic Science and Statistics.

IN the second Bulletin of Miscellaneous Information, issued from the Royal Gardens, Kew, there is an interesting account of Cape boxwood. Some time ago a sample of the wood of this tree was sent to Kew, and it was found that the two woods were almost identical. It was clear, therefore, that Cape boxwood was none other than a species of *Buxus*, and perhaps *B. sempervirens* itself. Small samples were exhibited in the Cape Court at the recent Colonial and Indian Exhibition, and in the Catalogue it was stated that the wood had been "very favourably reported on" engraving purposes." The general appearance of the speci[mens] at the Exhibition did not recommend Cape boxwood to [the] notice of engravers.

WE regret to announce the death of Dr. Birnbaum, [Professor] of Chemistry at the Technical High School at Carlsruhe, [on] February 20; and of Dr. Reinhold von Reichenbach, the well-known chemist, who died at Gratz on February 23.

THE South American Exhibition at Berlin has resulted in a great pecuniary loss.

M. E. BERILLON has just published a little book on Paul Bert's scientific career. Being a medical man himself, he has been able to give a very clear and accurate idea of M. Bert's work in physiology.

AT a recent meeting of the Paris Biological Society an apparatus was shown, made of iron and glass, in which a pressure of 1000 atmospheres can be developed for the purpose of studying the influence of pressure on animal life.

THE third meeting of the French Congrès de Chirurgie will take place in Paris in the month of April 1888. The second one was held in November 1886. Prof. Verneuil is President-Elect for 1888.

THE earthquake which took place on February 6 in Southern Indiana, Illinois, a small portion of Kentucky, and East Central Missouri is said by American newspapers to have had an area of about 75,000 square miles. The greatest intensity was in South-Western Indiana and South-Eastern Illinois. The U.S. Geological Survey is trying to obtain accurate information as to the boundary of the area covered.

CORRESPONDENTS in Athens report that on Friday last successive slight shocks of earthquake were felt from noon to midnight at Philiatra. The direction was south-west by south.

M. FLORAN DE VILLEPIGNE has devised, in Paris, an instrument, the autographometer, which records automatically the topography and difference of level of all places over which it passes. It is carried about on a light vehicle, and those who wish to use it have nothing to do but to drag it, or have it dragged, over the ground of which they desire to obtain a plan.

THE University of Berlin is being attended, during the present term, by no fewer than 5357 students. This is the largest number of students that have ever been enrolled by a German University. In the Faculty of Philosophy there are 1984 students; in that of Medicine, 1297; in that of Law, 1282; in that of Theology, 794. The number of instructors is 288, of whom 147 are in Philosophy, 103 in Medicine, 22 in Law, and 16 in Theology.

THE Chicago Manual Training School has lately issued its fourth annual Catalogue. The requisites for admission to this institution are that the candidates be at least fourteen years of age, and be able to pass a satisfactory examination in reading, spelling, writing, English composition, geography, and arithmetic. The course extends over three years, and includes instruction in mathematics, science, language, drawing, and shop-work, during the entire period. The school has a well-equipped wood-room, foundry, forge-room, and machine-shop,

and ample apparatus for teaching the various subjects in which instruction is given. Although the regular school exercises were begun only in February 1884, the total number of pupils enrolled is now 190.

In his Report for 1886, Mr. Andrew S. Draper, Superintendent of Public Instruction in the State of New York, points out that that State is now spending 14,000,000 dollars annually in support of its public school system; and he suggests that it might be well to spend a few thousands occasionally in efforts to determine the best way of using this vast sum. Mr. Draper puts some questions which show that he is far from being perfectly satisfied with the educational system he has to administer. "Is there not," he asks, "too much French, and German, and Latin and Greek, and too little spelling, and writing, and mental arithmetic, and English grammar, being taught? Have we been as ambitious of progress in the lower grades as in the advanced? Are not our courses of study too complex? Are we not undertaking to do more than we are doing well? Is not the examination business being overdone? Are we not cramming with facts, which will soon be forgotten, rather than instilling principles which will endure?"

In an article in the March number of the *Zoologist*, Mr. Robert Service tries to show that, until near the end of the first quarter of the present century, ptarmigan were natives of the south-west of Scotland. He thinks that when these birds were on the mountains of Dumfriesshire and Galloway they were probably also to be found on the Cumbrian Mountains. Mr. Service says that, in nearly all the outlying stations of the present race of ptarmigan in Scotland, such as Arran, Argyll, and the Outer Hebrides, they are decreasing.

Mr. William Burgess, who owns an extensive pheasantry at Malvern Wells, has recently made some observations upon the red worm, which is one of the worst assailants of birds. He thinks it comes from the droppings of cattle, which when young are especially liable to the attacks of this insect. Mr. Burgess finds that agricultural salt acts as a remedy against it.

A discovery of great geological interest was lately made on Juckatoo Island, Sydney, in the shape of a Mastodonsaurus. There is a similar specimen from Stuttgart in the collection of the University, but this one is remarkable from the fact that it is the first Labyrinthodont found in Australia. It belongs to the Triassic age of the Hawkesbury Sandstone formation.

Dr. Weill, of Paris, having carefully studied the new therapeutical agent, antifebrine, or acetanilide, discovered by Cohn and Hepp, of Strasburg, says that it is an anæsthetic agent, and that it combats fever very effectually.

A French translation of the "Phantasms of the Living" is being prepared in Paris by M. Ch. Richet and some other persons.

M. Hayez, of Brussels, has issued a second edition of "A General List of Observatories and Astronomers, and of Astronomical Societies and Reviews," prepared by M. A. Lancaster, Librarian of the Royal Observatory of Brussels. The List has been drawn up with great care, and, from the fact that a second edition has been called for, we may assume that astronomers have found it of considerable service. The names and addresses of all well-known astronomers are given, and the compiler has noted every Observatory, whether public or private, in which work is actually being done.

In the Proceedings of the U.S. National Museum, lately issued, there is a paper by Mr. G. H. Boehmer, on Norse naval architecture. Mr. Boehmer gives a clear and remarkably interesting account of the forms of boats represented in the ancient rock-sculptures of Sweden and Norway; of the boat-shaped stone burial-groups supposed to have been erected during the transition time from the Bronze period to the Iron Age; and of boat-remains dating from the third to about the ninth or tenth century of our era, and found at various times and places. The ship found at Tune, and the Gokstad ship, are carefully described. Mr. Boehmer thinks that the "Northland boats" now used in the fisheries along the coast of Norway are almost exactly like those which have always been used by Norsemen from the time of the rock-sculptures. These Northland boats are described as long, narrow, and low, light and elegant, and fit both for sailing and rowing.

The additions to the Zoological Society's Gardens during the past week include a Black-winged Kite (*Elanus cæruleus*) from the Cape of Good Hope, presented by Mr. R. Southey; a Hawfinch (*Coccothraustes vulgaris*), British, presented by Mr. W. H. Quintin; two Pike (*Esox lucius*) from British fresh waters, presented respectively by Mr. H. E. Young and Mr. G. G. Sykes; two Gloved Wallabys (*Halmaturus manicatus* ♂ ♀), two Cereopsis Geese (*Cereopsis novæ-hollandiæ*) from Australia, a Blossom-headed Parrakeet (*Palæornis cyanocephalus*) from India, received in exchange; two Pike (*Esox lucius*) from British fresh waters, purchased.

OUR ASTRONOMICAL COLUMN

Solar Activity in 1886.—The latter part of 1886 showed a most remarkable falling off in the number and size of the sun-spots, a falling off so great as to lead so experienced an observer as Prof. Tacchini to speak of it as possibly the minimum of the eleven-year period. The following numbers, taken from Prof. Tacchini's tables (*Comptes rendus*, vol. ciii. No. 2, and civ. No. 4), may be compared with those we gave (Nature, vol. xxxiii. p. 398) for the year 1885:—

	Relative frequence	Relative size of spots	Daily number of spot groups	Relative size of faculæ
January	8·84	60·42	2·00	47·63
February	6·30	29·00	1·70	32·10
March	14·39	84·78	3·87	43·91
April	8·13	51·91	3·00	41·32
May	6·50	52·77	1·92	37·81
June	7·14	25·22	2·32	37·14
July	8·30	39·93	2·17	35·42
August	3·24	18·70	1·40	8·33
September	5·59	23·41	1·45	18·52
October	1·46	8·08	0·69	18·08
November	0·04	0·15	0·04	7·41
December	6·17	27·04	1·22	15·65

After the fine group of spots which were seen on May 7 and 8 had passed out of sight, the spots decreased in number and size pretty steadily until the end of October. From October 31 to December 12 there then ensued a long period of almost total quiescence. On six days only out of the forty-two could there be discovered on the sun any trace even of a spot, and on those days only one tiny spot could be seen. For an entire rotation and a half the sun was practically free from spots. M. Riccò has also drawn attention to this remarkable interval, and on searching the Palermo records for the earliest comparable period after the maximum of 1870, he finds a somewhat similar interval of quiescence in 1875, five years after the maximum of 1870, and nearly eight years after the minimum of 1867. The depression of last November follows the maximum of 1884 by less than three years, but the previous minimum by about eight years; reckoning from the minimum, the November depression follows the precedent of 1875, but reckoning from the maximum, it would appear to have occurred most exceptionally early. It would seem, therefore, that the irregularity has not been so much in the principal or secondary minima as in the maximum of 1884, which fell later than the mean by nearly two years. M. Ricco anticipates that the true minimum of the eleven-year period will fall in 1890.

A striking feature of the past year has been the great diminution, and for some months, the almost total cessation of spot activity in the northern hemisphere of the sun, nearly all the principal groups having been located in the southern hemisphere.

Faculæ and prominences have shown a falling off in 1886, but

one far less marked than that shown by the spots. The following numbers derived from notes by the Rev. S. J. Perry in the *Observatory* for February 1886, and March 1887, shows that the mean extent of the prominence arc has greatly diminished, though the mean height of the prominences has suffered little change. This diminution in extent was especially marked during the last three months of the year.

	Mean height of chromosphere, excluding prominences	Mean height of prominences	Mean extent of prominence arc
	"	"	° ′
1885	8·00	28·67	28 25
1886	8·05	24·78	13 36
Mean 1880 to 1885 ...	8·07	25·71	32 45

The "mean extent" for October is 9° 54′, for November 7° 25′, and for December 9° 31′.

COMET 1887 *d* (BARNARD, FEBRUARY 15).—Prof. Boss has furnished other elements of this comet than those he gave in his first circular, the first set of elements being thus superseded. They are as follows:—

T = 1887 March 28·47

ω = 36 37
Ω = 135 28 } Mean Eq. 1887·0
i = 139 45
log q = 1·0059

Prof. Krueger (*Astr. Nach.*, No. 2774) has computed the following ephemeris for Greenwich midnight from these elements:—

1887	R.A.	Decl.	log r	log Δ
	h. m.	° ′		
March 13 ...	54 13	57 49 N.	0·0162	9·9430
15 ...	52 53	57 11	0·0129	9·9730
17 ...	51 44	56 39	0·0100	0·0008
19 ...	50 41	56 11	0·0076	0·0265
21 ...	49 46	55 46	0·0056	0·0400

THE WARNER OBSERVATORY.—Mr. Lewis Swift, director of the private observatory of Mr. Warner, of Rochester, N.Y., has recently published a pamphlet giving a description of the dome and 16-inch refractor and other accessories of the observatory. The great telescope has been used by Mr. Swift, since July 1883, in a systematic search for new nebulæ, of which 540 have been discovered up to January 1, 1887. The places and descriptions of over 400 of them are given. Mr. Swift is also engaged in searching for comets. The pamphlet, in addition, contains a list of the recipients of the Warner Prizes for cometary and other astronomical discoveries, as well as a reprint of the essays on comets and on the "sky-glows" of 1883 and 1884, to which prizes have been adjudged.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1887 MARCH 13–19

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on March 13

Sun rises, 6h. 21m.; souths, 12h. 9m. 39·3s.; sets, 17h. 58m.; decl. on meridian, 2° 56′ S.: Sidereal Time at Sunset, 5h. 22m.

Moon (at Last Quarter March 16) rises, 21h. 43m.*; souths, 3h. 8m.; sets, 8h. 23m.; decl. on meridian, 9° 34′ S.

Planet	Rises	Souths	Sets	Decl. on meridian
	h. m.	h. m.	h. m.	° ′
Mercury ...	6 22	12 54	19 26	5 33 N.
Venus	7 6	13 39	20 12	5 52 N.
Mars	6 41	12 46	18 51	0 15 N.
Jupiter... ...	21 49*	2 52	7 55	11 53 S.
Saturn... ...	11 34	19 43	3 52*	22 29 N.

* Indicates that the rising is that of the preceding evening and the setting that of the following morning.

Occultation of Star by the Moon (visible at Greenwich)

March	Star	Mag.	Disap.	Reap.	Corresponding angles from vertex to right for inverted image
			h. m.	h. m.	° °
14 ...	γ Libræ	4½ ...	3 56 ...	5 10 ...	82 252

March h.
17 ... 14 ... Saturn stationary.

Variable Stars

Star	R.A.	Decl.		
	h. m.	° ′		h. m.
η Geminorum ...	6 8·1	22 32 N.	... Mar. 15,	0 0 *M*
R Lyncis	6 51·9	55 29 N.	... ,, 18,	*M*
R Crateris ...	10 55·0	17 43 S.	... ,, 19,	*M*
δ Libræ ...	14 54·9	8 4 S.	... ,, 16,	23 13 *m*
U Coronæ	15 13·6	32 4 N.	... ,, 17,	3 18 *m*
U Ophiuchi... ...	17 10·8	1 20 N.	... ,, 13,	2 40 *m*
		and at intervals of		20 8
W Sagittarii ...	17 57·8	29 35 S.	... Mar. 13,	22 0 *M*
U Sagittarii... ...	18 25·2	19 12 S.	... ,, 15,	21 0 *m*
R Sagittæ	20 8·9	16 23 N.	... ,, 19,	*m*
U Capricorni ...	20 41·9	15 12 S.	... ,, 16,	*M*
R Vulpeculæ ...	20 59·4	23 22 N.	... ,, 19,	*M*
δ Cephei	22 25·0	57 50 N.	... ,, 18,	11 0 *M*

M signifies maximum; *m* minimum.

Meteor-Showers

	R.A.	Decl.	
	°	°	
Near α Persei	50 ...	48 N.	
β Virginis... ...	175 ...	10 N.	Slow bright meteors.
δ Ursæ Majoris..	185 ...	58 N.	March 17.
β Draconis ...	263 ...	50 N.	
η Serpentis ...	276 ...	6 N.	Very swift meteors.
κ Cephei	300 ...	80 N.	Slow bright meteors.

GEOGRAPHICAL NOTES

ON Tuesday last, the 8th inst., the Expedition under Mr. H. M. Stanley for the relief of Emin Pasha, arrived at Simonstown from Zanzibar. They were to resume their voyage on Wednesday, after taking supplies on board. Mr. Stanley is accompanied by Tippoo Tip, through whose agency, it is expected, Stanley Falls will be restored to the Congo State. Messengers have been sent across the continent to the Congo, and Mr. Stanley expects that a large addition to his caravan will be awaiting him when he arrives on the Upper Congo.

LIEUT. BAERT, of the Congo Free State, has recently made a journey up the Mongalla, a northern tributary of the Congo, considerably to the east of the Mobangi. The river had previously been navigated to some extent by Mr. Grenfell, but Lieut. Baert has succeeded in getting much beyond Grenfell's furthest. In fact, he attained the limit of navigation, at over 200 miles from the mouth of the river, where its course is broken by falls. The river flows in a general southward direction, through a well-wooded country, and its rapids are situated in about 3° 30′ N. lat., and 22° E. long. The Mongalla is very sinuous; its rapids are situated in a mountainous district inhabited by a people named Sebi, who do good work in iron.

A FRENCH traveller, M. Chaffanjon, is exploring the Orinoco. He has already surveyed the Bolivar and the San Fernando, and discovered numerous errors in existing maps. He has made large collections in ethnology, archæology, and philology. He hoped to solve the puzzling problem of the Casiquiare, and reach the sources of the Orinoco last December.

IN the first number for 1887 of the *Mitteilungen* of the Vienna Geographical Society, is a German translation of the interesting paper by D. Isabelo de los Reyes, on the Tinguians of the Philippine Island, Luzon. The author is himself an Ilocano, a tribe which marches with the Tinguians, and has had exceptional opportunities of investigating the origin, and customs, and beliefs of his fellow-countrymen, and, being educated, can tell what he knows. A good map accompanies the paper, and to this Dr. Blumentritt contributes explanatory text. To the same number Herr Edward Glaser contributes a sketch of his journeys in South Arabia, which, while mainly for archæological purposes, have yet been the means of adding much to our knowledge of the little-known South Arabian mountain-land.

THE *Bollettino* of the Italian Geographical Society for January publishes a detailed account of the recently acquired Italian possessions on the Red Sea coast, extracted from an official memoir presented to the Chamber of Deputies by S. E. di Robilant. These possessions are grouped under three separate divisions: (1) territory garrisoned and administered by Italy, including Massowa, Emberemi, the Abdel-Kader peninsula, Gherar, Taulud Island, and the neighbouring Dahlak Archipelago; (2) protected territory, comprising the

coast-lands from Adulis (Annesley) Bay southwards to Assab, with stations at Hawakil, Mader, and Ed; (3) territory placed under the absolute sovereignty of Italy—Assab and surrounding district stretching for thirty-six miles between Ras Dermah and Ras Sinthiar, and including the neighbouring islets, annexed in July 1882. Massowa, the centre of government, occupies a strong position on an island connected by an embankment with Taulad, and defended by forts at Gherar and on the Abd-el-Kader peninsula. Since the Italian occupation it has been largely rebuilt in European style, and according to a rough census taken in September 1885 has a population of about 5000. There are several mosques, a Catholic church attached to the French mission, and a meteorological observatory where observations have been regularly recorded since May 1885. During this period the temperature has varied from 19°·1 C. in January, to 42°·8 in August, with a mean of about 26°·4.

DR. OTTO KRÜMMEL publishes in the *Zeitschrift für wissenschaftliche Geographie*, under the title of "The Relief of the Australian Mediterranean," *i.e.* the sea lying between Australia and the islands on the north, some valuable data as to recent soundings therein. They are as follows:—

S. Lat.			E. Long.			Depth in fathoms
4° 45′	...	...	123° 40′	...	...	90
4° 29′	...	...	123° 48′	...	...	110
4° 14′	...	...	123° 58′	...	...	80
3° 58′	...	...	124° 10′	...	...	55
3° 45′	...	...	124° 18′	...	...	60
3° 32′	...	...	124° 34′	...	...	60
3° 22′	...	...	124° 51′	...	...	75
3° 12′	...	...	125° 10′	...	...	90
3° 3′	...	...	125° 22′	...	...	120
2° 53′	...	...	125° 36′	...	...	105
2° 45′	...	...	125° 48′	...	...	90

On the other hand, Dr. Krümmel recalls the fact that we have the neighbouring Banda Sea in a depth of 2000 to 3000 fathoms. These data seem to indicate that between Celebes and Buru there exists a sub-oceanic ridge. We cannot say whether it extends over Ceram to New Guinea, and so indicates an ancient land-bridge between Asia and Australia, for between Ceram and New Guinea we have no soundings, and those on the borders of the strait between Buru and Ceram are from 1500 to 3000 fathoms.

MR. W. GRIGGS has published a facsimile of the famous map of the world lent by the Pope to the Colonial and Indian Exhibition, and placed in the West Indian section. This map, which is a copy of the chart in which Pope Alexander drew the line dividing the possessions of Spain and Portugal in the New World, was bequeathed to the Pope by the last of the Borgias in 1830, and has since then been preserved with much jealousy. It is drawn on a sheet of vellum seven feet long by three broad. The colours of the original are reproduced.

ON RADIANT-MATTER SPECTROSCOPY:—EXAMINATION OF THE RESIDUAL GLOW[1]

II.

IN the search for bodies giving discontinuous phosphorescent spectra I have submitted a great number of earths and combinations to the electric discharge *in vacuo*, and have noted the results. As the superficial phosphorescence apart from the composition of the emitted light has formed the subject of several recent papers by my friend M. Lecoq de Boisbaudran, before the Académie des Sciences, it may be useful if I place a record some of the more striking facts which have thus come under my notice. The bodies are arranged alphabetically, and, unless otherwise explained, were tested in the radiant-matter tube in the form of ignited sulphates.

Alumina, in any of the forms which give the crimson line (λ6942—6937), has a very persistent residual glow. In the phosphoroscope rubies shine with great brilliancy. This phosphorescence of alumina has recently been the subject of a paper before the Royal Society (Roy. Soc. Proc. vol. xlii., 1887,

oxide with 95 per cent. of lime (in the form of te).—White phosphorescence, the spectrum showace in the yellow, cutting the red and orange off.

[1] Before the Royal Society by Mr. William Crookes, F.R.S., 7. Continued from p. 428.

In the phosphoroscopes the residual glow is very strong, and of a greenish colour. The spectrum of the residual light shows that the red and orange are entirely obliterated, leaving the green and blue very luminous. Antimony oxide with 99 per cent. of lime gives a pale yellowish phosphorescence, which on heating turns red. In other respects it is like the 5 per cent. mixture.

Arsenious acid with 99 per cent. of lime gives a greenish white phosphorescence like pure calcium sulphate.

Barium 5 per cent., calcium 95 per cent.—The sulphates phosphoresce green, with specks of yellow and violet. The spectrum is continuous, with slight concentration in the red, great concentration in the green, and in the orange a broad black band hazy at the edges.

Bismuth 15 per cent., calcium 85 per cent., phosphoresces of a bright reddish orange. The spectrum shows a tolerably sharp and broad dark band in the red and orange, and a strong concentration of light in the green and blue; the spectrum being continuous and divided into two parts by a black band in the yellow, as in the case of the antimony-calcium spectrum. In the phosphoroscope the red and orange disappear and the green and blue remain. Bismuth 7 per cent., calcium 93 per cent.—The action is similar to the 15 per cent. mixture, except the colour of the phosphorescence, which is whiter. In the phosphoroscope the red and orange below the dark band is cut off. With 2 per cent. of bismuth the same phenomena occur. With 0·5 bismuth the phosphorescence is greenish blue and the spectrum is continuous, with strong concentrations in the orange and green. The phosphoroscope cuts off the red and orange.

Cadmium 1 per cent., calcium 99 per cent.—Similar to calcium sulphate, *q.v.*

Calcium sulphate was prepared from a colourless and transparent rhomb of Iceland spar which had been used for optical purposes. It was dissolved in nitric acid, the nitrate was decomposed with distilled sulphuric acid, and the ignited sulphate tested in the tube. The phosphorescence is bright greenish blue without bands or lines. In the phosphoroscope the colour is a rich green; the spectrum shows the red and orange entirely cut off, leaving the green and blue; the blue is especially strong.

Calcium sulphates prepared from Prof. Breithaupt's calcites (Phil. Trans., 1885, Part II., p. 697) were re-examined. All phosphoresce with the normal greenish-blue glow of calcium, except No. 11, which gives a reddish glow. A minute trace of samarium was found in this calcite, but not enough to affect the colour of the glow. In the phosphoroscope all the specimens give a continuous spectrum beyond the yellow, the red and orange being cut off as usual.

Chromium 5 per cent., calcium 95 per cent., as sulphates, gives a pale reddish phosphorescence. In the phosphoroscope the colour is green, and the red and orange are cut off. 1 per cent. of chromium with calcium phosphoresces green in the cold, and becomes a red when slightly heated. The behaviour of chromium with aluminium has already been described (Roy. Soc. Proc. vol. xlii. p. 28, *et seq.*)

Copper sulphate with 95 per cent. calcium sulphate behaves like calcium sulphate.

Diamonds phosphoresce of various colours. Those glowing pale blue have the longest residual glow, next come those phosphorescing yellow; I am unable to detect any residual glow in diamonds phosphorescing of a reddish colour. A large diamond of a greenish hue, very phosphorescent, shines almost as brightly in the phosphoroscope as out of it.

Glucina phosphoresces of a rich blue colour. There appears to be no residual glow with this earth in the phosphoroscope.

Lanthanum.—All the specimens of lanthanum sulphate I have examined in the radiant-matter tube phosphoresce of a reddish colour, and give a broad hazy band in the orange, with a sharp line—1/λ°2280—superposed on it. This is identical with the line of Gε, one of the constituents of the samarium phosphorescent spectrum. Calcium added to lanthanum changes the colour of the phosphorescence from red to yellowish, and brings out yttrium and samarium lines, these metals being present as impurities; the Gδ and Gα lines are also seen, but the space which should be occupied by the Gβ green is now a dark space. I have shown that when Gδ, Gα, and Gβ are present in very small quantities with lime, the lines of Gδ and Gα are intensified, while that of Gβ is weakened. This new result seems to show that if only a small trace of Gβ is present with lime and lanthanum, the green line is not only suppressed, but the quenching

action has actually extended so far as to neutralise that part of the continuous lime spectrum having the same refrangibility as the Gβ line, the result being a black space in the spectrum. In the phosphoroscope the line of Gε is visible at the lowest speed; Gδ comes in at an interval of 0·0035 second, and the Gα line immediately afterwards.

Lead sulphate, by itself, in the radiant-matter tube glows with a nearly white colour, giving a continuous spectrum. In the phosphoroscope the red and orange are cut off, leaving a strong concentration of light in the green and blue. 5 per cent. of lead added to calcium sulphate phosphoresces like lime.

Magnesia phosphoresces pink. 5 per cent. with lime, as sulphates, give a greenish phosphorescence, with a tendency to turn red as the powder heats. The Oriental ruby containing about between 1 and 2 per cent. of magnesia, a mixture was prepared of acetate of alumina with 2 per cent. of magnesia, and tested after ignition. It gave no spectrum or lines. This was done to see if the crimson line of aluminium might be due to the presence of magnesia.

Nickel added to calcium sulphate in the proportion of 5 per cent. makes no alteration in the usual phosphorescent phenomena of calcium.

Potassium, 5 per cent., added to calcium sulphate gives a bright phosphorescence, and made the residual glow very persistent.

Samarium.—The phosphorescent behaviour of this body, alone and mixed with other substances, has been fully described in my paper on samarium (Phil. Trans., 1885, Part II., pp. 709–21.)

Scandium, either in the form of earth or sulphate, phosphoresces of a very faint blue colour, but the light is too feeble to enable a spectrum to be seen. Addition of lime does not bring out any lines.

Sodium sulphate mixed with an excess of calcium sulphate gives a greenish tinge to the usual colour of the phosphorescence. The sodium line is visible in the spectrum.

Strontia in the radiant-matter tube glows with a rich blue colour, showing in the spectroscope a continuous spectrum with a great concentration of light in the blue and violet. In the phosphoroscope the colour of the glow is bright green, showing in the spectroscope a continuous spectrum, with the red and blue ends cut off. A mixture of calcium sulphate with 5 per cent. of strontium sulphate behaves like calcium sulphate alone.

Thorium, as oxide or sulphate, refuses to phosphoresce, and the tube rapidly becomes non-conducting. A tube with thoria at one end and a phosphorescent earth such as lime or ytrria at the other end, and furnished with a pair of poles near each end, at a particular exhaustion is non-conducting at the thoria end, while it conducts at the yttria end. If the wires of the induction coil are attached to the poles at the thoria end, no current will pass; rather than pass through the tube, the spark prefers to strike across the spark gauge—a striking distance of 37 mm.—showing an electromotive force of 34,040 volts. Without doing anything to affect the degree of exhaustion, on transferring the wires of the induction coil from the thoria to the yttria end, the spark passes at once. To balance the spark in air the wires of the gauge must be made to approach till they are only 7 mm. apart, equivalent to an electromotive force of 6440 volts; the fact of whether thoria or yttria is under the poles making a difference of 27,600 volts in the conductivity of the tube. The explanation of this action of thoria is not yet quite clear. From the great difference in the phosphorescence of the two earths, it is evident that the passage of the electricity through these tubes is not so much dependent on the degree of exhaustion as upon the phosphorogenic property of the body opposite the poles. This view is supported by the fact that the thoria may be replaced by a metal wire, when the same obstructive action will result.

Lime does not give phosphorescent properties to thoria, if this earth be pure, but it brings out the lines of yttrium and samarium which are almost always present in small quantities in thoria unless it has been specially purified.

Tin with 95 per cent. of lime gives the lime phosphorescence only.

Thulium and *erbium* together phosphoresce with a green light, giving the erbium spectrum already described before this Society (Roy. Soc. Proc. vol. xl. p. 77, Fig. 1, January 7, 1886). There is, in addition, a faint blue line apparently double (see "Ytterbium"). The addition of lime causes the mixture to phosphoresce of a pale blue colour. The spectrum now shows a bright blue band, in the same position as the faint double blue band seen in the absence of lime. The blue line of Gα is also seen, and a faint line of Gδ. The red line of Gη, one of the constituents of the ordinary yttria spectrum, is prominent in this spectrum.

Tungsten and *uranium*, each mixed with 95 per cent. of lime, only give the lime spectrum.

Ytterbium.—I have not yet succeeded in preparing this body of trustworthy purity; but through the kindness of Prof. Clève, M. de Marignac, and Prof. Nilson, I have been enabled to experiment with specimens of ytterbia prepared by these chemists. Prof. Clève's ytterbia, in the form of sulphate, gives in the radiant-matter tube a blue phosphorescence, the spectrum of which shows a strong double blue band,[1] together with traces of the Gδ and the erbia green lines. The addition of lime broadens the blue band and makes it single. Prof. Clève writes that this ytterbia may contain some traces of thulia, perhaps also of erbia, but scarcely any other impurities. Measurements in the spectroscope give the following approximate results:—

Scale of spectroscope	λ	$\frac{1}{\lambda^2}$	Remarks
8·63	4626	4673	Commencement of first blue line. This edge is very hazy.
8·54	4574	4780	Centre of the first blue line.
8·45	4524	4885	End of first blue line.
8·44	4518	4898	Centre of dark interval between the two blue lines.
8·40	4475	4994	Centre of second blue line. This line is narrower than the first line.

The following are measurements taken with the mixture of this ytterbia and lime:—

Scale of spectroscope	λ	$\frac{1}{\lambda^2}$	Remarks
8·71	4674	4577	Up to this point there is the continuous spectrum of li-calcium. Here a black space commences.
8·515	4555	4819	Commencement of a hazy blue band.
8·475	4538	4855	End of hazy blue band. This band is of considerable brilliancy.

These blue bands are seen much fainter without lime, and are about as strong in the mixture of thulia and erbia with lime described above. I had ascribed them to ytterbia, when Prof. Nilson kindly forwarded me a small specimen of ytterbia, considered by him perfectly pure, and used for his atomic weight determinations. This ytterbia gives absolutely no blue bands. The origin of these bands therefore remains uncertain.

Ytterbia from Prof. Nilson, in the form of sulphate, refuses to phosphoresce without the addition of lime. When lime is added it only brings out traces of the phosphorescent bands of Gε, Gβ, and Gα. Evidently these are impurities.

Ytterbia from M. de Marignac is identical with that from M. Clève, as far as my examination can go. In sending me the ytterbia M. de Marignac warned me that he was very far from thinking it pure.

Yttrium.—During the fractionation of the higher fractions of yttria (+6, 118 and 119), a very sharp green line sometimes makes its appearance, situated between Gβ and Gγ (approximate position on the $1/\lambda^2$ scale, 325). It is very faint, and is not connected with the orange line of Sδ, although it is as sharp. The yttria showing these lines phosphoresces of a tra... golden-yellow colour, the fractions at the other ... phoresing yellowish green.

I have previously described the action of a lar...

[1] This is the band spoken of in my Royal Society paper (Roy. Soc. Proc. vol. xl. 1886, p. 507), provisionally called Sγ, ... ytterbia. If it is not due to ytterbia it is a new body.

bodies on the phosphorescence of samarium ("On Radiant-Matter Spectroscopy; Part 2, Samarium," Phil. Trans., 1885, Part II. pp. 710-22.) The experiments resulting in the following observations were tried at about the same time. I will describe them in alphabetical order. Unless otherwise mentioned all the mixtures were in the form of anhydrous sulphates.

Yttrium 5 per cent., *aluminium* 95 per cent., gives a good yttria spectrum; the blue line of Gα is very distinct, and the double green of Gβ is well divided. In the phosphoroscope the Gβ and Gα lines first appear simultaneously, then the Gδ line.

Yttrium 99·5 per cent., *bismuth* 0·5 per cent.—The spectrum is bright, and on close examination a trace of samarium green, Gγ, is to be detected forming a wing to the Gδ line. In the phosphoroscope the citron line of Gδ entirely disappears and the samarium double green line, which out of the phosphoroscope is almost obscured by the great brightness of Gδ, now appears distinctly, together with the green Gβ line. Yttrium 95 per cent., bismuth 5 per cent., gives the usual yttria spectrum. No Gδ line appears in the phosphoroscope at any speed. At first only the Gβ line is seen, and next the Gα line appears, as in yttria. On gradually increasing the percentage of bismuth the spectrum of yttria grows fainter, until with 95 per cent. of bismuth the phosphorescence is bad and the spectrum faint.

Yttrium 5 per cent., *cadmium* 95 per cent., gives a brilliant phosphorescence, but the spectrum is almost continuous. In the phosphoroscope a faint concentration of light is seen in the green, which becomes sharper as the speed increases.

The action of calcium on the phosphorescence of yttrium has already been described.

Yttrium and *cerium*.—Cerium has the effect of deadening the brilliancy of the yttrium spectrum in proportion to the quantity added. All the bands remain of their normal sharpness.

Yttrium 5 per cent., *copper* 95 per cent., phosphoresces very feebly.

Yttrium 90 per cent., *didymium* 10 per cent.—This mixture gives a good yttria spectrum. Yttrium 70 per cent., didymium 30 per cent., phosphoresces very fairly, and gives all the usual lines.

Yttrium 50 per cent., *didymium* 50 per cent., refuses to phosphoresce. The tube is either too full of gas to allow the phosphorescence to be seen or it becomes non-conducting. When the mixture is illuminated by the glowing gas the absorption-lines of didymium in the green are seen. With higher proportions of didymium the same results are produced. On adding 25 per cent. of lime to the mixture containing 50 per cent. of didymium the yttria spectrum is brought out very well. Lime added to a mixture of 10 per cent. yttria and 90 per cent. didymium brings out the yttrium spectrum fairly, but the tube soon becomes non-conducting.

Yttrium 5 per cent. and *glucinum* 95 per cent. gives a bright phosphorescence, but the definition of the spectrum lines of yttria is bad.

Yttrium 5 per cent., *thallium* 95 per cent.—No spectrum is given by this mixture; it turns black and refuses to phosphoresce.

Yttrium 5 per cent., *tin* 95 per cent., phosphoresces faintly, the lines being very indistinct.

Yttrium 5 per cent., *titanium* 95 per cent., acts like thoria, and the tube becomes non-conducting.

Yttrium 5 per cent., *tungsten* 95 per cent.—This phosphoresces of a bright yellow colour, the spectrum is brilliant, but the lines are not sharply defined. In the phosphoroscope the colour becomes greenish, and the spectrum shows only the green lines of Gβ.

Yttrium 5 per cent., *zinc* 95 per cent.—The phosphorescence is of a pale yellowish-white, and the spectrum is very brilliant, being equal to that shown by 30 per cent. of yttrium with barium, calcium, magnesium, or strontium. In the phosphoroscope the colour becomes reddish, and the Gβ green line is the first to come. No citron line is seen. If the yttrium contains a trace of samarium, the samarium spectrum, which is scarcely seen under ordinary circumstances, now comes out distinctly.

Zinc sulphate mixed with 95 per cent. of calcium sulphate phosphoresces a bright bluish-green colour; the spectrum contains no bands or lines.

Zinc sulphide (Sidot's hexagonal blende, *Comptes rendus*, vol. lxii., 1886, pp. 999-1001; vol. lxiii., 1886, pp. 188-89).—This is the most brilliant phosphorescent body I have yet met with. In the vacuum tube it begins to phosphoresce at an exhaustion of several inches below a vacuum. At first only a green glow can be seen; as the exhaustion gets better a little blue phosphorescence comes round the edges. At a high exhaustion, on passing the current the green and blue glows are about equal in brightness, but the blue glow vanishes immediately the current stops, while the green glow lasts for an hour or more. In the phosphoroscope the blue glow is only seen at a very high speed, but the green glow is seen at the slowest speed, and the body is almost as bright in the instrument as out of it. Some parts of a crystalline mass of blende which, under the action of radiant matter, leave a glow with a bright blue colour, leave a green residual light when the current ceases; other parts which glow blue become instantly dark on stopping the current.

The different action of calcium, barium, and strontium on the constituents of yttrium is an additional proof, if confirmation be needed, that the bodies I have provisionally called Gα, Gβ, Gδ, &c. (Roy. Soc. Proc. vol. xl. 1886, p. 502), are separate entities. It may be as well here to collect together the evidence on which I rely to support this view. I will take the bodies *seriatim*:—

Gα.—An earth phosphorescing with a blue light, and showing in the spectroscope a deep blue line, of a mean wave-length 482. This earth occurs in different proportions in purified yttria from different minerals. Samarskite, gadolinite, hielmite, monazite, xenotime, euxenite, and arrhenite contain most Gα, whilst fluocerite and cerite contained notably less of this constituent. The addition of lime brings out the phosphorescence in Gα in advance of that of the other constituents. The behaviour in the phosphoroscope of Gα when mixed with the alkaline earths also points to a difference between it and its associates. With lime the blue phosphorescent band of Gα comes into view at a very low speed, the order of appearance with a small quantity of lime being Gβ, Gα, Gδ, and with a large quantity of lime, Gδ, Gα, Gβ. Employing strontia instead of lime, the order of appearance in the phosphoroscope when the quantity of strontia is small is Gβ, Gα, Gη, and when the quantity of strontia is in excess, Gα, Gη, Gβ. Baryta in small quantity brings out the lines in the phosphoroscope in the following order, Gβ, Gα, Gη, but when the baryta is in excess the order is Gβ, Gη, Gα. The chemical position taken up by Gα in the fractionation scheme precludes it from being due to the bodies I have called Gβ, Gγ, Gε, Gζ, Sγ, or Sδ. It closely accompanies Gδ (the earth giving the citron line), concentrating at the least basic end, and I have not yet succeeded in effecting a separation of the two. If, therefore, Gα is not a separate entity, its blue line must be due to the citron-band-forming body called Gδ. The difference between Gα and Gδ is brought out in a marked manner by the phosphoroscope when baryta or strontia is present; the citron line of Gδ being entirely suppressed, while the blue line of Gα is brought out with enhanced brilliancy. For these reasons I am inclined to regard Gα as a separate body, although the evidence in favour of this view is not so strong as in the case of some of its other associates.

Gβ.—An earth phosphorescing with green light, and showing in the spectroscope a close pair of greenish-blue lines of a mean wave-length of 545. This earth can be separated by chemical fractionation from the other constituents of yttrium. It concentrates at the most basic end, and is present in the samarium which invariably makes its appearance at this end of the fractionation of yttrium. It is one of the prominent lines in Yα, where also it accompanies some of the samarium lines. Gβ, however, is not a constituent of samarium, for it is easy to purify samarium by chemical means so that it does not show a trace of the Gβ green lines, although it is very difficult to get Gβ free from some of the samarium lines. The residual phosphorescence of Gβ is very considerable, and its green lines show first in the phosphoroscope when only yttrium is present. The addition of lime keeps back the glow of Gβ, and brings forward that of Gδ. Strontium and barium act on Gβ very differently to lime. A small quantity of strontium brings forward the residual glow of Gβ, whilst in large quantities strontium keeps the phosphorescence of Gβ back to the last.

Gγ.—An earth phosphorescing with a green colour, and showing in the spectroscope a green line having a wave-length of 564. This is one of the least definite of all the supposed new bodies. It appears to be a constituent of samarium, occurring in the fractionation of yttrium among the most basic constituents connecting yttrium and samarium. Its point of maximum intensity is, chemically, very well marked, and is at a different part of the fractionation scheme to those of the other lines of

samarium, especially Gε. On dilution with lime, the phosphorescent line of Gγ vanishes before that of Gε.

Gδ.—An earth phosphorescing with a citron coloured light, and showing in the spectroscope a citron line having a wave-length of 574. Gδ is one of the least basic of all the bodies associated in yttrium, occurring almost at one extremity of the fractionation. It is not very difficult to separate chemically Gδ from all the other accompanying bodies except the one which I have called Gα (giving the deep blue line). Not only can Gδ be obtained free from the other four constituents of yttrium, but the body called by M. de Marignac Yα is a proof that the other four components of yttrium can be obtained quite free from Gδ. Lime intensifies the phosphorescence of Gδ, and deadens that of Gβ, while strontium has the opposite action. The behaviour of Gδ in the phosphoroscope, when mixed with lime, strontia, or baryta, also affords a striking evidence of individuality, lime enhancing the residual glow, while strontia or baryta altogether suppress it.

Gε.—An earth phosphorescing with a yellow colour, and, in the spectroscope, showing a sharp yellow line having a wave-length of 597. It is seen in the samarium spectrum as a sharp yellow line superposed on a hazy double band. As I have already pointed out, Gε fractionates out high up among the most basic earths, and generally accompanies lanthanum. In the phosphorescent spectrum of lanthanum the line Gε is seen quite free from the lines of other bodies.

Gζ.—An earth phosphorescing with a red light, showing in the spectroscope a red line of wave-length 619. This body is always more plentiful in yttrium obtained from samarskite and cerite than from gadolinite, hielmite, and euxenite, and is almost absent in yttrium from xenotime. Gζ is of about intermediate basicity. Working with samarskite yttria, Gζ becomes most brilliant after the line of Gη has completely disappeared. Further fractionation causes the line of Gζ to fade out, and the citron and blue lines are then left.

The phosphorescence of Gζ is developed to a different extent according to the metal with which the yttria is mixed. The order (beginning with the substance having the greatest action) is zirconium, tin, aluminium, bismuth, glucinum.

Gη.—An earth phosphorescing with a deep red light, and showing in the spectroscope a red line having a wave-length of 647. Like its fellow red constituent, Gη occurs most plentifully in samarskite yttrium, and scarcely at all in yttrium from hielmite, euxenite, and cerite. It is the first of the strictly yttrium constituents to separate out, on fractionation, at the most basic extremity, leaving Gα, Gβ, Gδ, and Gζ. In almost all samples of yttria, except when very highly purified, Gη is seen very brilliantly, and by its side can be detected the faint red band of samarium. In the phosphoroscope the line of Gη is the last to appear when yttria alone is being observed; strontia and baryta enhance the residual glow of Gη, strontia in moderate quantities bringing it out before that of Gβ, while baryta brings it out after Gβ.

Sδ.—An earth giving in the spectroscope when phosphorescing a very sharp orange line of wave-length 609. I have already (Roy. Soc. Proc. vol. xl. 1886, p. 504) discussed the claims of this earth to be considered a separate entity. It is not present in the rare earths from gadolinite, xenotime, monazite, hielmite, euxenite, and arrhenite; it is present in small quantity in cerite, and somewhat more plentifully in samarskite. In samarskite yttrium it concentrates at a definite part of the fractionation. Its sharp orange line is not strong enough to be seen in the phosphoroscope. A little calcium entirely suppresses the orange line, while samarium or yttrium seems to intensify it.

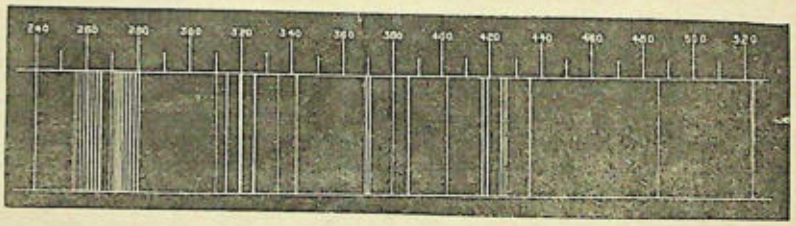


FIG. 5.

In addition to the above earths, it is not improbable that the sharp green line $\left(\frac{1}{\lambda^2}\ 325\right)$ mentioned under the heading "Yttrium" may be caused by still another earth.

The brilliant and characteristic spark spectra yielded when certain elements are volatilised and rendered incandescent by the spark from a powerful induction coil are relied on by chemists as an indisputable proof of the identity of such elements. Bearing this in mind I have endeavoured to ascertain how these yttrium constituents would behave in respect to the spark spectrum. Do the definite system of lines in the old yttrium spark spectrum belong to one constituent only, or are the yttrium lines broken up and distributed among the different bodies I have designated as Gα, Gβ, &c.? Also do the other constituents possess special spark spectra of their own? Very careful and long-continued experiments have shown me that neither of these hypothetical cases occur.

The spark spectrum given by old yttrium is shown in the drawing (Fig. 5). It is chiefly characterised by two very strong groups of lines in the red and orange. I now take the earth Gδ. This occurs near one end of the fractionating, and not only differs from the parent yttrium in its phosphorescent spectrum, but by virtue of the process adopted for its isolation it must likewise differ in its chemical properties. On examining its spark spectrum I see absolutely no difference between this spectrum and the one given by old yttrium.

I now pass to the other end of the fractionation of yttrium, where occurs a concentration of a body giving a totally different phosphorescent spectrum from the one at the first end. And it also differs chemically from old yttrium, and in a more marked manner from its brother, Gδ, at the other extremity of the fractionation. Here again its spark spectrum is perfectly identical both with old yttrium and with Gδ, and however closely I examine these three spectra in my laboratory, the whole system of lines is still identical.

Respecting the theoretical considerations involved in these results, I see two possible explanations of the facts brought forward. According to one hypothesis, research has somewhat enlarged the field lying between the indications given by ordinary coarse chemistry and the searching scrutiny of the prism. Our notions of a chemical element have expanded. Hitherto, the molecule has been regarded as an aggregate of two or more atoms, and no account has been taken of the architectural design on which these atoms have been joined. We may consider that the structure of a chemical element is more complicated than has hitherto been supposed. Between the molecules we are accustomed to deal with in chemical reactions and the ultimate atoms, come smaller molecules or aggregates of physical atoms; these sub-molecules differ one from the other, according to the position they occupied in the yttrium edifice.

An alternative theory commends itself to chemists, to the effect that the various bodies discussed above are new chemical elements differing from yttrium and samarium in basic powers and several other chemical and physical properties, but not sufficiently to enable us to effect any but a slight separation. One of these bodies, Gδ, gives the phosphorescent citron line, and also the brilliant electric spectrum. The other seven do not give electric spectra which can be recognised in the presence of a small quantity of Gδ, whilst the electric spectrum of Gδ is so sensitive that it shines out in undiminished brilliancy even when the quantity present is extremely minute. In the process of fractionation, Gα, Gβ, Gδ, &c., are spread out and more or less separated from one another, yet the separation is imperfect at the best, and at any part there is enough Gδ to reveal its presence by the sensitive electric spark test. The arguments in favour of each theory are strong and pretty evenly balanced.

The compound molecule explanation is a good working hypothesis, which I think may account for the facts, while it does not postulate the rather heroic alternative of calling into existence eight or nine new elements to explain the phenomena. However, I submit it only as an hypothesis. If further research shows the new element theory is more reasonable, I shall be the first person to accept it.

Neither of these theories agrees with that of M. Lecoq de Boisbaudran, who also has worked on these earths for some time. He considers that what I have called old yttrium is a true element, giving a characteristic spark spectrum, but not giving a phosphorescent spectrum *in vacuo*. The bodies giving the phosphorescent spectra he considers to be impurities in yttrium. These he says are two in number, and he has provisionally named them Zα and Zβ. By a method of his own, differing from mine, M. de Boisbaudran obtains fluorescent spectra of these bodies; but their fluorescent bands are extremely hazy and faint, rendering identification difficult. Some of them fall near lines in the spectra of my Gβ and Gδ. At first sight it might appear that his and my spectra were due to the same bodies, but according to M. de Boisbaudran the chemical properties of the earths producing them are widely distinct. Those giving phosphorescent lines by my method occur at the yttrium extremity of the fractionation, where his fluorescent bands are scarcely shown at all; whilst his fluorescent phenomena are at their maximum quite at the terbium end of the fractionation, where no yttrium can be detected even by the direct spark, and where my phosphorescent lines are almost absent.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—Girton College has withdrawn from the arrangement by which it was hoped that a united scholarship for men and women might be established in geology and palæontology out of the Harkness fund. The council of Girton do not consider that the scheme proposed fulfils the essential condition of placing students of Girton and Newnham on the same terms as members of the University. A scheme has consequently been propounded for men alone, open to B.A.'s of not more than four years' standing. The electors are to be the Vice-Chancellor, the Woodwardian Professor, the Examiners in Geology in the Natural Sciences Tripos for the current and the preceding year, and an additional elected examiner. The electors are to take any steps they think desirable to ascertain the qualifications of candidates, and in making the award they are to have regard to proficiency in geology and palæontology, and to promise of future work. One scholar is to be elected annually; but in case no person shall be deemed worthy of election, the income for the year is to go to a reserve fund, to be given, when advisable, to scholars to aid them in prosecuting geological or palæontological researches.

The acceptance of the John Lucas Walker Studentship for the furtherance of original research in pathology, which has been offered to the University by the Attorney-General, is to be voted on in the Senate to-day. The amended regulations provide that the studentship shall be usually tenable for three years, with power of further prolongation for two years more when exceptionally valuable work has been done by the student. The fund, consisting of about 830*l.* 4 per cent. debentures, is to be managed by the Professor of Pathology for the time being, the Professors of Physic and Physiology, and the President of the London College of Physicians. The studentship is not to be awarded by competitive examination, but any other mode of ascertaining qualifications may be taken. After full announcement of a vacancy, the Professor of Pathology is to nominate the best qualified candidate, but the other electors may overrule the nomination if they are unanimous in favour of some other candidate. The student shall not necessarily be a member of Cambridge University, and may be of either sex. No occupation interfering with pathological research may be followed by the student, who is also to vacate his studentship if elected to a professorship or fellowship. At least three terms of study are to be pursued at Cambridge. Exhibitions or prizes not exceeding 50*l.* may from time to time be awarded by the managers to any person, except the student for the time being, in respect of any essay, discovery, or meritorious service connected with or conducing to the science of pathology, and grants may be made for the furtherance of original research in the science.

The amended regulations for the Mechanical Sciences Tripos also come to a vote to-day.

The Senate has accepted the subscription of 500*l.* offered through Prof. Newton to enable the University to become a Governor of the Marine Biological Association.

The following new appointments of electors to various Professorships have been made: Botany, Mr. Thiselton Dyer; Political Economy, Right Hon. A. J. Balfour, M.P.; Experimental Physics, Dr. D. MacAlister; Downing Professorship of Medicine, Dr. A. Macalister; Mental Philosophy and Logic, Prof. A. Marshall; Surgery, Dr. A. Macalister. The remaining appointments are re-elections.

SCIENTIFIC SERIALS

American Journal of Science, February.—Kilauea after the eruption of March 1886. Under this general heading are grouped three separate papers, disposed in chronological order, describing the appearance of the volcano at different times since the great outburst of last March. The first is a communication to Prof. W. D. Alexander, Surveyor-General of the Hawaiian Islands, by J. S. Emerson, assistant in the Survey, dated August 27, and embodying a series of observations ranging from March 24 to April 14. This paper is illustrated by a plate showing the crater and new lake drawn to a scale of 1 : 20,000. The second, by L. L. Van Slyke, Professor of Chemistry, Honolulu, describes the general appearance of the volcanic district during the month of July, when considerable changes had already occurred, including a general upheaval in the centre of Halema'uma'u, and the reappearance of liquid lava in three different places. The third comprises a report to Prof. Alexander by Mr. Frank S. Dodge, on the survey of Kilauea in the last week of September and the first of October, with a plate of the crater on a scale of 1 : 6000. This observer expects that perhaps in a few months the great central pit will again fill up and overflow, as it did prior to the last eruption.—Volcanic action, by James D. Dana. The general question of igneous disturbances is discussed in connection with the recent eruptions of Kilauea, Vesuvius, and Tarawera. The author's conclusions on the causes of these phenomena, as summed up in his "Manual of Geology" (1863), are mainly confirmed, being attributed to the hydrostatic pressure of the column of lava; the pressure of vapours escaping in underground regions from the lavas, or produced by contact with them, acting either quietly or catastrophically; and the pressure of the subsiding crush of the crust forcing up the lavas in the conduit.—On the Coahuila meteorites, by Oliver Whipple Huntington. It is shown that the assumed new meteorite discovered near Fort Duncan, Maverick County, Texas, and recently described by Mr. W. E. Hidden, is really one of the "Coahuila irons," described by J. Lawrence Smith, and supposed to belong to one fall, although found on the opposite side of the Rio Grande from Maverick County.—A new rhizostomatous Medusa from New England, by J. Walter Fewkes. This is a large acraspedote jelly fish, not only new to New England, but also unlike any yet captured on the Atlantic coast of North America. It was captured in September 1886 in New Haven harbour, and is allied to a common species found on the west European seaboard, *Pilema* (*Rhizostoma*, auth.) *octopus*, Haeck., and to *P. pulmo* of the Mediterranean.—A short study of the atmosphere of β Lyræ, by Orray T. Sherman. The author's observations lead to the conclusion that in stars known to possess a spectrum comprising bright lines, these lines, while persistent in place, are not persistent in intensity. Comparing Lockyer's result in the study of the atmosphere with his own, he draws a general conclusion regarding the condition of the stellar atmosphere, describing it as consisting of an outer layer of hydrogen positively electrified, an inner layer of oxygen negatively electrified, and between them a layer of carbon mingling on its edge with the hydrogen. The electric spark passing through the mixture forms the hydrocarbon compound, whose molecular weight carries it into the oxygen region where combustion ensues with the formation of carbonic acid and aqueous vapour, both of which descending under the influences of their molecular weight are again dissociated by internal heat, and return again to their original positions.—Phenacite from Colorado, by Samuel L. Penfield, with notes on the locality of Topaz Butte, by Walter B. Smith. Some interesting facts are communicated with regard to the crystallisation of this remarkable mineral, the occurrence of which in the United States (Pike's Peak, El Paso County, Colorado), was determined by Messrs. Cross and Hillebrand.

Topaz Butte, five miles north of Florissant, marks the southern limit of the "crystal beds" whence have come most of the specimens labelled *Pike's Peak*. The largest phenacite ever found in this locality is a rough lenticular crystal about 15 mm. in diameter.—The norites of the Cortlandt series on the Hudson River, near Peekskill, New York, by George H. Williams. In continuation of his memoir on the peridotites of the Cortlandt series (*American Journal of Science*, 1886, p. 26) the author here begins a petrographic description of the massive rocks of this system. The present paper deals with the non-chrysolitic rocks, norite proper and hornblende norite. He designates all rocks in which one-half or more of the non-feldspathic constituents are hypersthene as norite, and names varieties of this after the prevailing accessory component.—A method for subjecting living protoplasm to the action of different liquids, by George L. Goodale. An apparatus is described by means of which the necessity is obviated of transferring specimens from the litre-flask to the stage of the microscope, all handling being thus avoided, while the object can be placed under the action of as large a quantity of liquid as may be desirable.—On the topaz from the Thomas Range, Utah, by A. N. Alling. The topaz crystals here under examination are from the cabinet of Prof. Brush, vary in length from 3 mm. to 10 mm., and are perfectly clear and colourless.—On a simple and convenient form of water battery, by Henry A. Rowland. A simple, convenient, and cheap form of water battery is described, which the author has had in use for many years.

Bulletin des Sciences Mathématiques, tome x. December 1886, tome xi. January 1887, Paris.—We single out these two recently issued parts, as they contain papers on subjects intimately connected with notices of Greek geometry, which we have from time to time communicated to NATURE when giving an account of Dr. Allman's contributions to *Hermathena*. In the *Mélanges* of the earlier number M. Paul Tannery has two notes: one of nine pages, entitled "Démocrite et Archytas" (see Gow's "History," p. 129, and NATURE, vol. xxxiv. p. 548); the other, of eleven pages, on "Les Géomètres de l'Académie." The later part has an article of twelve pages, by the same writer, on "La Technologie des Éléments d'Euclide." All three are quite up to M. Tannery's well-known excellent form for thoroughness of research and soundness of inference. The rest of the matter consists as usual of reviews (*inter alia*, of the French translation of Clerk Maxwell's "Electricity and Magnetism" and Mr. Greenhill's "Differential and Integral Calculus"), and of useful abstracts of papers in the various Continental and British mathematical journals.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, February 24.—"Problems in Mechanism regarding Trains of Pulleys and Drums of Least Weight for a given Velocity Ratio." By Prof. H. Hennessy, F.R.S.

As trains of wheels, pulleys, and drums are frequently employed in machinery for the transformation of large and small velocities of rotation, it appeared to the author desirable to inquire into the conditions which would favour the greatest economy of weight of the parts forming such trains. Eighty years since Dr. Thomas Young had arrived at a theorem for the minimum number of teeth in a train of wheels and pinions with a given velocity ratio, and when the pairs of wheels and pinions are similar. By investigating the question of minimum volume for minimum weight of trains the author has been led to the following results, which are fully demonstrated in his paper: namely, that for a train of cylindrical pulleys composed of similar pairs the ratio of the diameter of a large to that of a small pulley should be as 19 to 10. For drums composed of hoops supported by disks of the same thickness, and with the breadth of each hoop equal to the radius of the small drum, the ratio of the diameters should be 11 to 5. If the hoop was supported by spokes whose volume taken together would be half the volume of a complete disk, the ratio would be 51 to 20. With regard to a train of pulleys, it was shown that a single pair possessing the same velocity ratio as a series with the ratio of diameters found for minimum volume, the latter would be considerably less than the former. Thus, with five pairs whose velocity ratio would be nearly $21\frac{1}{4}$, the volume would be less than the 1/26 of a single pair possessing the same velocity ratio. A model constructed in brass of such a train, with all the large pulleys 1·9 inches in diameter, and all the small 1 inch, weighed 18·34 ounces. A train of four pairs of drums illustrative of the last problem solved weighed 16·788 ounces, the large drums being 2·55 inches, and the small 1 inch diameter, while all the hoops were half an inch broad. The velocity ratio of this train is 42·2825, or a little more than $42\frac{1}{4}$.

March 3.—"The Etiology of Scarlet Fever." By E. Klein, M.D., F.R.S., Lecturer on General Anatomy and Physiology at the Medical School of St. Bartholomew's Hospital, London.

The investigation, the results of which I now record, was commenced at the end of December, 1885. It arose out of an inquiry into the prevalence of scarlatina in different quarters of London, undertaken by the Medical Department of the Local Government Board as a part of its business of investigating local epidemics. That inquiry had demonstrated milk from a farm at Hendon as the cause of the scarlatina, and had adduced strong circumstantial evidence that the scarlatina had been distributed, not in the whole, but in certain sections of the Hendon milk, and further that the ability of the sections of milk service to convey the disease had been related to a malady affecting particular cows. This evidence against particular cows at the Hendon farm could not and did not aim at furnishing direct and definite proof of the connection of this cow disease with scarlet fever of man, for the inductive methods usually employed by the Medical Department of the Local Government Board when applied to inquiries about epidemic spread of scarlatina can for obvious reasons yield but circumstantial evidence. As on various former occasions, so also on this, the Medical Department sought to put the above conclusions to the test of scientific experiment. This task was delegated to me by the Board. The first part of this work has been published in the recently issued volume of the Reports of the Medical Officer of the Local Government Board for 1885-86. I have therein shown that the suspected cows from the Hendon farm that had been made the object of special study, showed besides a skin disease—consisting in ulcers on the udder and teats, and in sores and scurfy patches and loss of hair on different parts of the skin—also a general disease of the viscera, notably the lungs, liver, spleen, and kidney, which resembled the disease of these organs in acute cases of human scarlatina. I have further shown that the diseased tissues of the ulcers on the teats and udder produced on inoculation into the skin of calves a similar local disease, which in its incubation and general anatomical characters proved identical with the ulceration of the cow; and further, that from the ulcers of the cow a species of micrococcus was isolated by cultivation in artificial nutritive media, which micro-organism in its mode of growth on nutritive gelatine, on Agar-Agar mixture, on blood serum, in broth, and in milk, proved very peculiar and different from other species of micrococci hitherto examined. With such cultivation of the micrococcus I have produced by subcutaneous inoculation in calves a disease which in its cutaneous and visceral lesions (lung, liver, spleen, and kidney) bears a very close resemblance both to the disease that was observed in the Hendon cows as well as to human scarlatina.

The second part of the work, carried out during 1886-87 for the Medical Department, had for its object to investigate whether or no the disease, human scarlatina, is associated with the identical micrococcus, and whether this, if obtainable from the human subject, is capable of producing in the bovine species the same disease as was observed in the Hendon cows and in the calves experimented upon from the latter source. The definite and clear proof that this is really the case has now been obtained, and the evidence I now bring to the notice of the Royal Society.

On examining acute cases of human scarlatina—for which opportunity I owe great thanks to Dr. Sweeting, the Medical Superintendent of the Fulham Fever Hospital—I soon ascertained the fact that there is present in the blood of the general circulation a species of micrococcus, which on cultivation in nutritive gelatine, Agar-Agar mixture, blood serum, and other media, proved to be in every respect identical with that obtained from the Hendon cows. Out of eleven acute cases of scarlet fever examined in this direction, four yielded positive results: three were acute cases between the third and sixth day of illness with high fever temperature, and the fourth was a case of death from scarlatina on the sixth day. In all these four cases several drops of blood were used, after the customary methods and under the required precautions for establishing cultivations in a series of tubes containing sterilised nutritive gelatine, and generally only a very small number of these tubes revealed after an incubation of several days one or two colonies of the micrococcus. This

shows that the micrococci were present in the blood in but small numbers.

Having ascertained the identity in morphological and cultural respects of the micrococcus of the blood of human scarlatina with the organism obtained from the Hendon cows, the action of the cultivations of both these sets of micrococci was then tested on animals and the results compared. It was found that mice—wild mice better than tame ones—after inoculation or after feeding, became affected in exactly the same manner, no matter whether the one set of cultivations or the other was used. The great majority of these animals died after between seven and twenty days; the *post-mortem* examination revealed great congestion of the lungs, amounting in some cases to consolidation of portions of the organ, congestion of the liver, congestion and swelling of the spleen, great congestion and general disease of the cortical part of the kidney. From the blood of these animals, taken directly from the heart, cultivations were established in nutritive gelatine, and hereby the existence of the same species of micrococci was revealed; they possessed all those special characters distinguishing the cultivations of the micrococcus of the Hendon cows, and of the human scarlatina.

In the third and concluding section of the work, cultivations of the micrococcus of two cases of human scarlatina were used for infecting calves: two calves were inoculated, and two were fed from each set of cultivations. All eight animals developed disease, both cutaneous and visceral, identical with that produced in the calves that had been last year infected with the micrococcus from the Hendon cows.

From the heart's blood of calves thus infected from human scarlatina the same micrococcus was recovered by cultivation, possessing all the characters shown by the cultures of the micrococcus of the Hendon cows, and of the cases of human scarlatina.

It must be evident from these observations that the danger of scarlatinal infection from the disease in the cow is real, and that towards the study and careful supervision of this cow disease all efforts ought to be directed in order to check the spread of scarlet fever in man. It is also obvious that in the agricultural interest investigations of this cow disease are greatly called for.

Anthropological Institute, February 22.—Mr. Francis Galton, F.R.S., President, in the chair.—The election of Mr. Joseph Straker was announced.—Prof. Ferrier read a paper on the functional topography of the brain. He discussed the question how far recent investigations into the functional topography of the brain could be brought into relation with craniological and anthropological researches with a view to establish the foundations of a scientific phrenology. Then he sketched the functional topography of the brain so far as it had been settled, but pointed out that the psychological aspects of brain functions were still far from being made out, although that correlation must be established and proved before a practical psychology, in any degree serviceable to the physician or the anthropologist, could be regarded as possible. He offered some speculations on the subject, and illustrated them by reference to certain facts and phenomena of disease in man. On the question as to how far it was possible from an anatomical examination of the brain to form an estimate of the forces and capacities of the individual, he pointed out many great difficulties which had to be encountered. *Cæteris paribus*, greater anatomical development might be considered as an index of greater functional capacity. He thought the attempt to determine differences in functional capacity from the examination of the head involved all the difficulties connected with the examination of the brain, and a great many more. He indicated the cranial relations of the principal convolutions, but expressed his belief that in the present state of our knowledge the data of a scientific phrenology were still very deficient. There was reason to believe, however, that, if the subject were taken up from different points of view by anatomists, physiologists, psychologists, and anthropologists, great progress might be made.—Mr. H. D. Rolleston read a paper on the cerebral hemispheres of an adult Australian; and a paper by Mr. Sören Hansen on a fossil human skull from Lagoa Santa, Brazil, was taken as read.

Entomological Society, February 2.—Dr. D. Sharp, President, in the chair.—The President nominated Mr. R. McLachlan, F.R.S., Mr. O. Salvin, F.R.S., and Mr. H. T. Stainton, F.R.S., Vice-Presidents during the Session 1887-88.—The Rev. W. J. Holland, Dr. F. A. Dixey, Mr. C. J. Gahan, and Mr. S. Klein, were elected Fellows.—Mr. P. Crowley exhibited a new species of *Synchlo*—*S. johnstoni*—from Kilima-njaro; also, for comparison, specimens of *Synchloë mesentina* and *S. hellica*, which the new species closely resembled.—Mr. W. White exhibited a number of preserved larvæ of European Lepidoptera in various stages of growth, illustrating the gradual development of the markings and colours, as explained by Prof. Weismann, in his "Studies in the Theory of Descent."—Mr. Gervase F. Mathew exhibited a variety of a female of *Lycæna telicanus*, from the neighbourhood of Gallipoli; some specimens of a *Lycæna* from Vigo, believed to be varieties of *Lycæna baton*; and several examples of a *Leucophasia* from Vigo, which appeared to be identical with *L. æstiva*.—Mr. Porritt exhibited, on behalf of Mr. N. F. Dobrée, a series of a remarkable red form of *Teniocampa gracilis*, bred from larvæ collected in Hampshire.—Mr. Eland Shaw exhibited specimens of *Pachytylus cinerascens* (Fab.), *Mecostethus grossus* (Linné), and *Gryllus flavipes* (Gmel.), and read a note on the identity of *Gryllus* (*Locusta*) *flavipes* (Gmel.).—Mr. H. Goss read a communication from Prof. Riley, of Washington, on the subject of the Australian bug (*Icerya purchasi*). It was stated that the insect had of late years become very destructive to various trees and shrubs in California, into which country, as well as into New Zealand and Cape Colony, it had been introduced from Australia.—The Rev. T. A. Marshall communicated a monograph of the British *Braconidæ*, part 2.—Mr. F. P. Pascoe read a paper entitled "Descriptions of some new species of *Brachycerus*."—Mr. Francis Galton, F.R.S., read a paper "On pedigree moth-breeding as a means of verifying certain important constants in the general theory of heredity," in which he suggested the institution of a system of experimental breedings, to be continued for several years, with the object of procuring evidence as to the precise measure of the diminution of the rate at which a divergence from the average of the race proceeds in successive generations of continually selected animals.—Mr. F. Merrifield read a paper entitled "A proposed method of breeding *Selenia illustraria*, with the object of obtaining data for Mr. Galton." Mr. McLachlan said he considered the fact that *S. illustraria* was dimorphic an objection to its selection for the experiments proposed, and suggested that the common silkworm moth would be more suitable. Prof. Meldola remarked that, although for some reasons the species selected was well adapted for testing Mr. Galton's conclusions, he believed that the fact of the moth being seasonally dimorphic was likely to introduce disturbing elements into the experiments which might influence the results. The discussion was continued by Dr. Sharp, Messrs. Baly, Kirby, White, Klein, Porritt, Dunning, Waterhouse, Bates, Merrifield, Galton, and others.

Chemical Society, February 17.—Dr. Hugo Müller, F.R.S., President, in the chair.—It was announced that the following changes in the Council list were proposed by the Council:—As President: Mr. W. Crookes, F.R.S., *vice* Dr. Hugo Müller, F.R.S. As Vice-Presidents: Prof. McLeod, F.R.S., Prof. Schorlemmer, F.R.S., and Mr. Ludwig Mond, *vice* Mr. Crookes, F.R.S., Prof. Liveing, F.R.S., and Prof. T. E. Thorpe, F.R.S. As ordinary Members of the Council: Prof. A. H. Church, Dr. P. F. Frankland, Prof. Kinch, and Dr. H. F. Morley, *vice* Messrs. H. T. Brown, A. E. Fletcher, and Profs. Meldola and Pickering.—The following papers were read:—The influence of temperature on the heat of dissolution of salts, by Prof. S. U. Pickering. This is an extension of the author's previous work on the sulphates, entitled "The Influence of Temperature on the Heat of Chemical Combination" (Trans., 1886, 260), which tended to show that the heat of dissolution of a salt does not increase regularly with a rise of temperature, but that irregularities occur at various points, so that the heat of dissolution must be represented by a series of curves. The experiments with potassium sulphate, hydrated and anhydrous magnesium sulphate, and hydrated and anhydrous copper sulphate have been repeated, and the investigation extended to potassium, sodium, hydrated and anhydrous strontium chloride, potassium and the two strontium nitrates, the two sodium carbonates, sodium acetate and potassium sodium tartrate. The investigation comprises over 700 determinations, the mean results with each salt being deduced from two to five distinct series of experiments, each performed with different thermometers. The observations extended from 3° to 25°. In all cases it was found that the irregularities previously noticed were the result of error, and that the heat of dissolution of a salt is represented by a series of straight lines. In rising from low temperatures the heat of dissolution is expressed by a straight line up to a certain point, when the rate becomes suddenly lowered and remains constant till a further sudden reduction occurs at

some still higher temperature. The average divergence of all the mean results from lines of perfect straightness amounted to less than one-thousandth of a degree. . . . The heat of combination of a salt with its water of crystallisation is deduced from the author's results. He concludes that it is not a constant quantity at all temperatures; the general effect of rise of temperature being to diminish it, although at very low temperatures this effect seems to be more than counterbalanced by some other cause, probably the tendency of the water molecules to unite with each other, the heat of combination diminishing then with fall of temperature. The more water a salt contains the more marked are both these results.—Periodates, by Dr. C. W. Kimmins.—Sulphonic acids derived from the β-monohaloid-derivatives of naphthalene, by Prof. Henry E. Armstrong and Mr. W. P. Wynne.—The decomposition of potassium chlorate and perchlorate by heat, by Dr. Frank L. Teed.—The formation of ethylic cyanacetoacetate, by Dr. J. William James.—The relation of diazobenzene anilide to amidoazobenzene, by Mr. R. J. Friswell and Mr. A. G. Green.—Note on Wallach's explanation of the isomeric transformation of diazoamidobenzene into amidoazobenzene, by Prof. R. Meldola, F.R.S.

Victoria Institute, February 21.—Prof. T. McKenny Hughes read a paper on caves, their formation, uses as places of refuge, and the influences which in many cases cause uncertainty as to the ages of the deposits therein. In regard to English sea caves he held that our coasts had not recovered their present elevation, after the submergence that followed on the Glacial age, before man came on the scene, marine shells being found buried in the same earth as Palæolithic man and the extinct animals.

Middlesex Natural History Society, February 15.—Mr. Mattieu Williams in the chair.—Mr. Logan Lobley read a paper on the geology of the parish of Hampstead. Commencing with a sketch of the work of those distinguished geologists who have made Hampstead classic ground, Mr. Lobley referred especially to the work of the late Mr. Caleb Evans, and mentioned that Mr. Evans's well-known model of the area had passed into safe keeping. The London Clay was described in detail; its minerals, the nature of its clays, and the material manufactured from them, were treated of, as well as the sections, and the fossils they have yielded. Passing on to the Bagshot Sands, Mr. Lobley traced their age, their connection with similar beds of other districts, and the important part they play in the question of water-supply. Some remarks upon the formation of the present features of the area by denudation, and some interesting and suggestive notes upon the sources and direction of flow of the former smaller streams, such as the Fleet, the West Bourne, and the Bays Water, with a reference to the great folds of the Chalk, and the relation of the geology of London to that of the southern area, concluded the paper.

Edinburgh

Royal Society, February 7.—Lord Maclaren, Vice-President, in the chair.—Dr. E. Saug read a paper on cases of instability in open structures.—Mr. W. Peddie communicated a paper on the time-rate of increase of electrolytic polarisation.—Sir W. Thomson discussed the equilibrium of a gas under its own gravitation alone, and pointed out the bearing of the problem on the question of the probable age of the sun.—Dr. Ralph Copeland, of Dun Echt Observatory, communicated some astronomical notes.

Royal Physical Society, January 19.—Dr. Alexander Bruce showed some microscopic specimens tending to confirm Gower's views with regard to the existence of the ascending lateral tract in the spinal cord. His sections were taken from a case of meningo-myelitis confined to the lower dorsal cord. They showed ascending degeneration of Goll's columns, of both cerebellar tracts, and of a comma-shaped tract in the situation of the ascending lateral tract of Gower's.—Dr. R. H. Traquair communicated the first part of a revision of the nomenclature of the fishes of the Old Red Sandstone of Scotland.—Mr. W. E. Hoyle read a report on a collection of shells brought from the West Coast of Africa, the Canaries, and Cape Verde Islands, by Mr. John Rattray.

Mathematical Society, February 11.—Mr. George Thom, President, in the chair.—Mr. W. J. Macdonald gave a proof of a geometrical theorem; Mr. A. Y. Fraser submitted a paper on vortices, by Mr. Charles Chree; Mr. R. E. Allardice communicated a note on a theorem in algebra, by Mr. John L. Mackenzie; Mr. George A. Gibson called attention to a point in the history of definite integrals; and Mr. John S. Mackay gave a few trigonometrical notes.

Cambridge

Philosophical Society, January 31.—Prof. Babington in the chair.—On the motion of a ring in an infinite liquid, by Mr. A. B. Basset.—Form and position of the Horopter, by Mr. J. Larmor.—On the finer structure of the walls of the endosperm cells of *Tamus communis*, by Mr. Walter Gardiner. It would appear, from the author's more recent researches, that the perforation of the walls of the endosperm cells in the plant referred to is established after the formation of the wall, and in a similar manner to that which occurs in sieve-tubes during the formation of the sieve-plate. The author further hopes to show that this is a special instance of a general phenomenon.

February 14.—Mr. Trotter, President, in the chair.—On the influence of capillary action in some chemical decompositions, by Prof. Liveing.—On homotaxis, by Mr. J. E. Marr.—Note on the function of the secreting hairs found upon the nodes of young stems of *Thunbergia laurifolia*; on the petiolar glands of the Ipomœas; and on the occurrence of secreting glandular organs on the leaves of some Aroids, by Mr. Walter Gardiner. In the last paper the author remarked that it has been frequently stated that the entire absence of all extra-floral secretory structures in monocotyledonous plants furnishes one of the most striking points of difference between the above-named group and the Dicotyledons. One would be led to expect, however, that some form of secretive organ should be present, and that probably they would be found—if anywhere—among the Aroids. Guided by these considerations, the author made a careful examination of the Aroids at Kew, and was so fortunate as to find two individuals, viz. *Aglaonema Mannii* and *Alocasia cuprea*, which appear to him to possess definite organs of secretion. The structure of these organs was then shortly described, and a comparison was instituted between them and certain forms of extra-floral nectaries. As to the existence of intramural glands, *e.g.* in *Anthurium punctatum*, the author's observations confirmed those of Dalitzsch recently published in the *Botanisches Centralblatt*.

Liverpool

Biological Society, January 22.—Prof. W. Mitchell Banks, President, read his inaugural address, which dealt with the aims and objects of the Society.—Prof. W. A. Herdman read a paper on recent researches in connection with the vertebrate brain (the pineal eye in lizards, and the pituitary gland in the Vertebrata and Tunicata), and their bearing on the hypothetical protochordata.

February 12.—Prof. W. A. Herdman, Vice-President, in the chair.—Mr. A. O. Walker contributed some notes on the *Mysidæ* of Liverpool Bay, with a description of some abnormal specimens.—A paper was read by Mr. J. Lomas on some points in the structure of *Alcyonidium gelatinosum*.—The Secretary (Mr. R. J. Harvey Gibson) drew attention to the new English translation of Sachs's "Text-book of Botany," Book II., by Goebel, and made some remarks on the value of a uniform terminology for the reproductive organs, not merely in botany, but in biology generally.—Dr. Ellis contributed some notes on boring insect larvæ.—Dr. Larkin exhibited and described some physiological apparatus.

Paris

Academy of Sciences, February 28.—M. Gosselin, President, in the chair.—Remarks accompanying the presentation of MM. Charcot and P. Richer's work, "Les Démoniaques dans l'Art," by M. Charcot. Representations of persons "possessed by the devil," that is subject to epilepsy and other nervous affections, have been brought together from ivories, enamels, tapestries, engravings, paintings, and other sources, for the purpose of studying these works from the stand-point of scientific truth. Such masters as Andrea del Sarto, Domenichino, and Rubens are generally found to have depicted these subjects with a strict regard to nature, so that their figures accurately reproduce the traits of a now well-understood pathological state.—Determination of the constant of aberration: first and second method of observation, by M. Lœwy. The author here deals with the somewhat feeble part played by refraction in these already described processes. From this study it appears that, the action of refraction being at all altitudes the same, the measure of the distance (except for very low regions) may be everywhere effected under almost

identical conditions of accuracy. Hence it is no longer necessary to observe the two stars only when found at considerable altitudes, a circumstance which greatly facilitates compliance with the other geometrical conditions of the problem.—On the great movements of the atmosphere, in connection with M. Mascart's last note of February 21, by M. Faye. The author reviews the whole subject of aerial movements as bearing more especially on his well-known theory regarding the direction of the wind in cyclones. The paper is followed by a brief reply from M. Mascart, who still maintains that this theory is unsupported by observation.—Note on the measurement of the photographic plates of the transit of Venus across the solar disk in 1882, by M. Bouquet de la Grye. These measurements, which have been executed in the Institute, deal altogether with 1019 plates, involving lengthy calculations which cover no less than 32,000 sheets of paper.—On the phosphorescence of the sulphuret of calcium, by M. Edmond Becquerel. In connection with M. Verneuil's recent paper on the determining causes of the phosphorescence of the sulphuret of calcium, the author makes some observations on the views already announced by him on the influence of foreign substances in modifying the molecular condition of the sulphuret of phosphorescent calcium.—On the red fluorescence of alumina, by M. Lecoq de Boisbaudran. It has recently been shown that highly calcined alumina yielding a bluish fluorescence *in vacuo* assumes a red tint in the phosphoroscope. Notwithstanding this observation the author still contends that the presence of chromium is necessary to obtain the red fluorescence of alumina. A mere trace of Cr_2O_3 superadded suffices to produce the fine fluorescence described by M. Becquerel in his work on "Light."—Note on the earthquake of February 23 at Marseilles Observatory, by M. E. Stephan. The movement which was attended by such disastrous effects along the Riviera, and even in the Maritime Alps, was very little felt at Marseilles, where two series of shocks were recorded at the Observatory, the first at 5.55 in the morning, and lasting about 90 seconds, the second ten minutes later, and lasting only some 15 seconds. The astronomic pendulums were somewhat disturbed, but the meridian-circle was not appreciably affected.—Observations of Barnard's new comet (1887 *d*), and of Palisa's new planet 265, made at the Paris Observatory (equatorial of the West Tower), by M. G. Bigourdan.—On a new method of determining the parallax of the sun by the photographic observation of the transit of Venus, by M. Obrecht. The method here described yields formulæ by means of which the parallax may be determined from the observations of *a single station*.—Additional note on the measurement of aberration, by M. J. C. Houzeau. It is shown that the objections recently raised by M. Lœwy to the author's method rest on a serious error.—On applicable surfaces, by M. E. Amigues. A definition is given of rectilineal applicable surfaces, from which several theorems are deduced.—On the product of two sums of eight squares, by M. X. Antomari. A fresh demonstration is given of the theorem that the product of two sums of eight squares is a sum of eight squares. It is further remarked that by means of this theorem a rule of multiplication of complex quantities in a space of eight dimensions may be conceived analogous to the rule of multiplication of quaternions.—Note on entropy, by M. Félix Lucas. It is shown on theoretical grounds that when a gas is heated under constant volume or under a constant pressure, the increase of entropy is in proportion to the increase of its true temperature.—On the coefficients of chemical affinity, by MM. P. Groustchoff and A. Martinoff. Certain analytic and thermic experiments are described, from which it is inferred that neither the initial nor the final composition of precipitates can serve to give coefficients of chemical affinity. Characteristic constants of affinity cannot be evolved by the method of simultaneous precipitation.—The action of heat on heptene, by M. Adolphe Renard. From the experiments here described, it follows that under the influence of heat heptene is decomposed chiefly into toluene and hydrogen, at the same time yielding a certain quantity of its lower homologues, hexene and pentene.—On the special characters of the loss of activity experienced by diastase under the action of heat, by M. Em. Bourquelot. A series of experiments are described, from which it would appear that the quality of the fermentation is modified rather than its quantity diminished, unless it be admitted that in natural diastase there are two or more soluble ferments intermingled, which by the increase of temperature become successively destroyed.—On the earths of cerite, M. Eug. Demarçay.—On the ferrite of zinc, by M. Alex. Gorgeu. Several methods are described for easily preparing this substance, and comparing it with the natural ferrite known as franklinite.—On the nitrates and superphosphates, by M. A. Andouard. The author's experiments show that it is a mistake to mix these substances together as artificial manures.—On the destruction of the Nematodes of beetroot, by M. Aimé Girard. The sulphuret of carbon is proposed as a more practical remedy than the expensive system of "decoy plants" (*plantes pièges*) introduced by Kühn.—On the cause of the changes which take place in the blood on contact with air, oxygen, and carbonic acid, by M. A. Béchamp. These changes are referred to the activity and influence of the microzymes of the blood.—On the transfusion of blood into the head of decapitated animals, by MM. Hayem and Barrier. It is argued that the assertions contained in M. Laborde's recent communication on this subject are not justified by his own publications.—On the gastric glands secreting mucus and ferment in birds, by M. Maurice Cazin.—On the structure of the muscular fibres in the edriophthalmous crustaceans, by M. R. Koehler.—On the anatomy of Bilhazia (*B. hæmatobia*, *Distomum hæmatobium*), by M. Joannes Chatin.—On the geology of the Lake Kelbia district and of the Central Tunisian seaboard, by M. G. Rolland. From his extensive studies of this region the author concludes that during the historic period the relief of the land has not perceptibly changed, and that in the Roman epoch as well as now Lake Kelbia communicated only intermittently with the sea.—On the deposits of tin, from the geological stand-point, by Mr. Reilly. Excluding those of Mexico and Bolivia, the author argues that all these deposits, from Cornwall to Australia, are connected by a vast curve, which he calls the "axis of Sumatra."—On some new methods of artificially producing crystallised silica and orthose, by M. K. de Kroustchoff.—On the earthquake of February 23, recorded at the Perpignan Observatory, by M. Fines. As at Marseilles, the vibrations were but slightly felt in this district.—On the effects of the same earthquake in East Switzerland, by M. F. A. Forel. The main shock appears to have been very generally felt throughout this region.—Papers followed describing its effects at Nice, Voreppe (Isère), and Saint-Tropez, and discussing the relations that may exist between seismic and magnetic disturbances.

BERLIN

Physiological Society, January 28.—Prof. Du Bois-Reymond in the chair.—Dr. Benda mentioned that his researches, according to which the "spermatoblasts" resulted from the coalescing of the cells forming the spermatozoa with the supporting cells, had some years earlier been anticipated by the French anatomists, and that Prof. Grünhagen, who formerly opposed this view, was now likewise presenting it as his own.—Dr. Rawitz had examined the green gland of fresh-water crayfish. It was situated on the first member of the antennæ, was uniformly green on the ventral side, but on the dorsal side only at the periphery, elsewhere white, with a round yellow-brown speck in the centre. The gland consisted of two tubules closely interwoven. The cells of the green part had a round grass-green drop of protoplasm, the yellow-brown cells a uniformly yellow-brown coloured nucleus. The tubules anastomosed, the yellow-brown cells being the terminal portions of the tubules, and secretory. No conclusions respecting the function of the glands could be drawn from their anatomical structure.—Dr. Gad made a communication respecting the peculiar strange albumen-precipitate with salt recently described by Dr. Wurster. If to the white of eggs lactic acid, peroxide of hydrogen, and common salt were added, almost the whole of the albumen was precipitated as a white flaky mass, perfectly similar in appearance and taste to newly-precipitated caseine (curd), but distinguished from caseine by its chemical reactions. The easy digestibility of this form of albumen, which had hitherto been precipitated by no other reagent was especially remarkable. It was interesting that, in accordance with the reactions shown by Dr. Wurster's test paper for active oxygen, hydrochloric acid was formed on the mixture of lactic acid, peroxide of hydrogen, and common salt, and this acid *in statu nascendi* might be the specific precipitate for this new form of albumen, which could be obtained just as well from blood serum as from white of eggs.

Meteorological Society, February 1.—Prof. von Bezold in the chair.—Dr. Frölich gave a report on measurements of solar heat, which, following up those instituted in 1883 and already published, he had made in the years 1884 to 1886 after some alterations in his apparatus. The most important modifications made in the apparatus consisted in the removal of the rock-salt

plate in front of the thermo-electric pile which he had made use of in his first measurements. He had been induced to remove the rock-salt plate by the conviction that after a time rock-salt developed a quality of transmissibility which was not identical both for luminous and for non-luminous heat. The bare thermo-electric pile showed itself by oft-repeated proofs to be constant towards the rays of a Leslie cube. The relation of the rays from the blackened side of the cube to the rays from the white side continued invariably the same. The same constancy was manifested in the registrations of the thermal element towards the luminous heat of a white-glowing platinum chimney, which was uniformly heated by two gas-flames. The observations of solar heat were made on perfectly bright days and under a perfectly clear atmosphere, the thermo-electric pile being directed to the sun under very different heights, as far as 10°, and exposed to the sun till the diversion of the galvanometer had become constant. The values obtained on the various days and under different solar positions were graphically delineated, on the supposition that the absorption of the atmosphere was an exponential function of its density. The result came out that the "curve" was practically a straight line, or a line concave or convex to so small a degree as to deviate but very little from a straight line. When the curve was lengthened till it met the perpendicular co-ordinate, then the intersecting point representing the magnitude of the solar heat was the same for all days of observation. The deviating results of Mr. Langley and Messrs. Angot and Crova were explained, in part from the fact that in their calculation the reflection of the thermal rays in the different atmospheric strata had not been taken account of, and in part from the fact that the different atmospheric strata were assumed to be parallel, and so their incurvation was left out of account. Notwithstanding the circumstance that the absorption by the atmosphere was different for the different kinds of rays, and also different from day to day, yet was the "curve," the co-ordinates of which were represented by the observed heat and the abscissæ by the logarithms, without exception, a straight line. This empirically ascertained fact was the main result of the whole series of investigations extending over three years.

Physical Society, February 4.—Prof. Helmholtz in the chair.—Dr. Sprung described the barograph designed by him, which avoided the errors of the older balance-barometer (first constructed in 1760 by Samuel Moreland) by making the barometer work on a resting horizontal beam, which through horizontal automatic displacement of a sliding weight was kept always in exact equilibrium. The travelling vertical tread-wheel constantly marked its position on the writing-table of the instrument. Seeing, moreover, that this displacement of the tread-wheel was effected by a clockwork, any disturbance that might arise from its rubbing against the barometer was completely precluded. The automatic equilibration of the beam of the balance was produced by an electric current. The speaker had quite recently instituted a series of the most various experiments, by which he demonstrated how the registering balance designed by him was with great advantage available for a large number of physical investigations: how, for example, he was able by his balance to permanently register the state of the quicksilver in the barometer; the progress of the evaporation of alcohol; the discharge of a fluid from a capillary tube; the change of intensity in an electric current; the evaporation of water through a clay-ball; the changes of density in the atmospheric air recorded by the variations of rise on the part of a large glass ball; and phenomena connected with permanent change of weight. The registering balance, which was being executed by the mechanician Fues in Berlin, allowed, in short, a large series of physical processes to be automatically recorded, and would prove highly useful in many physical investigations.—Prof. Helmholtz, by an experiment, demonstrated the great cohesion of an air-free column of water. A siphon-shaped glass tube, the longer leg of which was closed and the shorter one open, was filled with quicksilver, and above the quicksilver there was superposed a small quantity of distilled water. If the filling was effected without admission of air, then, on the tube being placed in an upright position, the water adhered to the closed end, and its adhesion supported the quicksilver column, which was longer than the barometer height. The speaker now brought the open end of the siphon tube into communication with an air-pump, and caused to be pumped out as much as down to 2 mm. pressure, but even then the cohesion of the water supported the quicksilver column. Only by shaking was the water column shattered, and the quicksilver immediately sank. If there was no shaking, the apparatus continued for an unlimited length of time unchanged. This contrivance should serve the purpose of electrolysing air-free water and ascertaining the strength of the current under which gas bubbles developed themselves by electrolysis. The experiment showed that on the transmission of a current of 2 volts the water continued adherent. The depression of the quicksilver column in consequence of gas development occurred, however, in an experiment with a current of 2·15, and in another with a current of 2·18 volts.

February 18.—Prof. Schwalbe in the chair.—Dr. Frölich spoke of his measurements of the solar heat in the years 1883, 1884, and 1886, and refuted at length the objections which had been raised against these measurements by MM. Vogel, Langley, Angot, and Crova. In the discussion following thereon, Dr. König stated that experiments carried out in the Physical Institute with a Langley bolometer indicated that very considerable influence is exercised by the air-currents on this delicate measuring-instrument.

BOOKS AND PAMPHLETS RECEIVED

Catalogue of the Fossil Mammalia in the British Museum, Natural History, part iv.: R. Lydekker.—Practical Electricity: W. E. Ayrton (Cassells).—A Treatise on Algebra: Profs. Oliver, Wait, and Jones (Finch, Ithaca).—Contributions to Meteorology, chap. ii. revised edition: E. Loomis (New Haven).—The Game of Logic: L. Carroll (Macmillan).—Bees and Bee-keeping, vol. ii. parts 5 and 6: F. R. Cheshire (U. Gill).—British Dogs, parts 2-5: H. Dalziel (U. Gill).—Fancy Pigeons, 3rd edition: J. C. Lyell (U. Gill).—Vegetable Biology: Dr. T. W. Shore (Churchill).—Anecdota Oxoniensia: Alphita: edited by J. L. G. Mowat (Clarendon Press).—Journal of the Anthropological Institute, February (Trübner).—Outlines of Lectures on Physiology: T. W. Mills (Drysdale, Montreal).—Schools of Forestry in Germany: Dr. J. C. Brown (Oliver and Boyd).—Social History of the Races of Mankind, 2nd division: A. Featherman (Trübner).—Complete Hand-book on the Management of Accumulators, 2nd edition: Sir D. Salomons (Whittaker).—The Encyclopædic Dictionary, vol. vi. part 1 (Cassells).—Journal of the Chemical Society, March (Gurney and Jackson).—Bulletin of the American Geographical Society, Nos. 4 and 5, 1885 (New York).—Annual Report of the Proceedings of the Sussex Association for the Improvement of Agriculture, 1886.—Journal of the Asiatic Society of Bengal, vol. lv. part 2.—Aborigines of Hispaniola: H. Ling Roth (Harrison).—Bibliography and Cartography of Hispaniola: H. Ling Roth.

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THURSDAY, MARCH 24, 1887

THE NECESSITY FOR A MINISTER OF EDUCATION

IF we are justified in judging of the progress of right ideas on the importance to the nation of science and scientific instruction by the outcomes of one week, then certainly we may congratulate ourselves upon the fact that at last the views which we have for the last eighteen [illegible] season and out of season, been putting forward [illegible]ginning to attract public attention.

There can be no doubt that the general interest is now thoroughly aroused on this matter. In spite of the absolute block of anything like a debate upon education in Parliament, scientific and political leaders say their say elsewhere, and the manner in which these utterances are referred to and enlarged upon in the leading journals is a sure indication that the public interest is known to be growing, and that it is now generally acknowledged that our welfare as a nation depends upon a proper consideration of educational questions.

The first utterance we have to refer to is the admirable speech delivered by Lord Hartington on the night our last number went to press. Lord Hartington had consented to give away the prizes and make an address at the Polytechnic Young Men's Christian Institute, an organisation which now numbers nearly 7000 students, for the existence and endowment of which England is indebted to the munificence and clear-sightedness of one individual, Mr. Quintin Hogg.

It was not to be wondered at that Lord Hartington, with such an unaccustomed task before him, should have referred, in the course of his speech, to Prof. Huxley's recent address, in which the fact was emphasised that if peace has her victories, there must be some who are vanquished; that there is a death to the conquered in peace as in war, the victims of peace being starved as a result of continual depression of trade.

The interest of Lord Hartington's speech was that the question which Prof. Huxley had approached from the Darwinian point of view—the survival of the fittest, the destruction of the unfittest—was to him a question of possible contemporary politics which he had to consider, and the consideration he gave to it led him to emphasise Prof. Huxley's view of the situation. It is [illegible]ear moreover that the opinion given was not one hastily [illegible]rmed, for the former paramount position of this country [illegible]en she had a monopoly of iron, and coal, and other material resources, and when there was no science to speak of anywhere, either here or abroad, had been fully taken into consideration. We quote from the speech:—

"No doubt we should still have our material resources, our iron and steel, and the muscular energy of what would then be our superabundant population; but instead of being what we are now, we should be hewers of wood and drawers of water for the world. If ever our raw materials could be manufactured for the uses and wants of the world better in other countries than in our own, we should become the slaves and servants of the rest of the world, instead of its leaders and masters, as we have been hitherto."

Now, if a politician of Lord Hartington's eminence tells us that this may happen as a result of our being beaten in a campaign of peace, it is proper to consider whether we could be very much worse off in the event of a disastrous war. Certainly, to fend off this result by war, we, as a nation, would not hesitate to double the national debt.

Lord Hartington next went on to show that war also now depends upon science.

"There are some who go so far as to deprecate any large expenditure whatever, even when necessary for the efficiency of our services. These people point to the success which we have attained in former times when almost alone we have contended successfully against a whole continent; they point to the undiminished strength and courage of our soldiers and sailors, to the vast resources—industrial, manufacturing, and financial—of the country; and they tell us that if we only husband these resources they will pull us through in future emergencies as they have done in the past. But I would say that all these arguments are utterly vain and futile unless we can prove that the conditions under which we should have to fight are entirely similar to those under which we have fought in the past. If, on the other hand, it can be proved that wars are no longer decided by personal courage or endurance, but by the possession of scientific knowledge and all the most approved and perfected appliances, then we cannot afford to disregard the teaching and the experience of the rest of the world, and cannot afford to allow ourselves to be behindhand in the possession of the scientific knowledge and appliances that are demanded."

Lord Hartington then insists upon the importance of science both in peace and war.

"If undoubted success can only be gained by the possession of scientific knowledge and the application of the most scientific instruction to the masses of our people, then it follows that we shall fall behind in this industrial competition and warfare if we do not possess ourselves of these necessities."

He holds that the army of peace must be aided by the State as well as the other. We no longer think of keeping out an invasion by train-bands, and volunteers, and our merchant fleet. For peace purposes also, then, local effort alone will not do all that is necessary. We have found this out already, and we have the Science and Art Department as well as the Admiralty and War Office. Lord Hartington holds that the Science and Art Department must be strengthened so far as technical instruction is concerned.

We see, then, that at last we have one political leader who views science and scientific instruction in the true light, and has the courage of his opinion. Science is to be *aided* on precisely the same grounds that we *aid* the army and the navy. It is no longer a question of merely paying for Sweetness and Light, or of giving a poor dog a bone.

It was not to be expected that Prof. Huxley, who has so unceasingly done all in the power of a single individual to place the right views on this matter before the public, would rest content with the note of warning to which Lord Hartington, as we have seen, has so forcibly drawn attention.

Under the title of "The Organisation of Industrial

Education" a letter appeared in the *Times* of the 21st inst., which we print *in extenso* elsewhere. The main purpose of this second outcome is to show that at the present moment what is chiefly lacking in the army of peace is organisation and a proper headquarter staff—an Educational Commander-in-Chief. Reading between the lines of the letter, it is easy to see that one of the things "organisation" is expected to do, nay, must do, is to prevent so-called "economy" from thwarting every attempt at progress. "Economy does not lie in sparing money, but in spending it wisely," is a maxim that must be commended not only to the Treasury, but to local bodies.

It is probably the feeling that the proposals of a strong Minister of Education, with a full knowledge of his subject and in touch with all the most eminent educationalists of his time, would be sure to commend themselves to Parliament, and that the annual charge would be increased, which has induced successive Ministries to postpone the creation of such an office. It is now thirteen years since both the Duke of Devonshire's Commission and Parliament itself discussed the question; the latter on the motion of Mr. (now Sir Lyon) Playfair. Three years ago the Report of the Select Committee presided over by Mr. Childers unanimously recommended that a Minister of Education should be appointed. With the growing feeling on the part of the public on this matter, if an opportunity presents itself of again bringing forward this proposal it will not be allowed to be dropped.

It is clear from Prof. Huxley's letter that the present machinery is not adequate: it can only be strengthened and consolidated by the appointment of a Minister. One enormous advantage of such a Minister would be that we should have an acknowledged Department to apply to, absolutely in sympathy with those who wish to bring about any improvement in our educational machinery. Quite recently we have had two deputations on purely educational matters: one, for an endowment to the Victoria University, to the Chancellor of the Exchequer, and the other, for further aid to technical education, to the Lord President. It is very difficult for a plain man to understand why the Chancellor of the Exchequer should have been chosen in one case and the Lord President in the other: of course there is an official reason, but it only adds point to the grotesqueness of the present arrangements.

We have, however, to refer to these deputations from another point of view. The prayer of the Victoria University has been granted: that the needed assistance in the other matter—technical instruction—will be granted at once is by no means certain. However this may be, well-wishers of science must thank Mr. Mundella for his vigorous pleading of the cause they have at heart.

The object of the last deputation, as Mr. Mundella pointed out, was to ask the Government to take a very modest step in the direction of the organisation of industrial and commercial education. The education of the 4,600,000 on the books of the elementary schools is confined to education of a purely elementary character, and anything in the shape of manual or industrial education is treated in a way very disheartening to those interested in the question. At present our industrial classes are like badly drilled soldiers fighting a battle with antiquated weapons—it is like sending our soldiers into the field, armed with Brown Bess, to meet the best armed soldiers of Europe. Dr. Konrad, in a report on the Prussian system in its bearing on the national economy, said the superiority of the Western to the Eastern workman, and of the German to the Englishman, was well established; and he added that no doubt the Englishman by his enormous perseverance and his wonted diligence got through considerably more work in the sphere to which he had been long accustomed, but he was far behind the German in capacity for adapting himself to new circumstances. This was the result of the better and more general training which the Germans got in their schools. Mr. Mundella acknowledged that there had been repeated attempts to do something in England to improve the condition of things, but where public bodies had interfered they had acted beyond their powers and been punished accordingly. It was freedom from the restrictions under which these authorities laboured that the deputation sought. They asked also for increased powers to promote industrial, scientific, and technical training, and that for this purpose they should be put in connexion with the Science and Art Department. The cost of executing what they proposed would be trifling.

Sir Lyon Playfair contended that a short Act of three clauses would do all that is wanted. We hope soon to see it. Sir B. Samuelson, as Chairman of the Associated Chambers of Commerce, presented a memorial from that body, and Mr. Howell hit the nail on the head by stating that for "unemployed," in connexion with our industrial population, now so often used, the word "unskilled" should be substituted.

We are bound to say that Lord Cranbrook's answer was sympathetic, but he is clearly of opinion that the Government can do nothing because "Parliament has not really pronounced on the subject of technical instruction"!

ROSENBUSCH'S "PETROGRAPHY"

Mikroskopische Physiographie der massigen Gesteine. Von H. Rosenbusch. I. Abtheilung. Zweite gänzlich umgearbeitete Auflage. (Stuttgart, 1886.)

THE first part of the second edition of this important work has at length appeared, the author having wisely decided not to keep back this instalment until the whole has been completed. Petrography advances nowadays with such gigantic strides, and so quickly are new facts accumulated and new theories elaborated, that as soon as the last chapters of a treatise on this subject have been written it is almost time to begin re-writing the first.

This book has been looked forward to by petrographers with a certain amount of pardonable impatience, in the hope that it would do something towards clearing away the mists that envelop rock-classification and nomenclature. Since the introduction of the polarising microscope into petrographical research, old familiar names—like greenstone, trap, felstone, trachyte, &c.—have either been discarded or materially modified in their use; and we now talk with Gümbel of lamprophyre, proterobase, picrophyre, palæophyre, palæopicrite, leucophyre, and the like; or we use names manufactured from the locali-

ties where the rocks are found, such as tonalite, ortlerite, or palatinite; or, lastly, following in the wake of the organic chemists, we construct complex names by stringing together those of the component minerals, as, for example, quartz-augite-diorite or hornblende-augite-mica-andesite. The result is that either different petrographers call the same rock by different names, or use the same name to designate different rocks. At the same time, so many views have arisen as to the fundamental elements of petrographical classification, that there are almost as many systems of classification as there are petrographers.

Up to the present time Continental geologists have been in the habit of making geological age a primary factor in classification. Now, although this may apply to Germany, it certainly will not hold for other countries. In England and America it has been shown conclusively that rocks identical in structure and composition have been formed in pre-Tertiary and Tertiary times.

The new edition of Rosenbusch's work would, it was hoped, bring order into this chaos, and give us a classification and nomenclature which, without being too rigid, would allow of referring any particular rock to its family. Such a classification, agreeing with all the known facts, would doubtless readily be accepted by all geologists in this country, were it only for the sake of uniformity and unanimity.

A brief review, or epitome, of Prof. Rosenbusch's book may not be unwelcome here. Any criticism had best be reserved until the work is completed. We owe, indeed, such a debt of gratitude to the author for collecting, collating, and arranging the vast quantity of facts which have been accumulating within the last few years, that it would be almost presumptuous to attempt to find fault with a work so excellent, so invaluable in every way.

In the introduction Prof. Rosenbusch gives us his views on classification. These differ very materially from those expressed in the former edition. "A natural system of classification must," he writes, "in the first place lay stress on the geological mode of occurrence (*geologische Erscheinungsform*), as determining structure and the mineral components. In the second place comes chemical composition, and, lastly, geological age." Secondary alteration in structure or mineralogical composition can have no classificatory value.

It is the geological mode of occurrence that almost exclusively determines the structure of an eruptive rock. Eruptive masses of the same chemical and mineralogical composition possess a totally different structure, according as they were poured out at the earth's surface in the form of lava, or consolidated in the deeper regions of the earth's solid crust. This may, of course, also be expressed by saying that the structure of a rock depends, *ceteris paribus*, only on the differences of temperature and pressure to which it has been subjected during its formation.

Classified, then, according to their mode of occurrence, eruptive rocks may be divided into two great groups: (1) the *Plutonic* rocks (*Tiefengesteine*); and (2) the *Volcanic* or *effusive* rocks (*Ergussgesteine*). Occupying an intermediate position between these two chief groups is a third—that of the rocks occurring in the form of dykes (*Ganggesteine*). Both plutonic and volcanic rocks are often found as dykes; but this group comprises those rocks which are found occurring alone in this form, and which possess certain structural peculiarities entitling them to be considered apart from the plutonic and effusive rocks. With regard to the latter it may be remarked that it is in this group that Prof. Rosenbusch does not feel justified in dropping altogether geological age as a classificatory factor. Accordingly these rocks are subdivided by him into *palæovolcanic* and *neovolcanic*: the former embracing those erupted in pre-Tertiary times, the latter those of Tertiary age.

In the introductory chapter to the plutonic rocks Prof. Rosenbusch treats of the structure and order of crystallisation of the mineral components of these rocks. In this chapter he embodies the substance of his paper on the granular and porphyritic structure of massive rocks, published some time since in the *Neues Jahrbuch*. In that paper he showed how in an eruptive silicate-magma the minerals separate in the order of decreasing basicity, so that at any given moment the uncrystallised magma is more acid than the sum of the separated compounds. Further, that the relative masses of the compounds present in such a magma act only in so far on the order of their separation, that generally those present in less quantity crystallise out first. To facilitate petrographical expression, Prof. Rosenbusch has proposed a couple of words which appear to be worthy of general acceptation. He calls those mineral components which occur in individuals, bounded on all sides by crystallised faces, *idiomorphic*: *allotriomorphic*, those which owe their boundaries to causes other than an internal arrangement of the molecules composing them. Applying this to the plutonic rocks, he points out that, whereas certain rocks, occurring as dykes, possess a "panidiomorphic granular" structure, the plutonic rocks are characterised by a granular structure essentially "hypidiomorphic" (a part of the minerals only possessing their own crystallographic form).

The group of the Plutonic rocks is subdivided by Prof. Rosenbusch as follows:—

(*a*) Family of the granitic rocks.
(*b*) Family of the syenitic rocks.
(*c*) Family of the elæolite syenites.
(*d*) Family of the diorites.
(*e*) Family of the gabbros and norites.
(*f*) Family of the diabases.
(*g*) Family of the theralites.
(*h*) Family of the peridotites.

Among these we notice a new name—the *theralites*. Under this head are included the plagioclase-nepheline rocks, formerly represented by the teschenites. The latter have been shown by Rohrbach (Tschermak's *Min und Pet. Mitt.*, 1885, ii. 1-63) to contain no nepheline, and have consequently been referred by him partly to the diorites, partly to the diabases. Still, plutonic rocks representing this mineralogical combination appear to exist (*e.g.* in the Crazy Mountains in Montana, U.S.); and thus the gap left by the removal of the teschenites is filled up. Prof. Rosenbusch derives the name theralite from θηρᾶν (to seek eagerly).

The group that embraces the rocks occurring in the form of dykes, is subdivided, according to mineralogical

and chemical composition, into a *granitic*, a *syenitic*, and a *dioritic* series.

Looking at the rocks, however, from the point of view of habit and structure, three types, independent of mineralogical composition, may be established, namely: a "*granitic*," only known to occur among the more acid representatives; a "*granito-porphyritic*," which is represented in each of the above series; and a "*lamprophyric*," which appears to be unrepresented in the more acid subdivisions. The following classification is accordingly proposed for the "dyke-rocks":—

(*a*) Granitic dyke-rocks (aplite, tourmaline-granite, &c.).

(*b*) Granito-porphyritic dyke-rocks (granite-porphyry, syenite-porphyry, elæolite-porphyry, diorite-porphyrite).

(*c*) Lamprophyric dyke-rocks.

This last family may perhaps be best designated as a refuge for certain classes of rocks, such as the kersantites and kersantons, the minettes, and the lamprophyres, which have been long wandering about in the various systems of classification without finding any fixed abode. It is further subdivided into the syenitic lamprophyres (minettes and vogesites) and the dioritic lamprophyres (kersantite and camptonite).

Passing on to the group of the true Volcanic rocks, we note an important distinction between them and those of the Plutonic group, contained in a general law laid down by the author in this chapter. A volcanic (effusive) rock is always more acid and specifically lighter than its plutonic equivalent. To explain this the author suggests that an eruptive magma, during its slow ascent along cracks in the earth's crust, differentiates according to specific gravity, the heavier part, which ultimately gives rise to the plutonic rocks that consolidate within the earth's crust, being more basic, poorer in alkalies, and richer in alkaline earths and iron, than the specifically lighter part which reaches the earth's surface.

The author then proceeds to discuss the recurrence of phase in the crystallisation of the effusive rocks, and defines porphyritic structure as that structure which is produced by the recurrence of the same or similar minerals at two distinct periods of crystallisation. It is this structure which is the most essential characteristic of the effusive rocks. It may, however, be developed in very different ways. When the ground-mass is holocrystalline, the structure is "holocrystalline-porphyritic"; it is "vitro-porphyritic" when the ground-mass is glassy, and "hypocrystalline-porphyritic" when the ground-mass consists partly of vitreous, partly of crystalline elements.

Of the Volcanic group only the palæovolcanic series is discussed in the present volume. It is subdivided as follows:—

(*a*) Family of the quartz porphyries (palæovolcanic equivalents of the granites).

(*b*) Family of the quartzless porphyries (equivalents of the syenites).

(*c*) Family of the porphyrites (equivalents of the diorites).

(*d*) Family of the augite-porphyrites and melaphyres equivalents of the gabbros and diabases).

(*e*) Family of the picrite-porphyrites (equivalents of the peridotites).

The neovolcanic rocks (rhyolites, trachytes, andesites, basalts, phonolites, tephrites, &c.) are reserved for the Second Part, which is promised for Easter of this year, and will contain the plates to the whole volume. Thus completed, the work will form a most valuable addition to petrographical literature. One of its important features is the full collation of literature under each head. Students of petrographical science will thank Prof. Rosenbusch for the inestimable boon he has conferred upon them in indexing almost all the papers dealing with petrographical subjects which had appeared up to the date of publication of his book.

FREDERICK H. HATCH

LOCH CRERAN

Loch Creran: Notes from the Western Highlands. By W. Anderson Smith. (Paisley and London: Alexander Gardner, 1887.)

THE amateur naturalist who has leisure, a genuine interest in his subject, and abundant opportunities of exercising his observation, ought to be an exceptionally happy person; but he is not always well-advised in rushing into print with the result of his fugitive studies. That, however, is one of the foibles of the hour. The public are supposed to welcome somewhat bald catalogues of the common objects of the way-side, the heath, and the sea-shore; the newspaper reporter is glad to be temporarily withdrawn from the Divorce Court and sent to describe the chestnut-trees in Bushey Park; and young ladies, who have got the length of distinguishing between *Ranunculus Ficaria* and *R. acris* narrate in the evening papers the story of their exploration of the hedge-rows. The result is harmless enough. It is not science; it is not literature; but it serves to teach a few people here and there to keep their eyes open; and that is something. And perhaps a world groaning under a load of books need not mind an additional volume or two—which it is not compelled to read.

Mr. W. Anderson Smith does not inform us whether these "Notes from the Western Highlands" have been, like some other of his writings, reprinted from a provincial journal; but if they are so, he has done himself injustice in not stating the fact; for carelessness that is comparatively venial in the columns of a newspaper becomes vexatious in a book. And truth compels us to say that Mr. Smith's style is slovenly in the extreme. Mis-spellings abound; the few scraps of French or Latin quoted are almost invariably mangled; there is an occasional lapse of grammar; and now and again the heedless composition provokes a smile, as when he says, "Into the luxurious beds we sink up to the knees, many of them at present with dainty seed-vessels ripe and full." And yet there is a chatty simplicity here and there in the book that is not without attraction. The ways and humours of certain domestic pets are described in a kindly fashion which recommends itself; and there are incidental glimpses of winter life and winter occupations in the West Highlands that are sufficiently pleasant. As for the bulk of the volume, that is devoted to marine zoology; and marine zoology, to be made interesting, not to say intelligible, to the general reader, should be accompanied by illustrations; while, on the other hand, the trained scientific student is not likely to concern himself much with the unmethodical investigations here noted down.

But in merely making incidental memoranda of the every-day experiences of life in his northern home, Mr. Smith has mentioned not a few interesting things; and for these one soon begins to be grateful in reading a volume that is otherwise none too lively. He tells us, for example, how a heron was suspected of stealing ducklings, was watched, and finally caught in the act of devouring one of the birds—which seems a singular occurrence. On the other hand, the appearance of a bat in January, when the West Highlands happen to be visited by a spell of mild weather, is by no means the phenomenon he supposes it to be. There are some interesting remarks on the incubation of the cuckoo's egg (pp. 13 and 16) which seem to suggest a need for further inquiry. But we cannot say that we place implicit faith in Mr. Anderson Smith as an observer. His story of how, on one occasion, in passing through a wood, he startled a number of fallow-deer and roebuck may be forgiven on account of the darkness prevailing at the time: we should prefer to wait for some daylight notes before believing that the fallow-deer and the roe have agreed to lay aside their long-standing and mutual antipathy. "The pheasant is an unwieldy bird and of no great power of flight." Did the writer of that sentence ever try to "stop" a rocketer well on the wing and coming down wind; and what was the expression of his face when he wheeled round to find the "unwieldy" bird already disappearing into the next parish? Mr. Smith in this volume revives a controversy in which, as it appears, he has been engaged before, with regard to the lower animals committing suicide; and remarks that it may be assumed they know what death is from the fact that many of them can simulate it with marvellous accuracy. It is no doubt true that the young of certain animals, when confronted with danger, will suddenly become motionless, and remain so until the danger is removed—just as it is a common trick among street arabs for a small boy, when pursued by a bigger boy, to throw himself down in the roadway and lie perfectly still, prepared for the worst. But to assume that the young curlew or the young rat that suddenly stiffens itself and shuts its eyes is aware that it is simulating death, or has any understanding of such a state, is a far jump. Mr. Smith cites the case of a terrier belonging to a friend of his which, having the distemper, deliberately went off and drowned itself. Clearly the verdict here must be temporary insanity; the dog did not know what it was doing. The chief reason for concluding that the lower animals are not aware that they possess the liberty of suicide is that so few of them (or none of them) take advantage of it; if they did know, the overworked cart-horse, the mangy cur, the long-enduring donkey, would forthwith knock their heads against the nearest wall—unless, indeed, it is to be supposed that these animals are so highly intelligent as to have heard of the significant French proverb: "Quand on est mort, c'est pour longtemps." But this question of suicide among animals has always been a stumbling-block. Prof. Edward Forbes accused a whole tribe of star-fish of having a suicidal instinct on no better grounds than that they, on being brought into the air, or put in fresh water, went to bits. He even describes one of them as rejoicing in its power of eluding scientific scrutiny:—"I saw its limbs escaping through every mesh of the dredge. In my despair I seized the largest piece, and brought up the extremity of an arm with its terminal eye, the spinous eyelid of which opened and closed with something exceedingly like a wink of derision." After this we shall not be surprised to hear of a body of scientific experts meeting to consider the question of suicide among animals—with Mark Twain as President of the Committee.

"Loch Creran" is not a vivacious book; but it is unpretentious; and the author, in a rambling and hap-hazard fashion, contrives to give us some idea of his surroundings and pursuits. Indeed, the dweller in towns, who has the patience to follow this somewhat prolix writer, will probably part company with him with no slight feeling of envy.

OUR BOOK SHELF

The Encyclopædic Dictionary. Vol. VI. Part 1. (London: Cassell and Co., 1887.)

THE work to which this volume belongs is much more than a mere dictionary in the ordinary sense. It includes the description of things as well as of words, special attention being given to objects and processes indicated by scientific and technical terms. The information offered is never, of course, exhaustive, but it is sufficient for the purposes the compilers have had in view, and generally it has the merit of being clear, concise, and, as far as it goes, accurate. As a dictionary the work deserves high praise. It contains all the English as well as all the Scotch words now in use, with their significations re-investigated, re-classified, and re-illustrated by examples. A large number of obsolete words have also been introduced. The etymology is inclosed within brackets immediately following each word; and the pronunciation is indicated by diacritical marks, a key to which is given at the foot of the several pages. The present volume includes all words from "quoi" to "shipp," and, so far as we have been able to test it, we have found it lucidly arranged and thoroughly trustworthy.

Descriptive Catalogue of the General Collection of Minerals in the Australian Museum. By A. Felix Ratte. Printed by order of the Trustees. (Sydney: Thomas Richards.)

THIS Catalogue has been carefully compiled, and no doubt it has already been of considerable service to persons making use of the Australian Museum. For the classification of silicates the compiler has taken as a guide Dana's "System of Mineralogy"; for the classification of metallic minerals, Roscoe's "Chemistry." But these authors' systems have not been entirely followed, especially where rare mineral products are concerned. The notes, although generally brief, are adequate, and there is a valuable appendix on gems and ornamental specimens.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

West Indian Meteorological Confederation

IN the leading article in NATURE, vol. xxxv. p. 241, remarks were made respecting the advantages which would accrue to the West Indian Islands, and to the Meteorological Council of the

Royal Society, if those islands were confederated for meteorological purposes."

The writer was apparently unaware that in the year 1879 those islands agreed to confederation. It was not restricted to the British colonies—Guadaloupe, for instance, passed a vote of credit through its chamber before the decision of the British Meteorological Council was received—but all the work broke down when the Meteorological Council insisted upon Antigua as the central station.

It is unnecessary to say that unmitigated failure was the result.

The advantages to the United States of any West Indian system, however poor, are palpable to the lowest stratum of scientific intelligence; yet we find that Congress disestablished the whole of their West Indian stations without the slightest reason, as far as I have been able to discover. But the words of the Chief Signal Officer have a thousand times the weight of mine, and I quote them accordingly:—

"Among the objects for which appropriations were refused were 'foreign reports.' A request was made for 4000 dollars to pay for these warnings of tropical hurricanes, which, last year, were instrumental in saving millions of dollars of property. Two storms of great fury swept up from the Gulf, one in September and one in October. Warnings of the coming of these storms were given from the West India stations, so that the indications officer on duty in each month was able to give at least two days' notice of the coming of the storm to every port in the Gulf and on the Atlantic coast. The result was an immense saving of valuable property and of human life. The statistics were gathered as fully as possible from all the stations passed over by the cyclones, and the names of the vessels, their value, and the value of their cargoes, remaining in port in obedience to the storm warnings of this service, were ascertained. The reports were not wholly satisfactory, because accurate information could not be obtained from the largest places of the country, such as New York, Philadelphia, Baltimore, and Boston. These cities lie at the head of large harbours that have safe anchorages near their openings, and vessels delayed by a storm almost invariably go down the harbour to there await its conclusion. But, without these great ports, it was ascertained that 6,460,586 dollars of property remained safe in harbour during the September cyclone, and 6,051,393 dollars in October. The failure to appropriate the 4000 dollars asked for for the current fiscal year has reduced the warnings received from the West Indies, and made it less possible to predict with certainty the approach of tropical hurricanes." (Report for 1885, p. 4.)

The anticipations of the Chief Signal Officer have been fully confirmed.

In the face of such opposition I would ask what is the use of proposing schemes of confederation requiring the support of the authorities? There is no doubt that if meteorological confederation is to obtain in the West Indies, it must be done among the British colonies themselves; but who will come forward to undertake such a task? Should anyone attempt it, he will at least have the support of Jamaica.

MAXWELL HALL,
February 15 Jamaica Government Meteorologist

Units of Weight, Mass, and Force

YOUR reviewer, of the well-known initials "P. G. T.," has taken exception to some of the terminology employed by Mr. Anderson in his book "On the Conversion of Heat into Work," particularly to the expressions of "pounds on the square inch" and "tons on the square inch," which he says would define a superficial density if used in their proper sense; and it is this opinion I wish, with your permission, to dispute, as I think "P. G. T." and mathematicians generally, are at present in this endeavour to avoid one ambiguity in dynamical language only creating greater confusion.

I presume that "P. G. T." would have been satisfied with the above expressions provided the word "weight" had been introduced somewhere; but let us examine carefully what is implied by "weight" as used in ordinary language.

Turning to the chapter on elementary dynamical principles in Maxwell's "Theory of Heat," we find that "the word *weight* must be understood to mean the *quantity of the thing as determined by the process of weighing against standard weights.*" And again:—"In a rude age, before the invention of means for overcoming friction, the weight of bodies formed the chief obstacle to setting them in motion. It was only after some progress had been made in the art of throwing missiles, and in the use of wheel-[illegible] and floating vessels, that men's minds became practic[illegible] pressed with the idea of mass as distinguished from weight."

The language we employ, including the use of the ambiguous word "weight," was formed in this rude age before the discovery of true dynamical principles and before the theory of gravitation, and now, in order to avoid ambiguity, the mathematician uses, *wherever it is possible*, the word "mass" for greater precision, where an ordinary person would use the word weight.

But unfortunately for his principle the rules of language do not permit him to be consistent, and he is compelled to speak of "*weights* and measures" and of "bodies *weighing* so many pounds or tons" instead of "bodies *massing* so many pounds," or "*masses* and measures," which might be mistaken for a political phrase.

The word "weight" will, then, be found to be used in ordinary language in most cases in the same sense as the word "mass," introduced with laudable intention by the mathematicians to avoid confusion; but unfortunately some mathematicians introduce greater confusion than they remove by appropriating the word "weight" to the subsidiary sense of the word, undistinguishable by those ignorant of dynamics, namely, the force with which the earth attracts the weight.

Thus we find in ordinary treatises on dynamics, after an effort at the definition of the mass, the weight of a body defined as "the force with which it is attracted by the earth."

As Maxwell says, "The only occasions in common life in which it is required to estimate weight considered as a force is when we have to determine the strength required to lift or carry things, or when we have to make a structure strong enough to support their weight." Herein is comprised in general terms the whole province of the theory of engineering, and consequently the engineer always employs the gravitational measure of forces.

The force with which the earth attracts the standard weight is taken as the gravitation unit of force; and for brevity the force with which the earth attracts a pound weight (the mathematician would say a pound mass) is called the force of a pound, abbreviated again to "a pound." Hence we have steam pressures, gunpowder pressures, moduli of elasticity, tenacities, &c., as well as the expressions objected to by "P. G. T." in Mr. Anderson's book, expressed in pounds or tons on the square inch, without creating any confusion in the mind of the practical man; and we find the words "pound" or "ton" used side by side, now in the sense of weight or mass, and now in the sense of force; as, for instance, in the statement, "A train, weighing 100 tons, moving against a resistance of 20 pounds a ton, is drawn by an engine exerting a pull of 2 tons, &c."

But when the practical man opens the ordinary text-book on dynamics, then the confusion begins. Take, for instance, the familiar equation $W = Mg$: what does it mean? The writers tell us that W means the weight and M the mass of the body. Having defined "weight" as the force with which the body is attracted by the earth, the writer implies that he is keeping to the statical gravitational unit of force, and therefore his unit of mass is the mass of g pounds, if W, the weight, is measured in pounds. But, after defining a pound as a unit of mass, he ought to take M as the weight in pounds, and then the equation $W = Mg$ means that the earth attracts M pounds with a force of W poundals where $W = Mg$.

The confusion is intolerable ("most tolerable, and not to be endured"), and entirely due to the erroneous mathematical definition of the word "weight," combined with straining the units of mass and force so as to fit into the equation $P = Mf$, when absolute units are not employed.

To show the absurdity of the definition that "the weight of a body is the force with which it is attracted by the earth," take the question, "What is the weight of the earth?" Accord-

ing to this definition, the answer is "Zero," but ordinary people would calculate the result in millions of tons, from the data of the mean radius and the mean density.

Take again a question of a similar nature: "Prove that 288 pounds at the pole weigh the same as 289 pounds at the equator." To realise this question we must imagine a balance constructed of which the arm is curved into a quadrant of the earth, reaching along a meridian from the pole to the equator, and supported by a fulcrum in latitude 45°; then 288 pounds at the pole will equilibrate 289 pounds at the other end of the balance at the equator. Without requiring a balance with so long an arm, we [illegible] have 289 pounds at the bottom of the shaft of a mine weighing the same as 288 pounds at the surface, provided the shaft is [illegible]nt depth.

[illegible]e years ago, being troubled myself with this confusion of [illegible]ge, I wrote to Prof. Maxwell to ask him for a good illustrative example of the correct and incorrect use of the word "weight," and received the following characteristic reply on a postcard:—"Compare St. John xix. 39, ὡσεὶ λίτρας ἑκατόν, with the A.V. (authorised version), and keep to the original Greek." The translation in the authorised version is "about a hundred pounds *weight*."

Here we see that Maxwell recognised the ambiguous nature of the word "weight," and advised its omission wherever possible; but the exigencies of language compel us to use it; and in fact we shall generally find writers, even after the above incorrect definition of weight, proceed subsequently to use the word in its ordinary meaning of daily life.

I wish to repeat that writers on dynamics only create confusion in appropriating the word "weight" to the sense of the force of attraction of the earth on a body, as we never speak of "a force *weighing* so many pounds"; and I wish to support the language in ordinary use by engineers and practical men as perfectly correct in using the words "pound" or "ton" side by side in two senses, first as meaning the weight (or mass) of a body, and secondly as meaning the force with which the body is attracted by the earth; one being sometimes distinguished as a pound weight, and the other as a pound force.

If we use Prof. James Thomson's admirable word "poundal" for the British absolute unit of force, this slight confusion of terms will disappear, although engineers will still continue to think in gravitation units of force, as gravity is the one universal force from which there is no escape; and I fear it will be impossible ever to persuade them to think in C.G.S. units like the centimetre, gramme, dyne, erg, &c., which, though admirably adapted for the minute measurements of experiments in physics, are unsuitable for large magnitudes.

In conclusion, let the equation $W = Mg$ be dismissed from the text-books, as leading to statements such as "The mass of a body weighing W pounds is $\frac{W}{g}$;" the true equivalent equation being $W = M$, and therefore unnecessary; and with it let the confusing "astronomical unit of mass" disappear, and introduce instead the "constant of gravitation" in our equations. Let us also recognise that the primary idea of "weight" is the same as "mass," and form our dynamical definitions on the usages of ordinary language.

A. G. GREENHILL.

Woolwich, February 28

Mr. Herbert Spencer's Definition of Life

I HAVE read with much interest the report in NATURE of Prof. Judd's address to the Geological Society, in which he attempts to show that Mr. Herbert Spencer's definition of life is not restricted to those cases only which display the ordinarily acknowledged characteristics of vitality; a certain correspondence between internal and external changes being displayed by minerals.

I write to draw attention to what I think tends to show that the mass of evidence brought forward really tells *in favour* of the definition; bearing in mind that the hypothesis of evolution "implies insensible modifications and gradual transitions, which render definition difficult—which make it impossible to separate absolutely the phases of organisation from one another" ("Principles of Biology," vol. ii. p. 10), and that consequently there can be no "absolute" commencement of life.

The fact, treated by Mr. Spencer when seeking a definition of life, that there is a correspondence between life and its circumstances gives the clue showing us that the "vitality of minerals" is a misnomer; a fallacy he himself exposes when he treats of the internal actions—the feathery crystallisation—displayed by the misnamed storm glass in correspondence with external changes. Using his own words, we see that:—

"Subtle as is the dependence of each internal upon each external change, the connection between them does not, in the abstract, differ from the connection between the motion of a straw and the motion of the wind that disturbs it. In either case a change produces a change, and there it ends. The alteration wrought by some environing agency on an inanimate object, does not tend to induce in it a secondary alteration, that anticipates some secondary alteration in the environment. But in every living body [in a living body, mark!] there is a tendency towards secondary alterations of this nature; *and it is in their production that the correspondence consists.* The difference may be best expressed by symbols. Let A be a change in the environment; and B some resulting change in an inorganic mass. Then A having produced B, the action ceases. Though the change A in the environment, is followed by some consequent change *a* in it; no parallel sequence in the inorganic mass simultaneously generates in it some change *b* that has reference to the change *a*. But if we take a living body of the requisite organisation, and let the change A impress on it some change C; then, while in the environment A is occasionally *a*, in the living body C will be occasioning *c*: of which *a* and *c* will show a certain concord in time, place, or intensity. . . . ." (vol. i. p. 78).

"That the word *correspondence* will not include, without straining, the various relations to be expressed by it," is best met by the reply "that we have no word sufficiently general to comprehend all forms of this relation between the organism and its medium, and yet sufficiently specific to convey an adequate idea of the relation; . . . The fact to be expressed in all cases is, that certain changes, continuous or discontinuous, in the organism, are connected after such a manner that, in their amounts, or variations, or periods of occurrence, or modes of succession, they have a reference to external actions, constant or serial, actual or potential—a reference such that a definite relation among any members of the one group, implies a definite relation among certain members of the other group; and the word *correspondence* appears the best fitted to express this fact." (vol. i. p. 79).

In deer-stalking we see a realisation of these symbols. In the deer the primary internal change—the perception of odour, or, as I believe it is called, "winding"—is followed by that secondary internal change which induces a desire to increase the distance between the living organism and the inferred source of danger, a change differing not only in degree, but in kind, differing *toto cælo* from any of those actions which take place in minerals and crystals.

That the address contains many valuable facts furthering not only Mr. Spencer's view of life, but also his views of evolution, becomes apparent when we consider how it carries out and develops these ideas to an extent which would have been impossible at the time when the "Principles of Biology" were first published, now twenty years since. I say "furthering," for I wish now to touch upon a very important point, which I cannot but think has been much enlarged and amplified by Prof. Judd. It is to the much more expanded meaning which can now be attached to the fact *that the degree of life varies as the degree of correspondence between internal and external relations.*

For the correspondence displayed by a crystal or mineral is shown to be of a very much lower degree than that displayed by the simplest plant or animal. These latter present correspondences of greater complexity, greater rapidity, and greater length in the series of them than the former, which, during its long "millions of years," can respond only to the two or three forms of molar and molecular forces alluded to. The changes in the mineral simply respond to changes in the environment; whereas in an organism it is a *relation* between changes in it which responds to a *relation* between changes in the environment.

Churchfield, Edgbaston F. HOWARD COLLINS

An Equatorial Zone of almost Perpetual Electrical Discharge

THE recent reference in your columns to Edlung's theory of the aurora borealis, recalls a very curious observation that I

have made in my travels of a zone of almost perpetual electrical discharge in the belt of the "doldrums" all round the world.

Anywhere in that belt, a more or less intermittent display of sheet lightning commences the moment the twilight of sunset has sufficiently faded away, and continues with varying intensity till the light of morning prevents further observation.

The localisation of this belt of lightning is very obvious as we run a section across the equator on board ship. There is very little electrical discharge in the high-pressure belt of anti-cyclones which encircle the earth approximately under the lines of the tropics; but as we approach the low-pressure band of the "doldrums," where the two trade-winds, or the two monsoons meet, then the display of lightning is of nightly occurrence, even if there are no actual thunderstorms.

This electric discharge has a diurnal period like every other meteorological element; for night after night, as I have slept on deck in Malaysia during the change of the monsoons, I have noticed a very marked diminution of the lightning after 1 or 2 a.m. If a total eclipse of the sun could last for twelve hours, I have no doubt that we should see more or less lightning all the time, with a regular set of diurnal variations.

Edlung and others have noticed the gradual decrease in the frequency of thunderstorms as we recede from the equator; but I wish to show now, not only that the discharge is of nightly occurrence, but that the locality of maximum effect is not so much on the equator as in the "doldrums." The sheet lightning may be the reflection of distant thunderstorms, or it may be the silent discharge of electricity. Meteorologists are much divided as to the possibility of the latter; but it is certain that the amount of sheet lightning is out of all proportion to the frequency of actual thunderstorms.

Is it not possible that we may find in this perpetual lightning, some clue to the origin of earth-currents everywhere? and in the diurnal variation in the discharge, some probable reason for the hourly variation of the aurora, and of some magnetic elements? No doubt it is at present difficult to connect the electricity of lightning with the electro-magnetic effects of terrestrial magnetism or the aurora; and though Edlung's theory is defective in this respect, I cannot help thinking that he is right in collating thunderstorms on the equator with the glow discharge of electricity on the Arctic circle; and it is in the hope that the discovery of the constancy of electrical discharge in the "doldrums" may perhaps assist in the evolution of a true theory of the aurora, that I have penned this short notice.

RALPH ABERCROMBY

21 Chapel Street, London, March 15

Scorpion Virus

PROF. BOURNE'S experiments, related in the Proceedings of the Royal Society of January 6, 1887, seem to establish the fact that although the scorpion may be provoked to strike and wound itself or another scorpion, it is incapable, in either case, of causing any toxic action, however active the virus may prove in respect of other creatures. That it is, in short, with the scorpion as it is with the cobra or viper: they poison other creatures, but not themselves or each other.

Some years ago an exhaustive series of experiments brought me to the conclusion that a cobra is not poisoned by cobra virus, whether inoculated by its own fangs, by those of another cobra, or by a hypodermic syringe. The same in the case of daboia and other viperine snakes.

It seemed, however, that the bungarus, a less deadly snake than the cobra, occasionally is affected, though slowly, by the cobra virus, but that it escapes more frequently than it suffers; and when it does suffer the effect of the poison is greatly diminished. On the other hand, non-venomous snakes, lizards, frogs, fish, mollusca, and other low forms of life, all rapidly succumb to snake poison.

The details of these experiments are to be found in the "Thanatophidia of India," published in 1872, and in referring to them Prof. Bourne remarks: "They show conclusively that the cobra poison will not affect a cobra, and will not even affect the viperine ptyas." I would correct the latter part of the quotation so far as to say that the ptyas is a colubrine harmless snake, not a viperine snake, and that it rapidly succumbs to the cobra virus.

Prof. Bourne has helped to dispel another of the popular delusions which cling round venomous creatures.

March 14 J. FAYRER

THE RELATION OF TABASHEER TO MINERAL SUBSTANCES

MR. THISELTON DYER has rendered a great service, not only to botanists, but also to physicists and mineralogists, by recalling attention to the very interesting substance known as "tabasheer" (NATURE, vol. xxxv. p. 396). As he truly states, very little fresh information has been published on the subject during recent years, a circumstance for which I can only account by the fact that botanists may justly feel some doubt as to whether it belongs to the vegetable kingdom, while mi[illegible]eralogists seem to have equal ground for hesitati[illegible] accepting it as a member of the mineral kingdom.

It is very interesting to hear that so able a physio[illegible] as Prof. Cohn intends to investigate the conditions u[illegible] which living plants separate this substance from their tissues. That unicellular Algæ, like the Diatomaceæ, living in a medium which may contain only one part in 10,000 by weight of dissolved silica, or even less than that amount, should be able to separate this substance to form their exquisitely ornamented frustules is one of the most striking facts in natural history, whether we regard it in its physiological or its chemical aspects.

Sir David Brewster long ago pointed out the remarkable physical characters presented by the curious product of the vegetable world known as "tabasheer," though so far as I can find out it has not in recent years received that attention from physicists which the experiments and observations of the great Scotch philosopher show it to be worthy of.

Tabasheer seems to stand in the same relation to the mineral kingdom as do ambers and pearls. It is in fact an *opal* formed under somewhat remarkable and anomalous conditions which we are able to study; and in this aspect I have for some time past been devoting a considerable amount of attention to the minute structure of the substance by making thin sections and examining them under the microscope. It may be as well, perhaps, to give a short sketch of the information upon the subject which I have up to the present time been able to obtain, and in this way to call attention to points upon which further research seems to be necessary.

From time immemorial tabasheer has enjoyed a very high reputation in Eastern countries as a drug. Its supposed medicinal virtues, like those of the fossil teeth of China and the belemnites ("thunderbolts") of this country, seem to have been suggested by the peculiarity of its mode of occurrence. A knowledge of the substance was introduced into Western Europe by the Arabian physicians, and the name by which the substance is generally known is said to be of Arabic origin. Much of the material which under the name of "tabasheer" finds its way to Syria and Turkey is said, however, to be fictitious or adulterated.

In 1788 Dr. Patrick Russell, F.R.S., then resident [illegible] Vizagapatam, wrote a letter to Sir Joseph Banks in which he gave an account of all the facts which he had been able to collect with respect to this curious substance and its mode of occurrence, and his interesting letter was published in the Philosophical Transactions for 1790 (vol. lxxx. p. 273).

Tabasheer is said to be sometimes found among the ashes of bamboos that have been set on fire (by mutual friction?). Ordinarily, however, it is sought for by splitting open those bamboo stems which give a rattling sound when shaken. Such rattling sounds do not, however, afford infallible criteria as to the presence or absence of tabasheer in a bamboo, for where the quantity is small it is often found to be closely adherent to the bottom and sides of the cavity. Tabasheer is by no means found in all stems or in all joints of the same stem of the bamboos. Whether certain species produce it in greater abundance than others, and what is the influence of soil, situation,

and season upon the production of the substance are questions which do not seem as yet to have been accurately investigated.

Dr. Russell found that the bamboos which produce tabasheer often contain a fluid, usually clear, transparent, and colourless or of greenish tint, but sometimes thicker and of a white colour, and at other times darker and of the consistency of honey. Occasionally the thicker varieties were found passing into a solid state, and forming tabasheer.

Dr. Russell performed the interesting experiment of drawing off the liquid from the bamboo-stem and allowing it to stand in stoppered bottles. A "whitish, cottony sediment" was formed at the bottom with a thin film of the same kind at the top. When the whole was well shaken together and allowed to evaporate, it left a residue of a whitish-brown colour resembling the inferior kinds of tabasheer. By splitting up different joints of bamboo Dr. Russell was also able to satisfy himself of the gradual deposition within them of the solid tabasheer by the evaporation of the liquid solvent.

In 1791, Mr. James Louis Macie, F.R.S. (who afterwards took the name of Smithson), gave an account of his examination of the properties of the specimens of tabasheer sent home by Dr. Russell (Phil. Trans. vol. lxxxi., 1791, p 368). These specimens came from Vellore, Hydrabad, Masulipatam, and other localities in India. They were submitted to a number of tests which induced Mr. Macie to believe that they consisted principally of silica, but that before calcination some vegetable matter must have been present. A determination of the specific gravity of the substance by Mr. Macie gave 2·188 as the result; another determination by Mr. Cavendish gave 2·169.

In this same paper it is stated that a bamboo grown in a hot-house at Islington gave a rattling noise, and on being split open by Sir Joseph Banks yielded, not an ordinary tabasheer, but a small pebble about the size of half a pea, externally of a dark brown or black colour, and within of a reddish-brown tint. This stone is said to have been so hard as to cut glass, and to have been in parts of a crystalline structure. Its behaviour with reagents was found to be different in many respects from that of the ordinary tabasheer; and it was proved to contain silica and iron. The specimen is referred to in a letter to Berthollet published in the *Annales de Chimie* for the same year (October 1791). There may be some doubt as to whether this specimen was really of the nature of tabasheer; if such were the case, it would seem to have been a tabasheer in which a crystalline structure had begun to be set up.

In the year 1806, MM. Fourcroy and Vauquelin gave an account of a specimen of tabasheer brought from South America in 1804 by Humboldt and Bonpland (*Mém. de l'Inst.*, vol. vi. p. 382). It was procured from a species of bamboo growing on the west of Pichincha, and is described as being of a milk-white colour, in part apparently crystalline in structure, and in part semi-transparent and gelatinous. It was seen to contain traces of the vegetable structure of the plant from which it had been extracted. On ignition it became black, and emitted pungent fumes.

An analysis of this tabasheer from the Andes showed that it contained 70 per cent. of silica, and 30 per cent. of potash, lime, and water, with some organic matter. It would, perhaps, be rash to conclude from this single observation that the American bamboo produced tabasheer of different composition from that of the Old World; but the subject is evidently one worthy of careful investigation.

It was in the year 1819 that Sir David Brewster published the first account of his long and important series of observations upon the physical peculiarities of tabasheer (Phil. Trans., vol. cix., 1819, p. 283). The specimens which he first examined were obtained from India by Dr. Kennedy, by whom they were given to Brewster.

Brewster found the specimens which he examined to be perfectly *isotropic*, exercising no influence in depolarising light. When heated, however, it proved to be remarkably *phosphorescent*. The translucent varieties were found to transmit a yellowish and to reflect a bluish-white light—or, in other words, to exhibit the phenomenon of *opalescence*. When tabasheer is slightly wetted, it becomes white and opaque; but when thoroughly saturated with water, perfectly transparent.

By preparing prisms of different varieties of tabasheer, Brewster proceeded to determine its refractive index, arriving at the remarkable result that tabasheer "has a lower index of refraction than any other known solid or liquid, and that it actually holds an intermediate place between water and gaseous bodies!" This excessively low refractive power Brewster believes to afford a complete explanation of the extraordinary behaviour exhibited by tabasheer when wholly or partially saturated with fluids. A number of interesting experiments were performed by saturating the tabasheer with oils of different refractive powers, and by heating it in various ways and under different conditions, and also by introducing carbonaceous matter into the minute pores of the substance by setting fire to paper in which fragments were wrapped.

The mean of experiments undertaken by Mr. James Jardine, on behalf of Brewster, for determining the specific gravity of tabasheer, gave as a result 2·235. From these experiments Brewster concluded that the space occupied by the pores of the tabasheer is about two and a half times as great as that of the colloid silica itself!

From this time forward Brewster seems to have manifested the keenest interest in all questions connected with the origin and history of a substance possessing such singular physical properties. By the aid of Mr. Swinton, Secretary to the Government at Calcutta, he formed a large and interesting collection of all the different varieties of tabasheer from various parts of India. He also obtained specimens of the bamboo with the tabasheer *in situ*. In 1828 he published an interesting paper on "the Natural History and Properties of Tabasheer" (*Edinburgh Journal of Science*, vol. viii., 1828, p. 288), in which he discussed many of the important problems connected with the origin of the substance. From his inquiries and observations, Brewster was led to conclude that tabasheer was only produced in those joints of bamboos which are in an injured, unhealthy, or malformed condition, and that the siliceous fluid only finds its way into the hollow spaces between the joints of the stem when the membrane lining the cavities is destroyed or rent by disease.

Prof. Edward Turner, of the University of London, undertook an analysis of tabasheer, the specimens being supplied from Brewster's collection (*Edinburgh Journal of Science*, vol. viii., 1828, p. 335). His determinations of the specific gravities of different varieties were as follows:—

Chalky tabasheer	2·189
Translucent tabasheer	2·167
Transparent tabasheer	2·160

All the varieties lose air and hygroscopic water at 100° C., and a larger quantity of water and organic matter (indicated by faint smoke and an empyreumatic odour) at a red heat. The results obtained were as follows:—

	Loss at 100° C.	Loss at red heat
Chalky tabasheer	0·838 per cent.	1·277 per cent.
Translucent tabasheer	1·620 ,, ,,	3·840 ,, ,,
Transparent tabasheer	2·411 ,, ,,	4·518 ,, ,,

Dr. Turner found the ignited Indian tabasheer to consist almost entirely of pure silica with a minute quantity

of lime and vegetable matter. He failed to find any trace of alkalies in it.

In 1855, Guibourt (*Journ. de Pharm.* [3], xxvii. 81, 161, 252; *Phil. Mag.* [4], x. 229) analysed a specimen of tabasheer having a specific gravity of 2·148. It gave the following result :—

Silica	= 96·94
Potash and lime	= 0·13
Water	= 2·93
Organic matter	= trace

Guibourt criticised some of the conclusions arrived at by Brewster, and sought to explain the source of the silica by studying the composition of different parts of the bamboo. While the ashes of the wood contained 0·0612 of the whole weight of the wood, the pith was found to contain 0·448 per cent., the inner wood much less, and the greatest proportion occurred in the external wood. On these determinations Guibourt founded a theory of the mode of formation of tabasheer based on the suggestion that at certain periods of its growth the bamboo needed less silica than at other times, and that when not needed, the silica was carried inwards and deposited in the interior.

In the year 1857, D. W. Rost van Tonningen, of Buitenzorg, undertook an investigation of the tabasheer of Java, which is known to the natives of that island under the name of "singkara" (*Naturkundig Tijdschrift voor Nederlandsch Indie*, vol. xiii., 1857, p. 391). The specimens examined were obtained from the *Bambusa apus* growing in the Residency of Bantam ; it is described as resembling in appearance the Indian tabasheers. Its analysis gave the following result :—

Silica	= 86·387
Iron oxide	= 0·424
Lime	= 0·244
Potash	= 4·806
Organic matter	= 0·507
Water	= 7·632
Total ...	100·000

Apart from the question of its singular mode of origin, however, and its remarkable and anomalous physical properties, tabasheer is of much interest to mineralogists and geologists. All the varieties hitherto examined, with the exception of the peculiar one from the Andes, are in composition and physical characters true opals ; this is the case with all the Indian and Java varieties. They consist essentially of silica in its colloidal form, the water, lime, potash, and organic matter being as small and variable in amount as in the mineral opals ; and, as in them, these substances must be regarded merely as mechanical impurities.

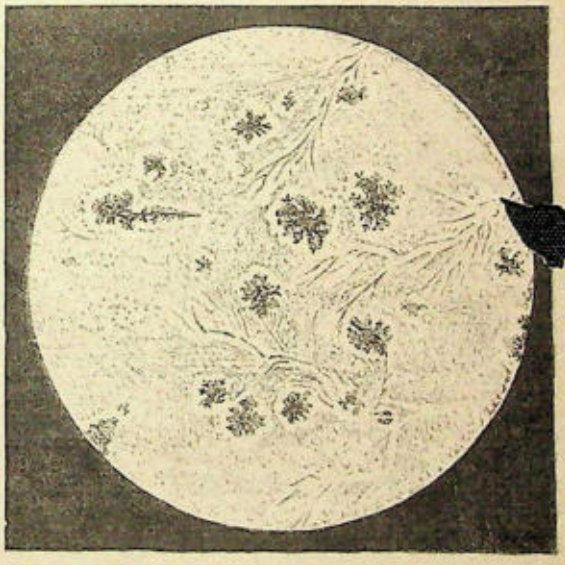
The tabasheers must be studied in their relations on the one hand with certain varieties of the natural semi-opals, hydrophanes, beekites, and floatstones, some of which they closely resemble in their physical characters, and on the other hand with specimens of artificially deposited colloid silica formed under different conditions. Prof. Church, who has so successfully studied the beekites, informs me that some of those remarkable bodies present singular points of analogy with tabasheer.

By the study of thin sections I have, during several years, been endeavouring to trace the minute structure of some of these substances. In no class of materials is it more necessary to guard one's self against errors of observation arising from changes induced in the substance during the operations which are necessary to the preparation of transparent sections of hard substances. Unfortunately, too, it is the custom of the natives to prepare the substance for the market by an imperfect calcination, and hitherto I have only been able to study specimens procured in the markets which have been subjected to this process. It is obviously desirable, before attempting to interpret the structures exhibited under the microscope, to compare the fresh and uncalcined materials with those that have been more or less altered by heat.

Tabasheer would seem, from Brewster's experiments, to be a very intimate admixture of two and a half parts of air with one part of colloidal silica. The interspaces filled with air appear, at all events in most cases, to be so minute that they cannot be detected by the highest powers of the microscope which I have been able to employ. It is this intimate admixture of a solid with a gas which probably gives rise to the curious and anomalous properties exhibited by this singular substance.

The ultra-microscopical vesicles filled with air in all probability give rise to the opalescence which is so marked a property of the substance. Their size is such as to scatter and throw back the rays at the blue end of the spectrum and to transmit those at the red end.

When the vesicles of the substance are filled with Canada balsam, and a thin slice is cut from it, this opalescence comes out in the most striking manner ; very thin sections are of a rich orange-yellow by transmitted light, and a delicate blue tint by reflected light.



Section of Indian tabasheer, seen with a magnifying power of 250 diameters.

I do not know of any substance which in such thin films displays such striking opalescence.

That the excessively low refractive power of tabasheer is connected with the mechanical admixture of the colloidal silica with air seems to be proved by the experiments of Brewster, showing that with increase of density there was an increase in the refractive index from 1·111 in specimens of the lowest specific gravity, to 1·182 in those of the highest specific gravity. Where the surface was hard and dense, Brewster found the refractive index to approach that of semi-opal. The wonderful thing is that a substance so full of cavities containing gas should nevertheless be transparent.

By the kindness of Mr. F. Rutley, F.G.S., I am able to supply a drawing taken from one of my sections of tabasheer.

The accompanying woodcut gives some idea of the interesting structures exhibited in some sections of tabasheer, though much of the delicacy and fidelity of the original drawing has been lost in transferring it to the wood.

In this particular case, the faint punctation of the surface may possibly indicate the presence of air-vesicles

of a size sufficiently great to be visible under the microscope. But in many other instances I have failed to detect any such indication, even with much higher powers. The small ramifying tubules might at first sight be taken for some traces of a vegetable tissue, but my colleague Dr. Scott assures me that they do not in the least resemble any tissue found in the bamboo. I have myself no doubt that it is an inorganic structure. It is not improbably analogous to the peculiar ramifying tubules formed in a solution of water-glass when a crystal of copper sulphate is suspended in it, as shown by Dr. Heaton (Proc. Brit. Assoc., 1869, p. 127). Similar forms also occur on a larger scale in some agates, and the artificial cells of Traube may probably be regarded as analogous phenomena.

The aggregates of globular bodies seen in the section do greatly resemble the globulites of slags and natural glasses, and in their arrangement so forcibly recall the structures seen in the well-known pitchstone of Corriegills in Arran, that one is tempted to regard them as indicating the beginnings of the development of crystalline structure in the tabasheer. But I have good grounds for believing the structure to have a totally different origin. They seem in fact to be the portions of the mass which the fluid Canada balsam has not succeeded in penetrating. By heating they may be made to grow outwards, and as more balsam is imbibed they gradually diminish, and finally disappear.

I must postpone till a future occasion a discussion of all the structures of this remarkable substance and of the resemblances and differences which they present to the mineral opals on the one hand, and to those of the opals of animal origin found in sponge spicules, radiolarians, and the rocks formed from them, some of which have recently been admirably investigated by Dr. G. J. Hinde (Phil. Trans., 1885, pp. 425-33).

I cannot, however, but think that it would be of the greatest service to botanists, physicists, and mineralogists alike, if some resident in India would resume the investigations so admirably commenced by Dr. Patrick Russell nearly a century ago; and it is in the hope of inducing someone to undertake this task that I have put together these notes. There are certain problems with regard to the mode of occurrence of this singular substance which could only be solved by an investigator in the country where it is found.

Most parcels of the commercial tabasheer appear to contain different varieties, from the white, opaque, chalk-like forms, through the translucent kinds to those that are perfectly transparent. It would be of much interest if the exact relation and modes of origin of these different varieties could be traced. It would also be important to determine if Brewster was right in his conclusion that the particular internodes of a bamboo which contain tabasheer always have their inner lining tissue rent or injured. The repetition of Dr. Russell's experiment of drawing off the liquids from the joints of bamboos and allowing them to evaporate is also greatly to be desired. My colleague Prof. Rücker, F.R.S., has kindly undertaken to re-examine the results arrived at by Brewster in the light of more recent physical investigations, and I doubt not that some of the curious problems suggested by this very remarkable substance may ere long find a solution.

JOHN W. JUDD

EXHIBITION OF MARINE METEOROLOGICAL INSTRUMENTS

THE eighth Annual Exhibition of the Royal Meteorological Society was held in the Library of the Institution of Civil Engineers, 25 Great George Street, Westminster, from Tuesday, March 15th, to Friday, the 18th. The exhibition was specially devoted to marine meteorological instruments and apparatus, and such new instruments as have been invented and first constructed during the past twelve months.

A very interesting and valuable collection of instruments from the *Challenger* Commission, the Scottish Marine Station at Granton, the Scottish Meteorological Society, and Mr. J. Y. Buchanan, were brought from Edinburgh under the charge of Dr. H. R. Mill, who showed several in action. This set included various forms of deep-sea thermometers, from the early pattern of the Miller-Casella to the Scottish frame for Negretti and Zambra's reversing thermometer, which has been adapted from Magnaghi's by Dr. Mill. Two specimens of the Miller-Casella thermometer, after four months' immersion in brackish water, were shown, with the following results: in No. 1, which was placed at the surface, the copper case was clean, but the scale figures were entirely obliterated from the porcelain; in No. 2, which was suspended in 9 fathoms, and at 1 foot above the bottom, the copper was entirely covered with a green crust, but the scale figures were not rendered illegible. Various forms of piezometers for ascertaining the depth when the temperature is known, or the temperature when the depth is known, were also exhibited. These were nearly all constructed by Mr. Buchanan on board the *Challenger*. Water-bottles for obtaining samples of water at the bottom, or any required depth below the surface, were suspended from the gallery to show their action when in use. The most interesting were Buchanan's sounding-rod and water-bottle for great depths, and Mill's self-locking slip water-bottle for moderate depths.

The Meteorological Council contributed sets of instruments as supplied to merchant ships and the Royal navy; the Royal Meteorological Institute of the Netherlands exhibited a set as supplied to the Dutch navy; and the Deutsche Seewarte sent a set as issued to the German navy.

The Rev. C. J. Steward exhibited a set of instruments as used at the Lochbuie Marine Institute, Isle of Mull, which, among others, included a dimenuion thermometer in a box for river temperatures, the box being suitable for the bottoms of pools, or rough stony bottoms; and a large disk for ascertaining the transparency of the sea.

In connexion with the deep-sea thermometers Mr. Casella showed some apparatus originally employed in testing these instruments for the Admiralty and the Royal Society, and damaged during the experiments; viz., a bottle broken at a pressure corresponding to 2½ miles of sea-water, a steel bar bent at 3 miles, and an iron plug broken at 4 miles. Specimens of almost every pattern of deep-sea thermometer were exhibited, including Johnson's registering metallic, the records of which are obtained by the varying expansion of brass and steel bars acting upon indices; Miller-Casella maximum and minimum; and Negretti and Zambra's turnover thermometer.

The barometers exhibited included patterns used in the British, Dutch, French, and German navies. The English marine barometer has an iron cistern and contracted scale, and the gun barometer is mounted with india-rubber packing to prevent breakage caused by gun-firing. MM. Richard Frères, of Paris, sent one of their self-recording aneroids, for use on board ship; and Mr. Abercromby showed several curves taken at sea by one of these instruments in various parts of the world.

The anemometers shown were: Sir Snow Harris's, which is an improved form of Lind's; Hagemann's, Robinson's, Black's pressure, and Whipple's maximum pressure, the latter being quite a new instrument. Dr. Black exhibited his marine rain-gauge and evaporator. Among the miscellaneous instruments were various forms of patent logs, current meters, clinometers, and a model of a section of a vessel fitted with lightning conductor.

In addition to the instruments, a number of charts

diagrams, &c., were exhibited, showing the meteorological conditions prevailing over the various oceans of the globe. The advance made in synoptic meteorology over the North Atlantic was clearly shown by comparing Leverrier's charts (1864) with the daily synchronous weather charts just published by the Meteorological Council. The specimens exhibited of the latter were (1) August 1-6, showing the meteorological conditions in the summer; (2) February 9-14, showing the conditions in the winter; and (3) February 24 to March 4, showing the conditions in early spring, and the persistence of the European anticyclone, producing cold dry winds over England. The Meteorological Council also exhibited a set of large charts showing the mean temperature of the sea surface round the coasts of the British Isles for each month. Dr. Mill had several interesting diagrams showing the distribution of temperature in a section of the Clyde sea area at seven periods from April 1886 to February 1887. Mr. Abercromby exhibited forty-six photographs and diagrams of clouds taken in various parts of the world; and Mr. Dyason showed a number of coloured drawings of clouds, &c. The Astronomer Royal sent the photographic registers of magnetic declination and horizontal force at the Royal Observatory, Greenwich, showing the earthquake shock which occurred on the morning of February 23.

The most interesting of the new instruments was the Watkin aneroid with open scale, by Mr. Hicks. Instead of the usual one-circle of figures, the scale of this instrument consists of a spiral of three complete turns. On the aneroid being put under an air-pump or taken up a mountain, the point of the index is gradually drawn *towards* the centre, so that it follows the *decreasing* spiral scale; but when the index moves in the opposite direction, the point moves *away* from the centre, thus following the *increasing* spiral. This is effected by the index-hand being made to slide in and out, so that one end may advance or recede from the centre, and thus follow the spiral scale. Attached to the spindle is a cross-piece, in which the index slides, and a hollow drum fixed to the dial-plate has a flexible chain or cord wound round it, the ends being fastened on the projecting pins riveted to the index. Consequently, if the spindle and the piece attached to it are revolved, one portion of the chain or cord winds off the drum, the other is wound on to the same extent, and the index is caused to slide through the cross-piece, the direction of motion being controlled by the direction in which the spindle is revolved.

MM. Richard Frères sent specimens of their self-recording thermometer, hygrometer, dry and wet bulb thermometers, and rain-gauge.

GEOGRAPHY AT THE UNIVERSITIES

AT last, after years of apparently fruitless labour, the Royal Geographical Society have been eminently successful in persuading almost simultaneously the two great English Universities to recognise geography as a University study, and to make definite provision for teaching it. In pursuance of a proposal made by the President and Council of the Royal Geographical Society to the Vice-Chancellors of the two Universities, and of the replies thereto, a deputation of a few members of their Council visited Oxford and Cambridge in turns, to meet delegates appointed by those Universities, in order to explain their proposal more fully, and to discuss any modifications that might be suggested. The main features of the proposal were, that the Royal Geographical Society offered to give 150*l.* annually to each University if they would establish a Lectureship or Readership in Geography, giving the Lecturer an adequate University status, and contributing, on their part, an equal sum, so as to raise the stipend of each Lectureship to 300*l.* They also offered to give the two Universities a Scholarship or Exhibition of 100*l.* in alternate years for geographical students. The Royal Geographical Society was to be represented on the Board that selected the Examiners, and on that which adjudged the Scholarship.

The meeting at Oxford with delegates from that University, including the present and past Vice-Chancellors, took place five weeks ago, at which the proposal was well discussed and favourably entertained, subject to the foreseen difficulty of finding adequate funds from the University resources; nevertheless everything seemed in train for its being eventually carried out, though after a little delay, in the intended manner. An unexpected incident, however, gave a new and collateral impulse, and has hurried the Lectureship into existence at once. It happened that the Readership in Ancient History became vacant, and it seems to have occurred to those with whom the election of a successor rested, that as there was a great difficulty in finding funds for geography, and as a Professorship of Ancient History was already in existence, and, again, as ancient history was taught by most classical tutors, the Readership in Ancient History might be abolished without much loss, and one in geography might be with propriety established in its place. There was a nearly even division of opinion on the matter, but the vote for geography prevailed and carried the day, and the advertisement inviting candidates has already been published. So Oxford now takes an independent line, and accepts only the offer of the Scholarship.

The Cambridge meeting took place about three weeks ago. The proposal was carefully discussed, and modifications were asked for. At Cambridge, as at Oxford, the University funds are seriously embarrassed by engagements already entered into, chiefly connected with building operations; and there seemed no way, so narrow was the available surplus, of raising the whole of the annual amount of 150*l.* in a direct form, but only 50*l.* of it. However, it appeared that indirect means existed by which this nominal sum would indirectly and eventually be raised to even something more than the proposed amount, and an amendment specifying only 50*l.* was therefore provisionally accepted. After this had received the approval of the Council of the Royal Geographical Society, it was submitted to the Council of the University of Cambridge, and adopted by them in the terms of the following recommendation:—

"That the approval of the Senate be given to the delivery in the University in the ensuing academical year of one or more courses of lectures on geography by lecturers selected by the Royal Geographical Society, that a teacher of geography be appointed by a Committee on which the Royal Geographical Society is represented, and that the Senate accept the proposal of the Royal Geographical Society to award in alternate years an Exhibition of 100*l.* or prizes of [illegible] and 25*l.* That before the end of the Easter Term, 18[illegible] a University Lecturer in Geography be appointed, for a period of five years, at a stipend of 200*l.* a year, of which sum 50*l.* is to be paid out of the common University fund and 150*l.* by the Royal Geographical Society. The appointment of the Lecturer to be made by a joint Committee of the representatives of the Royal Geographical Society and of the Council of the Senate, subject to the confirmation of the Senate; the Lecturer to submit his scheme of lectures to the Committee of Management; and power is to be given to the Council of the Senate, with the concurrence of the Committee of Management, to cancel the appointment of the Lecturer at any time."

This recommendation has to be submitted to the Senate at the beginning of next term, but its ultimate acceptance is placed almost beyond doubt through the very favourable reception given to the proposals of the Royal Geographical Society by the Council of the University.

THE ORGANISATION OF INDUSTRIAL EDUCATION

THE following is the letter by Prof. Huxley to which reference is made in our leading article (p. 482):—

"When a statesman of Lord Hartington's authority concurs with and enforces the opinions I ventured to express some little time ago, I have every reason for private and personal satisfaction. But the circumstance has a public importance as evidence that our political chiefs and leaders are giving their serious attention to those social questions which lie far above the region of party strife, and are of infinitely greater moment than the topics which ordinarily absorb the attention of politicians.

"The organisation of industrial and commercial education is not the least of these great problems. That it has to be solved, under penalty of national ruin, proves to be no mere alarmist fancy, but the belief of an experienced man of affairs, whose imperturbable coolness and strong common-sense are proverbial.

"It is an interesting question for us all, therefore, How do we stand prepared for the task thus imperatively set us? My conviction is that we are in some respects better off than most people imagine, in others worse. I conceive that two things are needful: on the one hand, a machinery for providing instruction and gathering information; on the other hand, a machinery for catching capable men wherever they are to be found and turning them to account. Now, I apprehend that both these kinds of machinery are to be found, though in a fragmentary and disconnected condition, in several organisations which, though independent, supplement one another.

"The first of these is that of the School Boards, which provide elementary education, and sometimes, though too rarely, have at their disposal scholarships by which capable scholars can attain a higher training. The second is the organisation of the Department of Science and Art. The classes, now established all over the country in connexion with the Department, not only provide elementary instruction, accessible to all, but offer the means whereby the pick of the capable students may obtain in the schools at South Kensington as good a higher education in science and art as is to be had in the country. It is from this source that the supply of science and art teachers, who in turn raise the standard of elementary instruction, is derived. The third organisation is that of the technical classes connected with the City and Guilds Institute, or with the Society of Arts, or with provincial Universities and Colleges, which provide special technical instruction for those who have, or ought to have, already acquired the elements of scientific and artistic knowledge in the science and art classes.

"A fourth organisation for the advancement of the interests of industry and commerce, of the nature of that which I imagined it was the intention of the founders of the Imperial Institute to create, and such as is, I believe, now actually in course of creation in the City of London, will complete the drill-grounds of the army of industry, and, so far as I can judge, omit nothing of primary importance. But, leaving the last aside as still in the embryonic condition, these excellent organisations are all mere torsos, fine—but fragmentary.

"The ladder from the School Boards to the Universities, about which I dreamed dreams many years ago, has not yet acquired much more substantiality than the ladder of Jacob's vision.

"The Science and Art Department has done, and is doing, admirable work, which I regret to see more often made the subject of small and carping criticism than of the praise which is its due. I trust it may not be diverted from efficiently continuing that work by having duties for which it is unfit forced upon it. That which the Department needs, in my judgment, is nothing but the means of doing that which Commission after Commission, Royal and departmental, have declared to be its proper business.

"As Dean of the Normal School I may be permitted to declare that it is impossible for us to perform the functions allotted to us unless the recommendations made by impartial and independent authority are carried into effect.

"The school exists, and common-sense surely suggests either make it efficient or abolish it. The alternative of abolition is not likely to be adopted, as that step would be equivalent to striking the keystone out of the edifice of scientific instruction for the masses of the people which it has taken a quarter of a century to raise, and which is the essential foundation for any sound system of technical education. The alternative of efficiency means spending a few thousand pounds on additional buildings; but the guardians of the national purse do not seem to feel the force of the adage about 'spoiling a ship for a halfpennyworth of tar.'

"The state of affairs in regard to that which ought to be the centre of our system of technical education is nearly the same. The Central Institute is undoubtedly a splendid monument of the munificence of the City. But munificence without method may arrive at results indistinguishably similar to those of stinginess. I have been blamed for saying that the Central Institute is 'starved.' Yet a man who has only half as much food as he needs is indubitably starved, even though his short rations consist of ortolans and are served up on gold plate. And I have excellent authority for saying that little more than one-half of the plan of operations of the Institute, drawn up by the Committee of which I was a member, has been carried out, or can be carried out, if the funds allotted for the maintenance of the Institute are not largely increased. At the same time, the Institute is doing all that could be rationally expected of it. Some of the guilds and many provincial towns are making admirable provision for elementary technical education. Such work, in my judgment, ought to be left to local administrators, whatever aid it may be thought desirable to give them. But the local schools should be brought into relation with the Central Institute, and this should be put upon such a footing as to subserve its proper purpose of training teachers and giving higher technical instruction.

"Economy does not lie in sparing money, but in spending it wisely. And it is, to my mind, highly necessary that some man or body of men, whom their countrymen trust, should consider these various organisations as a whole and determine the manner in which they should be correlated and in which it is desirable that the resources, public and private, which are available should be distributed among them.

"Lord Hartington has many claims on the gratitude and respect of his countrymen. I venture to express the wish that he would add to them by taking up this great work of organising industrial education and bringing it to a happy issue."

AUGUST WILHELM EICHLER

THE death of Dr. August Wilhelm Eichler, briefly announced in a previous number, is a great loss to botanical science, and especially to systematic botany. Year by year we are losing men of wide and consequently sound knowledge of plants without their places being adequately filled. We have doubtless arrived at a stage in botany where specialists are necessary; yet we venture to assert that men of general attainments are better qualified than specialists, in a narrow sense, for the head of large botanical establishments, such as the one over which the late Dr. Eichler presided, and which greatly extended its reputation during the nine years he was Director.

Dr. Eichler was barely forty-eight years of age, but before entering upon the absorbing duties connected with the University and Botanic Garden of Berlin he had already made a name as a botanical author.

For some years he was assistant to Von Martius at Munich, and succeeded him as editor of the colossal "Flora Brasiliensis," now nearly completed. This was in 1868, but he had previously been a considerable and excellent contributor to this work, having elaborated several difficult families in a masterly manner. The work by which he is more generally known is the "Blüthendiagramme," in which he admirably illustrates and explains the morphology and organogeny of the Phanerogamia. His labours were chiefly in the direction of morphology. His continued careful study of the female flower of the Coniferæ may be regarded as having finally settled the homologies of the different elements of the inflorescence of that family. One of his later contributions to science, if not his last, is entitled "Zur Entwickelungsgeschichte der Palmenblätter," in which the author fully elucidates the development of the various types of leaf in the Palmæ.

As a lecturer Dr. Eichler was exceedingly popular and successful; and he was regarded as an able administrator of the Botanic Garden. He was successively Professor of Botany at Munich, Gratz, Kiel, and Berlin, having been appointed to the last post in 1878. Two years later, "at the comparatively youthful age of thirty-nine," he was chosen a member of the Berlin Academy of Sciences; and in 1881 he was elected Foreign Member of the Linnean Society of London. He was also honorary and corresponding member of many other learned societies; and all who knew him, however slightly, will join in regretting his early death.

NOTES

Baron Eggers, commissioned by Dr. Urban and assisted by the Royal Academy of Sciences of Berlin, is about to undertake the botanical investigation of the hitherto unexplored higher mountains of St. Domingo. The specimens collected for distribution will be arranged (under corresponding numbers) in two series. One will consist only of species which have not yet been distributed in Baron Eggers' West Indian collections; the other and larger series will include everything except the commonest tropical species. The first-named series will be disposed of at forty shillings per century, the latter at thirty shillings. Dr. J. Urban, assisted by other systematists, will determine the collections and receive the names of subscribers. As the expense and difficulty of transit in the island must limit the number of collections for sale, early application to Dr. Urban is desirable. Dr. Urban's address is Friedenau, bei Berlin.

A conversazione given by the Council of the City and Guilds of London Institute was held at the Central Institution, Exhibition Road, on Wednesday evening, the 16th inst., and was attended by about 1300 visitors. Lord Selborne received the guests. A large number of interesting objects of scientific and artistic interest were exhibited, and during the evening demonstrations were given by the Professors in the various departments, as well as by several gentlemen who are associated with the work of the Institute.

On the 15th inst. a meeting was held at Grimsby to consider the expediency of establishing there an Institution for Technical Education with regard to Fish and Fisheries, and a Marine Fish-Culture Station. Mr. W. Oldham Chambers, Secretary of the National Fish-Culture Association, pointed out to the meeting the advantages of the proposed Station and Institute. Resolutions in support of the scheme were unanimously adopted, and an influential local Committee was appointed to further the object in view. Letters have been received from the various Fish Trade Associations and other bodies, heartily approving of the undertaking. The Manchester, Sheffield, and Lincolnshire Railway Company are prepared to grant a site for the Institute, and to erect a building, free of cost, at Cleethorpe, near Grimsby.

We are sorry to see that the income of the Mason Science College, Birmingham, during the year ending "Founder's Day," February 23, fell short of the expenditure by the sum of 1646*l*. After deducting what may be termed extraordinary expenditure, there remained a deficiency of 1074*l*. The Council, in their last report, remind the Trustees that the annual deficits, which since 1881 have been charged against the accumulated surplus, have now reduced this fund to the sum of 1419*l*., and that the estimates for the current financial year anticipate that the balance of the fund will be required. It is not creditable to the well-off citizens of Birmingham that an institution capable of doing great work for their town and district should have to meet these constantly recurring deficiencies.

The spring meeting of the Institution of Mechanical Engineers, under the presidency of Mr. E. H. Carbutt, will take place on Monday, May 16, and the following day. On Tuesday, May 17, the Duke of Cambridge will dine with the members of the Institution.

In order to determine between the rival sites for the Sedgwick Memorial Museum at Cambridge, and at the same time advance the chances of proceeding early with a portion at least of the building, the Council of the Senate propose to submit a grace next term to settle the question of site. The grace will take the form of authorising negotiations with Downing College for a site opposite the old Botanic Garden. If this be rejected, the latter affords the only practicable site.

Miss Gordon has presented to the Museum of the Royal Gardens, Kew, the collections and drawings made by her late brother, General Gordon, illustrative of the Coco de Mer (*Lodoicea seychellarum*), a palm peculiar to the Seychelles, and remarkable, among other things, for possessing the largest known seed in the vegetable kingdom. The seeds are well known in European museums. One amongst General Gordon's specimens is a model which he had made of the fruit in its mature state, before the external fibrous but perishable husk had become detached. Some of the specimens are placed, with others already possessed by Kew, in No. 2 Museum. The rest will be shown, with the drawings made by his own hand, in No. 3 Museum.

The Cambridge University Local Examination Report for the past year states that in zoology and physiology the answers showed very inefficient teaching. Botany is somewhat better done; but many senior candidates had not been taught the use of floral diagrams. In physical geography, while the answering was generally good, many had used antiquated text-books. Chemistry was fairly done, the candidates choosing, out of the alternative questions, the practical rather than the theoretical. Qualitative analysis was well done, both by seniors and juniors. The seniors showed general ignorance about the laws of multiple proportion, and combination by volume. Heat was badly done by both seniors and juniors. Many seemed never to have read any text-book, and to have presented themselves on the strength of a few isolated facts. Statics was very unequally mastered. There was better acquaintance with the mathematical than with the practical part of the subject. Electricity (senior subject) had not been studied seriously enough to warrant its inclusion in the examination. The mathematical subjects of the examination are reported on much more favourably.

THE botanical collections of the late Thomas Moore, F.L.S. Curator of the Botanic Garden at Chelsea, belonging to the Society of Apothecaries, have been acquired for the Herbarium of the Royal Gardens, Kew. The most important portions are:—(1) The general fern herbarium, which contains the types of the numerous species described by Moore, especially those introduced into European cultivation. (2) The collection of forms and varieties of British ferns, which is probably unique in richness and completeness; it is especially interesting as the basis of Mr. Moore's well-known and beautifully illustrated works on the fern flora of the British Isles. (3) The fern herbarium of R. Heward, F.L.S., which is especially strong in West Indian species.

BRITISH field botanists will be glad to learn that the Scottish Rights of Way Society has been successful in its action brought in the Court of Session against the proprietor of Glen Doll in Clova. Lord Kinnear has found that "the pursuers had established a sufficient use and possession of the road for more than forty years to entitle them to a judgment." There is probably no portion of the Highlands of Scotland from which botanists would feel it a greater hardship to be excluded. For years it has been so well watched by keepers that access to it has been impossible, except to such botanists as are swift and sure of foot. The present owner is the first who has denied a right of way through it, and, if we are not mistaken, the action only concerns this right to use the road. It is to be feared that efforts will not be wanting to confine the public to the road, and to deny all access to those parts so interesting to the field botanist.

A SERIES of charts showing the surface temperatures of the Atlantic coast waters, from the eastern coast of Maine to the extreme southerly coast of Florida, is being prepared by the United States Fish Commission. The Commission is aided in this important undertaking by the Lighthouse Board and the Signal Service. Observations have thus far been made at twenty-four lighthouse stations, showing the surface temperatures at these localities during the past five years. The temperatures at each station are shown in detail for each year by ten-day means, and the facts are combined with those brought out on a series of isothermal charts giving the relations of the different stations. The results are likely to be of great value in connexion with the study of the migration of the mackerel, menhaden, shad, and other migratory fishes.

AN interesting discussion has just been started in the Paris Academy of Medicine, concerning the bad results of mental straining in young persons. Attention has especially been called to the fact that many French girls, under the pressure of competition, are injuring their health by over-work at school. About 12,000 of them are trying to get the superior diploma which would confer upon them the right of getting an appointment in Government schools. Only 2000 will be able to get appointments.

AN excellent address on the physical training of girls was lately given by Dr. Rayner W. Batten to the Gloucestershire branch of the British Medical Association. It is printed in the *British Medical Journal*. Speaking of ladies' Colleges, Dr. Batten says he does not know of more than one that has such a thing as a proper playground, whilst a leading College, if not the first in the country, with abundant means and ample opportunities, makes no pretence of having any playground at all. Dr. Batten urges that drill and calisthenic exercises are not enough. There must be recreation as well, "and at present, in our ladies' Colleges," he says, "the exercise, with the exception of tennis, has little of the recreative element in it." Dr. Batten is of opinion that all Colleges should have playgrounds—large spaces, open to the fresh air and sunlight—that every girl should be made to play, two half-holidays a week at least being given for that purpose, and that the games should be varied, so that girls may not have to go on doing what they are conscious of not doing well. "Every girl will soon find out her strong and weak points in play as well as in work, and if the game is to be a recreation she must be allowed to choose her own form, the only obligation being that she is to play, and that no books or work are to be brought on the playground."

AT the meeting of the Essex Field Club on Saturday next, the 26th inst., Prof. Sylvanus P. Thompson will read a paper on William Gilbert, the founder of the science of electricity, and an Essex worthy entitled to rank with Ray among the pioneers of science. Those wishing to attend the meeting should communicate with the Secretary, Buckhurst Hill, Essex.

ON the night of March 7, about 11.30, a brilliant meteor was seen in Dalcarlia, in Central Sweden. It was first seen in the north-west, going in a southerly direction, but soon afterwards it changed its course more easterly. Its colour was a brilliant white, and its greatest size about that of the moon. It was lost to sight behind the horizon, leaving only a faint trail behind.

FROM a recent official French Report on oyster-culture in France we learn that the two principal centres are at Arcachon in the south-west and Auray in the north-west. The Bay of Arcachon has since 1854 held a foremost place in oyster-breeding. In 1857 there were twenty parks, or district oyster-beds: in 1865 the number had increased to 297, with an output of over 10,000,000 oysters. At the present time the little bay, which has a total area of 37,500 acres, has oyster-beds covering an area of 15,000 acres, which provide annually about 300,000,000 oysters for consumption. With regard to the oyster-beds at Auray, on the coast of Brittany, these, though not so important as those of Arcachon, have still a considerable output, and, from being exhausted and unproductive when their rehabilitation was first undertaken, have become full to overflowing. In 1876-77 we find that 7,000,000 oysters were placed on the market from Auray; in 1885 the number had risen to over 70,000,000.

THE ideas of M. Victor Meunier with regard to the domestication of apes are discussed in the new number of the *Revue d'Anthropologie* by Madame Clémence Royer, the French translator of Darwin. Madame Royer does not doubt that, under a proper system of training, apes might be made good workers. They lack perseverance, indeed, but in general intelligence they are, she thinks, superior to the dog, the horse, or even the elephant. She points out, however, that it would be necessary to feed domesticated apes with great quantities of fruit, bread, and eggs, that the process of educating them would be costly, and that for many generations they would probably be injuriously affected by the climate of Europe. Her opinion is that, if the experiment is to be made, it should be made first of all in tropical countries, where apes might be taught to labour in connexion with the cultivation of coffee, cocoa, and cotton.

AN interesting paper on "The Application of Gems to the Art of the Goldsmith" was read to the Society of Arts on Tuesday, the 15th inst., by Mr. Alfred Phillips. It is printed in the Society's Journal. Mr. Phillips gives a very favourable account of the capacity of English workmen employed by goldsmiths at the present day. When masters encourage them to depart from the beaten track, they readily adapt themselves, Mr. Phillips says, to work which, ten years ago, would have been sent as a matter of course to specialists on the Continent.

A HEALTH EXHIBITION will be opened in Warsaw on May 15 next.

AN International Agricultural Exhibition of Tools and Implements will be held at Parma in September next.

THE Royal Bavarian Academy of Sciences is collecting the numerous treatises of Joseph Fraunhofer, hitherto dispersed in numberless serials, and is about to publish them in one volume.

PROF. VERNEUIL AND L. H. PETIT have issued the first number of a periodical publication called "Études expérimentales et cliniques sur la Tuberculose." It is published by means of a fund especially raised for the promotion of the study of tuberculosis.

M. H. GADEAU DE KERVILLE has just published a work on evolution. It is entitled "Causeries sur le Transformisme," and contains an exposition of the facts and theories upon which the doctrine of evolution is based.

A BOOK on therapeutics, by M. G. Hayem, Professor in the Paris Medical School, has just been published.

THE February number of the Italian Geographical Bulletin contains a detailed account, by Dr. G. A. Colini, of the rich ethnological collection recently presented to the Prehistoric and Ethnographic Museum of Rome by General Genè, Commander of the Italian possessions on the East Coast of Africa. The collection includes a great variety of objects, such as arms, costumes, implements, ornaments, utensils from Abyssinia, Somali Land, and the Afar (Danakil) country. Amongst them are baking-ovens, braziers, incense-burners, cooking-utensils, pestles for grinding coffee, pepper, durrha, &c.; baskets, matting, veils, robes, loin-cloths, wooden sandals, lamps, swords, matchlock guns, knives, hairpins, &c., illustrating the arts and industries of the East African peoples.

WE have received the four latest Bulletins of the U.S. Geological Survey (Nos. 30–33). No. 30 contains Mr. C. D. Walcott's second contribution to "Studies on the Cambrian Faunas of North America." A systematic review of our present knowledge of fossil insects, including myriapods and arachnids, by Mr. S. H. Scudder, is presented in No. 31; and an elaborate account of mineral springs of the United States, by Dr. A. C. Peale, in No. 32. No. 33 is made up of notes, by Mr. J. S. Diller, on the geology of Northern California.

MR. EDWARD COOKWORTHY ROBINS, whose collected papers on technical education and applied science, buildings and fittings, &c., were reviewed in NATURE some time ago, is now engaged on a general work of reference on the same subject. It will appear shortly under the title of "Technical School and College Buildings," in a quarto volume of about 250 pages, with upwards of 100 full-page illustrations, plates, and maps.

IN the Proceedings of the American Antiquarian Society (vol. iv. p. 62) Mr. Frederick W. Putnam gives an account of twelve jade objects found in Nicaragua and Costa Rica, ten of which were ornaments made by cutting celts into halves, quarters, or thirds, a portion of the cutting edge of the celt remaining on each piece. Mr. O. W. Huntington, who was asked to report upon the nature and source of the material of these ornaments, is of opinion that the specimens "are unquestionably Chinese jade." They have, he says, "all the characters of that mineral, although the largest specimen from Costa Rica is rather unusual in its colour, and would not be taken for jadeite at sight." The *American Naturalist*, which calls attention to these facts, thinks "it will now be in order to collate during the next ten years the evidence for and against contact between the Orient and the western shores of America."

SOME interesting notes from Venezuela have lately been contributed by Dr. Ernst, of Caracas, to the Proceedings of the Berlin Anthropological Society. The writer brings together much valuable information as to the manners and customs of the aboriginal population, and about their food, ornaments, implements, weapons, and canoes.

THE additions to the Zoological Society's Gardens during the past week include a Mauge's Dasyure (*Dasyurus maugei* ♀) from Australia, presented by Mr. W. Miller; two White-crowned Pigeons (*Columba leucocephala*) from the West Indies, presented by Lieut.-Colonel Dawkins; two Long-tailed Grass Finches (*Poephila acuticauda*) from Australia, presented by Mr. Walter Burton; an Algerian Tortoise (*Testudo mauritanica*) from North Africa, presented by Mr. J. M. Green; a European Pond Tortoise (*Emys europea*), South European, presented by Mr. Henry Garle; five European Tree Frogs (*Hyla arborica*), European, presented by Mr. F. W. Green; an Axis Deer (*Cervus axis* ♀), a Collared Fruit Bat (*Cynonycteris collaris*), sixteen Puff Adders (*Vipera ariétans*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

RESEARCHES ON THE DIAMETER OF THE SUN.—Herr Auwers has published in the *Sitzungsberichte der Königlich Preussischen Akademie der Wissenschaften zu Berlin*, 1886, No. 1., the first part of an elaborate investigation of the value of the sun's diameter as found from meridian observations, and of the apparent variations thereof. The discussion now published refers to variations in the mean annual values only of the diameter. The series of observations discussed are the meridian observations of the sun made at Greenwich, 1851–83; at Washington, 1866–82; at Oxford (Radcliffe Observatory), 1862–83; and at Neuchâtel (transit observations only), 1862–83. The "personal equations" of the various observers are first determined on the supposition that there may be periodic annual variations, both in the horizontal and vertical diameters of the sun, such for instance as have been supposed by Secchi and others to exist, with a period corresponding to the sunspot cycle. The first determination of "personal equation" is therefore made by comparing observations taken in each year with others taken in the same year only. The resulting diameters are, however, such as to convince Herr Auwers that, although inequalities exist in each of the series of observations discussed, their comparison with each other and with the sunspot curve is sufficient to show that they have no connexion either with the latter or with a progressive change, but are most probably due to uncorrected "personal equations." A second determination of these on the assumption that, for some observers at least, they are liable to change, but that the sun's diameter is not subject to annual variation, leads to much more satisfactory results, and is regarded by Herr Auwers as the correct solution of the problem. The effect of personality on the deduced solar diameter, which on the average, for an individual observer, amounts to about 1" (sometimes 3", 4", and even 10"), may be inferred from the fact that the values of the horizontal and vertical diameters of the sun, deduced from thirty-three years' observation with the Greenwich transit-circle, and referred to the mean of Dunkin, Ellis, Criswick, and J. Carpenter, as standard, are respectively 32′ 2″·48 and 32′ 2″·00; whilst, referred to the mean of fifty-four observers, the same observations give, for the horizontal and vertical diameters respectively, the values 32′ 1″·99 and 32′ 2″·73.

COMET 1887 *b* (BROOKS, JANUARY 22).—The following ephemeris for Berlin midnight, is by Dr. R. Spitaler (*Astr. Nach.* No. 2776).

1887	R.A. h. m. s.	Decl. ° ′ ″	Brightness
March 24 ...	4 18 8 ...	35 46·5 N. ...	0·72
26 ...	4 21 20 ...	34 26·1 ...	
28 ...	4 24 26 ...	33 8·9 ...	0·66
30 ...	4 27 26 ...	31 54·9 ...	
April 1 ...	4 30 21 ...	30 43·9 ...	0·61
3 ...	4 33 11 ...	29 35·7 N. ...	

The brightness on January 24 is taken as unity.

MINOR PLANET No. 262.—This object has received the name of Valda.

HARVARD COLLEGE OBSERVATORY.—The late Uriah A. Boyden having left proprety to the value of 230,000 dollars in trust for the purpose of astronomical research, the Trustees of the fund have transferred the property to the President and Fellows of Harvard College, in order that the researches proposed by Mr. Boyden may be directed at the Harvard College Observatory. These researches will be supported by a portion of the means of the Observatory, in addition to the trust fund itself. By the terms of the will the money is to be devoted to observations "at such an elevation as to be free, so far as practicable, from the impediments to accurate observations which occur in the observatories now existing, owing to atmospheric influences."

ASTRONOMICAL PHENOMENA FOR THE WEEK 1887 *MARCH* 27—*APRIL* 2

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on March 27

Sun rises, 5h. 49m.; souths, 12h. 5m. 30·1s.; sets, 18h. 22m.; decl. on meridian, 2° 35′ N.: Sidereal Time at Sunset, 6h. 41m.

Moon (at First Quarter on April 1) rises, 7h. 19m.; souths, 14h. 12m.; sets, 21h. 16m.; decl. on meridian, 9° 44′ N.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury ...	5 19 ...	11 26 ...	17 33 ...	0 40 N.
Venus	6 38 ...	13 47 ...	20 56 ...	12 41 N.
Mars	6 3 ...	12 30 ...	18 57 ...	4 37 N.
Jupiter... ...	20 47* ...	1 52 ...	6 57 ...	11 28 S.
Saturn... ...	10 39 ...	18 48 ...	2 57* ...	22 30 N.

* Indicates that the rising is that of the preceding evening and the setting that of the following morning.

Occultations of Stars by the Moon (visible at Greenwich)

March	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image ° °
27 ...	μ Ceti	4 ...	18 42 ...	19 35 ...	108 359
29 ...	71 Tauri	6 ...	20 38	near approach	47 —
29 ...	θ^1 Tauri	4½ ...	21 17 ...	22 13 ...	117 335
29 ...	θ^2 Tauri	4½ ...	21 26 ...	22 8 ...	91 0
29 ...	75 Tauri	6 ...	21 46	near approach	226 —
29 ...	B.A.C. 1391 ...	5 ...	22 16 ...	23 7 ...	159 288
29 ...	85 Tauri	6 ...	23 12	near approach	42 —
31 ...	115 Tauri... ...	6 ...	0 9 ...	0 45 ...	173 258
April 2 ...	B.A.C. 2731 ...	6½ ...	21 20 ...	22 30 ...	111 288

March 27 ...	h. 0 ...	Venus in conjunction with and 4° 50′ north of the Moon.
April 3 ...	22 ...	Saturn in conjunction with and 3° 23′ north of the Moon.

Variable Stars

Star	R.A. h. m.	Decl. ° ′			h. m.	
Algol	3 0·8 ...	40 31 N. ...	Mar. 28,	19	3	*m*
ζ Geminorum ...	6 57·4 ...	20 44 N. ...	,,	30, 22	0	*m*
δ Libræ	14 54·9 ...	8 4 S. ...	,,	30, 22	21	*m*
U Coronæ	15 15·6 ...	32 4 N. ...	,,	30, 22	43	*m*
U Herculis	16 20·8 ...	19 9 N. ...	Apr. 1,			*m*
U Ophiuchi... ...	17 10·8 ...	1 20 N. ...	Mar. 28,	4	58	*m*
		and at intervals of		20	8	
W Sagittarii ...	17 57·8 ...	29 35 S. ...	Mar. 29,	3	0	*M*
R Lyræ	18 51·9 ...	43 48 N. ...	,, 31,			*m*
η Aquilæ	19 46·7 ...	0 43 N. ...	Apr. 2,	2	0	*M*
S Sagittæ	19 50·9 ...	16 20 N. ...	,, 2,	4	0	*M*
T Aquarii	20 44·0 ...	5 34 S. ...	Mar. 28,			*m*
T Cephei	21 8·1 ...	68 2 N. ...	,, 31,			*M*
δ Cephei	22 25·0 ...	57 50 N. ...	,, 28,	2	0	*m*

M signifies maximum; *m* minimum.

GEOGRAPHICAL NOTES

IN a recently-issued Colonial Office Report on the Gambia will be found some useful data on the climate of that colony which completely upset the results of previous observations and greatly reduce the temperatures hitherto accepted. The mean temperature, according to these latest observations, varies from 68°·5 in January to 80° in July at 7 a.m., and from 73°·7 in January to 82°·5 in July at noon. The same Report contains some interesting statements relating to the ethnology of the colony.

THE principal paper in the just-issued Bulletin (only No. 4 of 1885) of the American Geographical Society is on the historical and geographical features of the Rocky Mountain Railways, by Mr. James Douglass. There is also a translation of Baron Nordenskjöld's reply to criticisms on the "Voyage of the *Vega*." The criticisms relate to points of minor importance.

THE new number of the "Antananarivo Annual and Madagascar Magazine" (Christmas, 1886), consists, besides a reprint of Mr. A. R. Wallace's chapter on the fauna of Madagascar, mainly of papers on linguistic topics and on Malagasy folk-lore. M. Grandidier's paper on the channels and lagoons of the east coast of the island is translated with some interesting remarks by Mr. Sibree appended. Mr. Sibree points out that it would only require about thirty miles of canals to connect all these lagoons and so create a safe and extensive internal waterway of the greatest commercial value. The Rev. W. Montgomery contributes a paper on the Malagasy game of "Fanerana," in many respects resembling chess.

IN the new number (Heft i. Band 10.) of the *Deutsche Geographische Blätter*, we find a useful and careful, if rather too favourable, study of the trade-routes of Mexico, old and new, and their commercial importance, by Herr A. Scobel. From a scientific point of view the most valuable paper is that of Dr. Otto Finsch on his visit three years ago to the atoll of Diego Garcia in the Chagos Archipelago, about half-way between the Seychelles and Ceylon. Dr. Finsch was only a few hours on the islands, but his notes on the people (mostly of the Negro type from the Mauritius) and the richness of the bird life are interesting. An open space in the little east island was covered with "millions" of birds, whose combined cry was deafening. Eggs, also in "millions," lay about everywhere, unprotected by any nest. The commonest among these birds was the sooty tern (*Sterna fuliginosa*). Next to the Laccadives, the Chagos Islands seem to be the favourite breeding-place of this bird in the Indian Ocean. The variety in the colouring of the eggs was unprecedented in Dr. Finsch's experience, especially considering the fact that they all belonged to birds of the one species named above. The only other species noticed in the island by Dr. Finsch was the noddy (*Anous stolidus*). The birds arrive in the islands in the month of June, and stay till the young are fledged; by November they have all taken their departure. As on most coral islands, the animal world generally is very poor.

THE same number contains an account of Fontana's exploration of Eastern Patagonia in 1885, and also a short biography of Emin Pasha. From the latter we learn that Edward Schnitzer was born at Oppeln, in Silesia, in 1840; received his early education at Neisse, in Upper Silesia, and studied medicine at Breslau, Berlin, and Königsberg. From his earliest years he had a special taste for natural history, and especially ornithology, and in the latter department he has all along been a diligent collector. In 1864 we find Schnitzer at Antivari, in Albania, as a surgeon in the Turkish service. In 1870 he accompanied Ismail Pasha to Syria and Arabia, and afterwards to Trebizond, Erzeroum, and Epirus. At Ismail's death in 1874, Schnitzer came to Constantinople, and in 1875 made a short visit to his German home. Entering the Egyptian service, he, in 1876, followed Gordon Pasha from Cairo into the Soudan, where, under the title of Emin Effendi, he was appointed chief surgeon, and in 1878 Governor-General of the Equatorial Province, with the title of Bey. His work as administrator, scientific explorer, and collector, since then is well known. To Bremen and Vienna he has sent some 2000 bird-skins, carefully labelled with all necessary information, and including some twenty-five new species.

SINCE the time of Herodotus travellers in Africa have brought home reports of pygmy tribes scattered about in various regions of Africa. Readers of Schweinfurth will remember the Akkas

whom he met in the Monbuttu country, and now Dr. Ludwig Wolf, who, with Wissmann, recently explored the Sankuru, the great southern tributary of the Congo, gives us many details of a similar pygmy race among whom he sojourned for some time, in the district to the north-west of the station Luluaburg. He found entire villages inhabited by tiny men and women, of a height of not more than 1·40 metre. Among their neighbours they are known as Batua. These are nomad tribes devoting themselves exclusively to the chase and the manufacture of palm wine. Their villages, consisting of huts, are met with in clearings in the forests which cover the greater part of the country. Each district thus possesses a village of pygmies. As is the case of the Akkas among the Monbuttus, so the Batua among the Bakubu are regarded as little benevolent beings whose special mission is to provide the tribes among whom they sojourn with game and palm-wine. In exchange, manioc, maize, and bananas are given to the pygmies. Generally they live apart, but sometimes they unite themselves with races of larger stature. They excel in the art of scaling palm-trees to collect the sap, and in setting traps for game. Their agility is almost incredible. In hunting they bound through the high grass like grasshoppers, facing the elephant, antelope, and buffalo with the greatest audacity, shooting their arrows with rare precision, following up rapidly with a stroke of the lance. Physically the Batua are very well made, having absolutely no deformity. They are simply little men, well proportioned, very brave, and very cunning. Their mean height is 1·30 metre. Their skin is a yellow-brown, less dark than that of larger races. Their hair is short and woolly. Neither the Akkas nor the Batua have any beard.

SUNLIGHT COLOURS[1]

SUNLIGHT is so intimately woven up with our physical enjoyment of life that it is perhaps not the most uninteresting subject that can be chosen for what is—perhaps somewhat pedantically—termed a Friday evening "discourse." Now, no discourse ought to be possible without a text on which to hang one's words, and I think I found a suitable one when walking with an artist friend from South Kensington Museum the other day. The sun appeared like a red disk through one of those fogs which the east wind had brought, and I happened to point it out to him. He looked, and said, "Why is it that the sun appears so red?" Being near the railway station, whither he was bound, I had no time to enter into the subject, but said if he would come to the Royal Institution this evening I would endeavour to explain the matter. I am going to redeem that promise, and to devote at all events a portion of the time allotted to me in answering the question why the sun appears red in a fog. I must first of all appeal to what everyone who frequents this theatre is so accustomed, viz. the spectrum; I am going not to put it in the large and splendid stripe of the most gorgeous colours before you with which you are so well acquainted, but my spectrum will take a more modest form of purer colours some twelve inches in length.

I would ask you to notice which colour is most luminous. I think that no one will dispute that in the yellow we have the most intense luminosity, and that it fades gradually in the red on the one side and in the violet on the other. This then may be called a qualitative estimate of relative brightnesses; but I wish now to introduce to you what was novel last year, a quantitative method of measuring the brightness of any part.

Before doing this I must show you the diagram of the apparatus which I shall employ in some of my experiments.

RR are rays (Fig. 1) coming from the arc light, or, if we were using sunlight, from a heliostat, and a solar image is formed by a lens, L_1, on the slit S_1 of the collimator C. The parallel rays produced by the lens L_2 are partially refracted and partially reflected. The former pass through the prisms P_1P_2, and are focused to form a spectrum by a lens, L_3, on D, a movable ground glass screen. The rays are collected by a lens, L_4, tilted at an angle as shown, to form a white image of the near surface of the second prism on F.

Passing a card with a narrow slit, S_2, cut in it in front of the spectrum, any colour which I may require can be isolated. The consequence is that, instead of the white patch upon the screen, I have a coloured patch, the colour of which I can alter to any hue lying between the red and the violet. Thus, then, we are able to get a real patch of very approximately homogeneous light to work with, and it is with these patches of colour that I shall have to deal. Is there any way of measuring the brightness of these patches? was a question asked by General Festing and myself. After trying various plans, we hit upon the method I shall now show you, and if anyone works with it he must become fascinated with it on account of its almost childish simplicity—a simplicity, I may remark, which it took us some months to find out. Placing a rod before the screen, it casts a black shadow surrounded with a coloured background. Now I may cast another shadow from a candle or an incandescence lamp, and the two shadows are illuminated, one by the light of the coloured patch and the other by the light from an incandescence lamp which I am using to-night. [Shown.] Now one stripe is evidently too dark. By an arrangement which I have of altering the resistance interposed between the battery and the lamp, I can diminish or increase the light from the lamp, first making the shadow it illuminates too light and then too dark compared with the other shadow which is illuminated by the coloured light. Evidently there is some position in which the shadows are equally

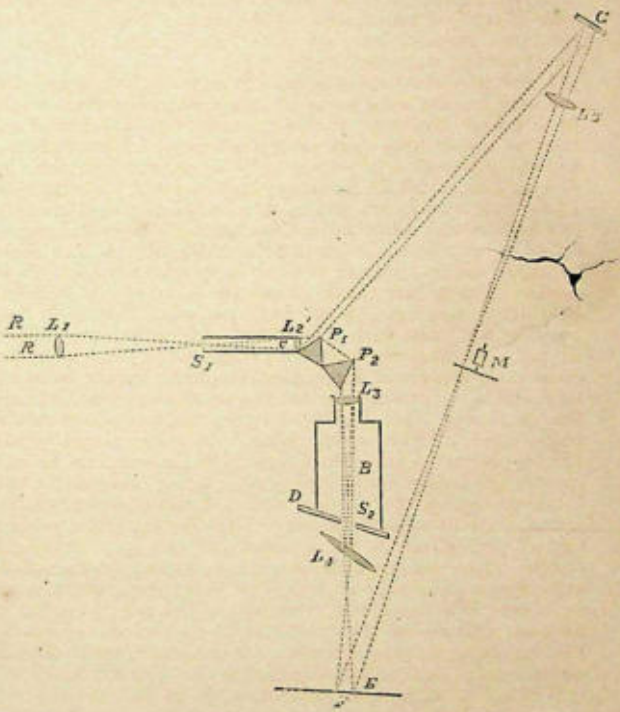


FIG. 1.—Colour Photometer.

luminous. When that point is reached, I can read off the current which is passing through the lamp, and having previously standardised it for each increment of current, I know what amount of light is given out. This value of the incandescence lamp I can use as an ordinate to a curve, the scale number which marks the position of the colour in the spectrum being the abscissa. This can be done for each part of the spectrum, and so a complete curve can be constructed which we call the illumination curve of the spectrum of the light under consideration.

Now, when we are working in the laboratory with a steady light, we may be at ease with this method, but when we come to working with light such as the sun, in which there may be constant variation owing to passing, and maybe usually imperceptible, mist, we are met with a difficulty; and in order to avoid this, General Festing and myself substituted another method, which I will now show you. We made the comparison light part of the light we were measuring. Light which enters the collimating lens partly passes through the prisms and is partly reflected from the first surface of the prism; that we utilise, thus giving a second shadow. The reflected

[1] Lecture delivered by Capt. W. de W. Abney, R.E., F.R.S., at the Royal Institution, on February 25, 1887.

rays from P_1 fall on G, a silver-on-glass mirror. They are collected by L_2, and form a white image of the prism also at F. The method we can adopt of altering the intensity of the comparison light is by means of rotating sectors, which can be opened or closed at will, and the two shadows thus made equally luminous. [Shown.] But although this is an excellent plan for some purposes, we have found it better to adopt a different method. You will recollect that the brightest part of the spectrum is in the yellow, and that it falls off in brightness on each side, so, instead of opening and closing the sectors, they are set at fixed intervals, and the slit is moved in front of the spectrum, just making the shadow cast by the reflected beam too dark or too light, and oscillating between the two till equality is discovered. The scale number is then noted, and the curve constructed as before. It must be remembered that, on each side of the yellow, equality can be established.

This method of securing a comparison light is very much better for sun work than any other, as any variation in the light whose spectrum is to be measured affects the comparison light in the same degree. Thus, suppose I interpose an artificial cloud before the slit of the spectroscope, having adjusted the two shadows, it will be seen that the passage of steam in front of the slit does not alter the relative intensities; but this result must be received with caution. [The lecturer then proceeded to point out the contrast colours that the shadow of the rod illuminated by white light assumed.]

I must now make a digression. It must not be assumed that everyone has the same sense of colour, otherwise there would be no colour-blindness. Part of the researches of General Festing and myself have been on the subject of colour-blindness, and these I must briefly refer to. We test all who come by making them match the luminosity of colours with white light, as I have now shown you; and as a colour-blind person has only two fundamental colour-perceptions instead of three, his matching of luminosities is even more accurate than is that made by those whose eyes are normal or nearly normal. It is curious to note how many people are more or less deficient in colour-perception. Some have remarked that it is impossible that they were colour-blind, and would not believe it, and sometimes we have been staggered at first with the remarkable manner in which they recognised colour to which they ultimately proved deficient in perception. For instance, one gentleman when I asked him the name of a red colour patch, said it was sunset colour; he then named green and blue correctly, but when I reverted to the red patch he said green. On testing further he proved totally deficient in the colour-perception of red, and with a brilliant red patch he matched almost a black shadow. The diagram shows you the relative perceptions in the spectrum of this gentleman and myself. There are others who only see three-quarters, others half, and others a quarter the amount of red that we see, whilst some see none. Others see less green and others less violet, but I have met with no-one that can see more than myself or General Festing, whose colour-perceptions are almost identical. Hence we have called our curve of illumination the "normal curve."

We have tested several eminent artists in this manner, and about one-half of the number have been proved to see only three-quarters of the amount of red which we see. It might be thought that this would vitiate their powers of matching colour, but it is not so. They paint what they see, and although they see less red in a subject, they see the same deficiency in their pigments; hence they are correct. If totally deficient, the case of course would be different.

Let us carry our experiments a step further, and see what effect what is known as a turbid medium has upon the illuminating value of different parts of the spectrum. I have here water which has been rendered turbid in a very simple manner. In it has been very cautiously dropped an alcoholic solution of mastic. Now mastic is practically insoluble in water, and directly the alcoholic solution comes in contact with the water it separates out in very fine particles, which, from their very fineness, remain suspended in the water. I propose now to make an experiment with this turbid water.

I place a glass cell containing water in front of the slit, and on the screen I throw a patch of blue light. I now change it for turbid water in a cell. This thickness much dims the blue; with a still greater thickness the blue has almost gone. If I measure the intensity of the light at each operation, I shall find that it diminishes according to a certain law, which is of the same nature as the law of absorption. For instance, if one inch diminishes the light one-half, the next will diminish it half of that again, the next half of that again, whilst the fourth inch will cause a final diminution of the total light of one-sixteenth. If the first inch allows only one-quarter of the light, the next will only allow one-sixteenth, and the fourth inch will only permit 1/256 part to pass. Let us, however, take a red patch of light and examine it in the same way. We shall find that, when the greater thickness of the turbid medium we used when examining the blue patch of light is placed in front of the slit, much more of this light is allowed to pass than of the blue. If we measure the light we shall find that the same law holds good as before, but that the proportion which passes is invariably greater with the red than the blue. The question then presents itself: Is there any connection between the amounts of the red and the blue which pass? Lord Rayleigh, some years ago, made a theoretical investigation of the subject; but, as far as I am aware, no definite experimental proof of the truth of the theory was made till it was tested last year by General Festing and myself. His law was that for any ray, and through the same thickness, the light transmitted varied inversely as the fourth power of the wave-length. The wave-length 6000 lies in the red, and the wave-length 4000 in the violet. Now 6000 is to 4000 as 3 to 2, and the fourth powers of these wave-lengths are as 81 to 16, or as about 5 to 1. If, then, the four inches of our turbid medium allowed three-quarters of this particular red ray to be transmitted, they would only allow $(\frac{3}{4})^4$, or rather less than one-fourth, of the blue ray to pass. Now this law is not like the law of absorption for ordinary absorbing media, such as coloured glass for instance, because here we have an increased loss of light running from the red to the blue, and it matters not how the medium is made turbid, whether by varnish, suspended sulphur, or what not. It holds in every case, so long as the particles which make the medium turbid are small enough; and please to recollect that it matters not in the least whether the medium which is rendered turbid is solid, liquid, or air. Sulphur is yellow in mass, and mastic varnish is nearly white, whilst tobacco-smoke when condensed is black, and very minute particles of water are colourless: it matters not what the colour is, the loss of light is *always* the same. The result is simply due to the scattering of light by fine particles, such particles being small in dimensions compared with a wave of light. Now, in this trough is suspended 1/1000 of a cubic inch of mastic varnish, and the water in it measures about 100 cubic inches, or is 100,000 times more in bulk than the varnish. Under a microscope of ordinary power it is impossible to distinguish any particles of varnish: it looks like a homogeneous fluid, though we know that mastic will not dissolve in water. Now a wave-length in the red is about 1/40,000 of an inch, and a little calculation will show that these particles are well within the necessary limits. Prof. Tyndall has delighted audiences here with an exposition of the effect of the scattering of light by small particles in the formation of artifical skies, and it would be superfluous for me to enter more into that. Suffice it to say that when particles are small enough to form the artificial blue sky they are fully small enough to obey the above law, and that even larger particles will suffice. We may sum up by saying that very fine particles scatter more blue light than red light, and that consequently more red light than blue light passes through a turbid medium, and that the rays obey the law prescribed by theory. I will exemplify this once more by using the whole spectrum and placing this cell, which contains hypo-sulphite of soda in solution in water, in front of the slit. By dropping in hydrochloric acid, the sulphur separates out in minute particles; and you will see that, as the particles increase in number, the violet, blue, green, and yellow disappear one by one and only red is left, and finally the red disappears itself.

Now let me revert to the question why the sun is red at sunset. Those who are lovers of landscape will have often seen on some bright summer's day that the most beautiful effects are those in which the distance is almost of a match to the sky. Distant hills, which when viewed close to are green or brown, when seen some five or ten miles away appear of a delicate and delicious, almost of a cobalt, blue colour. Now, what is the cause of this change in colour? It is simply that we have a sky formed between us and the distant ranges, the mere outline of which looms through it. The shadows are softened so as almost to leave no trace, and we have what artists call an atmospheric effect. If we go into another climate, such as Egypt or amongst the high Alps, we usually lose this effect. Distant mountains stand out crisp with black shadows, and the want of atmosphere

is much felt. [Photographs showing these differences were shown.] Let us ask to what this is due. In such climates as England there is always a certain amount of moisture present in the atmosphere, and this moisture may be present as very minute particles of water—so minute indeed that they will not sink down in an atmosphere of normal density—or as vapour. When present as vapour the air is much more transparent, and it is a common expression to use, that when distant hills look "so close" rain may be expected shortly to follow, since the water is present in a state to precipitate in larger particles; but when present as small particles of water the hills look very distant, owing to what we may call the haze between us and them. In recent weeks everyone has been able to see very multiplied effects of such haze. The ends of long streets, for instance, have been scarcely visible though the sun may have been shining, and at night the long vistas of gas lamps have shown light having an increasing redness as they became more distant. Everyone admits the presence of mist on these occasions, and this mist must be merely a collection of intangible and very minute particles of suspended water. In a distant landscape we have simply the same or a smaller quantity of street-mist occupying, instead of perhaps 1000 yards, ten times that distance. Now I would ask, What effect would such a mist have upon the light of the sun which shone through it?

It is not in the bounds of present possibility to get outside our atmosphere and measure by the plan I have described to you the different illuminating values of the different rays, but this we can do:—First, we can measure these values at different altitudes of the sun, and this means measuring the effect on each ray after passing through different thicknesses of the atmosphere, either at different times of day, or at different times of the year, about the same hour. Second, by taking the instrument up to some such elevation as that to which Langley took his bolometer at Mount Whitney, and so to leave the densest part of the atmosphere below us. Now, I have adopted both these plans. For more than a year I have taken measurements of sunlight in my laboratory at South Kensington, and I have also taken the instrument up to 8000 feet high in the Alps, and made observations *there*, and with a result which is satisfactory in that both sets of observations show that the law which holds with artificially turbid media is under ordinary circumstances obeyed by sunlight in passing through our air: which is, you will remember, that more of the red is transmitted than of the violet, the amount of each depending on the wave-length. The luminosity of the spectrum observed at the Riffel I have used as my standard luminosity, and compare all others with it. The result for four days you see in the diagram.

I have diagrammatically shown the amount of different colours which penetrated on the same days, taking the Riffel as ten. It will be seen that on December 23 we have really very little violet and less than half the green, although we have four-fifths of the red.

The next diagram before you shows the minimum loss of light which I have observed for different air thicknesses. On the top we have the calculated intensities of the different rays outside our atmosphere. Thus we have that through one atmosphere, and two, three, and four; and you will see what enormous absorption there is in the blue end at four atmospheres. The areas of these curves, which give the total luminosity of the light, are 761, 662, 577, 503, and 439; and if observed as astronomers observe the absorption of light, by means of stellar observations, they would have had the values, 761, 664, 578, 504, and 439—a very close approximation one to the other.

Next notice in the diagram that the top of the curve gradually inclines to go to the red end of the spectrum as you get the light transmitted through more and more air, and I should like to show you that this is the case in a laboratory experiment. Taking a slide with a wide and long slot in it, a portion is occupied by a right-angled prism, one of the angles of 45° being towards the centre of the slot. By sliding this prism in front of the spectrum I can deflect outwards any portion of the spectrum I like, and by a mirror can reflect it through a second lens, forming a patch of light on the screen overlapping the patch of light formed by the undeflected rays. If the two patches be exactly equal, white light is formed. Now, by placing a rod as before in front of the patch, I have two coloured stripes in a white field, and though the background remains of the same intensity of white, the intensities of the two stripes can be altered by moving the right-angled prism through the spectrum. The two stripes are now apparently equally luminous, and I see the point of equality is where the edge of the right-angled prism is in the green. Placing a narrow cell filled with our turbid medium in front of the slit, I find that the equality is disturbed, and I have to allow more of the yellow to come into the patch formed by the blue end of the spectrum, and consequently less of it in the red end. I again establish equality. Placing a thicker cell in front, equality is again disturbed, and I have to have less yellow still in the red half, and more in the blue half. I now remove the cell, and the inequality of luminosity is still more glaring. This shows, then, that the rays of maximum luminosity must travel towards the red as the thickness of the turbid medium is increased.

The observations at 8000 feet, here recorded, were taken on

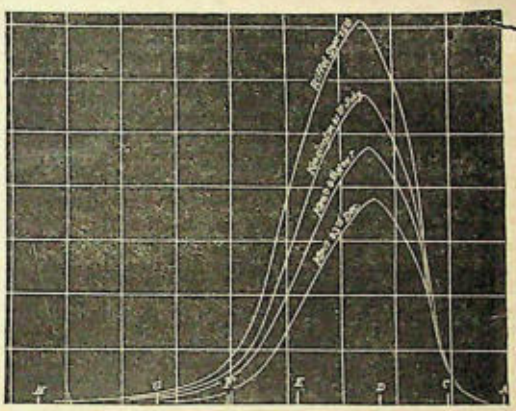


FIG. 2.—Relative Luminosities.

September 15 at noon, and of course in latitude 46° the sun could not be overhead, but had to traverse what would be almost exactly equivalent to the atmosphere at sea-level. It is much nearer the calculated intensity for no atmosphere intervening, than it is for one atmosphere. The explanation of this is easy. The air is denser at sea-level than at 8000 feet up, and the lower stratum is more likely to hold small water particles or dust in suspension than is the higher.

For, however small the particles may be, they will have a greater tendency to sink in a rare air than in a denser one, and less water vapour can be held per cubic foot. Looking, then, from my

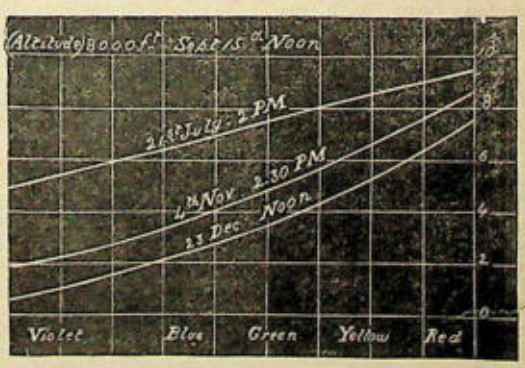


FIG. 3.—Proportions of Transmitted Colours.

laboratory at South Kensington, we have to look through a proportionately larger quantity of suspended particles than we have at a high altitude when the air thicknesses are the same; and consequently the absorption is proportionately greater at sea-level that at 8000 feet high. This leads us to the fact that the real intensity of illumination of the different rays outside the atmosphere is greater than it is calculated from observations near sea-level. Prof. Langley, in this theatre, in a remarkable and interesting lecture, in which he described his journey up Mount Whitney to about 12,000 feet, told us that the sun was really blue

outside our atmosphere, and at first blush the amount of extra blue which he deduced to be present in it would, he thought, make it so; but though he surmised the result from experiments made with rotating disks of coloured paper, he did not, I think, try the method of using pure colours, and consequently, I believe, slightly exaggerated the blueness which would result. I have taken Prof. Langley's calculations of the increase of intensity for the different rays, which I may say do not quite agree with mine, and I have prepared a mask which I can place in the spectrum giving the different proportions of each ray as calculated by him, and this when placed in front of the spectrum will show you that the real colour of sunlight outside the atmosphere, as calculated by Langley, can scarcely be called bluish. Alongside I place a patch of light which is very closely the colour of sunlight on a July day at noon in England. This comparison will enable you to gauge the blueness, and you will see that it is not very blue, and, in fact, not bluer perceptibly than that we have at the Riffel, the colour of the sunlight at which place I show in a similar way. I have also prepared some screens to show you the value of sunlight after passing through five and ten atmospheres. On an ordinary clear day you will see what a yellowness there is in the colour. It seems that after a certain amount of blue is present in white light the addition of more makes but little difference in the tint. But these last patches show that the light which passes through the atmosphere when it is feebly charged with particles does not induce the red of the sun as seen through a fog. It only requires more suspended particles in any thickness to induce it.

In observations made at the Riffel, and at 14,000 feet, I have found that it is possible to see far into the ultra-violet, and to distinguish and measure lines in the sun's spectrum which can ordinarily only be seen by the aid of a fluorescent eye-piece or by means of photography. Circumstantial evidence tends to show that the burning of the skin, which always takes place in these high altitudes in sunlight, is due to the great increase in the ultra-violet rays. It may be remarked that the same kind of burning is effected by the electric arc light, which is known to be very rich in these rays.

Again, to use a homely phrase, "You cannot eat your cake and have it." You cannot have a large quantity of blue rays present in your direct sunlight, and have a luminous blue sky. The latter must always be light scattered from the former. Now, in the high Alps you have, on a clear day, a deep blue-black sky, very different indeed from the blue sky of Italy or of England; and as it is the sky which is the chief agent in lighting up the shadows, not only in those regions do we have dark shadows on account of no intervening—what I will call—mist, but because the sky itself is so little luminous. In an artistic point of view this is important. The warmth of an English landscape in sunlight is due to the highest lights being yellowish, and to the shadows being bluish from the sky-light illuminating them. In the high Alps the high lights are colder, being bluer, and the shadows are dark, and chiefly illuminated by reflected direct sunlight. Those who have travelled abroad will know what the effect is. A painting in the Alps, at any high elevation, is rarely pleasing, although it may be true to Nature. It looks cold, and somewhat harsh and blue.

In London we are often favoured with easterly winds, and these, unpleasant in other ways, are also destructive of that portion of the sunlight which is the most chemically active on living organisms. The sunlight composition of a July day may, by the prevalence of an easterly wind, be reduced to that of a November day, as I have proved by actual measurement. In this case it is not the water particles which act as scatterers, but the carbon particles from the smoke.

Knowing, then, the cause of the change in the colour of sunlight, we can make an artificial sunset, in which we have an imitation light passing through increasing thicknesses of air largely charged with water particles. [The image of a circular diaphragm placed in front of the electric light was thrown on the screen in imitation of the sun, and a cell containing hyposulphite of soda placed in the beam. Hydrochloric acid was then added: as the fine particles of sulphur were formed, the disk of light assumed a yellow tint, and as the decomposition of the hyposulphite progressed, it assumed an orange and finally a deep red tint.] With this experiment I terminate my lecture, hoping that in some degree I have answered the question I propounded at the outset: why the sun is red when seen through a fog.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—From the University accounts for 1886, just issued, we learn that the Mathematical Tripos Examiners are paid 348*l.*; Examiners in Natural Science, 575*l.*; in Medicine and Surgery, 210*l.*; all extremely moderate payments.

Science Professors received 3725*l.* from the University Chest, 1800*l.* from the Common University Fund (derived from tax on the Colleges), besides payments from special endowments; Readers, Demonstrators, and other officers connected with Science and Medicine, 2100*l.* from the University Chest; 1800*l.* from the Common University Fund. Total, 9425*l.* for teachers mainly.

The University Observatory cost 786*l.*, in addition to 164*l.* from the Sheepshanks Fund. The Botanic Garden cost 1223*l.*; the Museums and Lecture Rooms, 4221*l.*, including 100*l.* for Dr. Guillemard's collection of bird-skins from the voyage of the *Marchesa*, 11*l.* for bird-skins bought by Prof. Newton at the Jardine sale, and 8*l.* 10*s.* for a skeleton of a European elk. The Pathological Laboratory cost 167*l.* out of the foregoing amount; the Department of Human Anatomy, 356*l.*; the Woodwardian Museum, 498*l.*; the Chemical Laboratory, 517*l.*; the Cavendish Laboratory, 274*l.*, including 60*l.* for instruments. The new dissecting-room (iron) for Human Anatomy cost 350*l.*, an additional class-room for Physiology 10*l.*, charged to the Museums Reserve Fund.

At Gonville and Caius College, Dr. Shuttleworth's Scholarship of 60*l.* for three years, open to medical students of the University of not less than eight terms' standing, given for proficiency in Botany and Comparative Anatomy, has been awarded to Francis Henry Edgeworth, B.A., Scholar of the College.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, March 3.—"On the Limiting Distance of Speech by Telephone." By William Henry Preece, F.R.S.

The law that determines the distance to which speaking by telephone on land-lines is possible, is just the same as that which determines the number of currents which can be transmitted through a submarine cable in a second.

It is dependent on a time-constant varying with the conditions of the circuit, invariable for the same uniform circuit, but differing for different circuits. It represents the time that elapses from the instant contact is made at the sending-end to the instant that the current begins to appear at the receiving-end. It is given by the following equation:—

$$a = Bkrl^2,$$

B being a constant dependent principally on the units used; k the inductive capacity per unit length (mile or knot); r the resistance per unit length, and l the lengths in miles or knots.

The number of reversals which can be produced at the end of a wire per second is quite independent of the impressed E.M.F., and therefore of the strength of the current. But it depends upon the sensitiveness of the apparatus used to receive the currents. This is why such discordant results are obtained by different observers who attempt to measure the velocity of currents of electricity. It is also why the telephone is such an admirable instrument for research—for it is sensitive to the least increment or decrement of current.

The inductive capacity of overhead and underground wires was measured with great care on very dry days in different parts of the country.

The results come out as follows:—

	Capacity per mile, microfarads		Resistance per mile, B.A. ohms
No. 7½ iron wire	0·0168	...	12·0
No. 12½ copper wire	0·0124	...	5·7
Gutta-percha-covered wire in iron pipes	0·2500	...	23·0
Gutta-percha-covered wire in cables	0·2900	...	10·25

It then became necessary to determine the speed of the current through wires of different lengths, resistances, and capacities.

It was found that, for mixed wires, the speed was given by the equation

$$v = 32 \times 10^{-8}\, KR,$$

but for copper alone the constant was 22×10^{-8}.

The limiting distance through which it is possible to speak varies inversely with the speed of the current, and that the speed of the current varies inversely with the product of the total resistance and the total capacity of the circuit. Hence the number of reversals that it is possible to send through any circuit varies inversely with the product of the total resistance (R) and the total capacity (K), or the limiting distance—

$$S = KR \times \text{constant} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

This is only another form of Thomson's law for $K = kl$, and $R = lr$, and

$$\therefore S = krl^2 \times \text{constant}.$$

If the equation (1) be put into this form,

$$A = krx^2, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

and A be given the following values :—

Copper (overhead)	15,000
Cables and underground	12,000
Iron (overhead	10,000

the limiting distance (x) through which speech is possible is

$$x^2 = A/kr.$$

There is an interesting consequence of Thomson's law which comes out of these experiments, and that is, whether the line be a single wire completed by the earth, or a double wire making a metallic circuit, the rate of speed between the two ends is exactly the same, and therefore the distance we can speak through is just the same whether we use a single or double wire circuit. This is owing to the fact that though in the latter case we double the total resistance, we halve the total capacity, and therefore the product remains the same.

The difference between copper and iron is clearly due to self-induction, or to the electro-magnetic inertia of the latter, and the difference between copper overground and copper underground is due to the facility that the leakage of insulators offers to the rapid discharge to earth, at innumerable points, of the static charge, which in gutta-percha-covered wire can find an exit only at the ends.

It is also evident that there is no difficulty in working telephones through underground wires, even though they attain fifty miles in length, and in fact it would be better to work underground with proper copper wire from London to Brighton, than to use iron wires along the railway telegraph poles, owing to the absence of external disturbances in the former case.

March 17.—"Second Note on the Geometrical Construction of the Cell of the Honey Bee (Roy. Soc. Proc. vol. xxxix. p. 253, and vol. xli. p. 44)." By Prof. H. Hennessy, F.R.S.

The author deduces from the results established in his communications as above cited that, while the trihedral pyramid at the apex of the cell may be inscribed in a sphere whose diameter, D, is equal to the sum of the three edges of the pyramid, another sphere may be inscribed within the cell touching all of its nine faces and whose diameter, D', is equal to the diameter of the cell, and that between these diameters the following relation exists :—

$$\frac{D}{D'} = \left(\frac{3}{2}\right)^{\frac{3}{2}}.$$

The connexion between the geometrical cell and its inscribed and circumscribing spheres is pointed out as possibly bearing on the mode of formation of the actual cells.

"A Coal-dust Explosion." By W. Galloway. Communicated by R. H. Scott, M.A., F.R.S.

Zoological Society, March 1.—Prof. W. H. Flower, F.R.S., President, in the chair.—Prof. Jeffrey Bell read extracts from a communication sent to him by Mr. Edgar Thurston, Superintendent of the Government Central Museum, Madras, containing observations on two species of Batrachians of the genus *Cacopus*.—Mr. O. Salvin (on behalf of Mr. F. D. Godman) exhibited a pair of a large and rare Butterfly (*Ornithoptera victoriæ*), the male of which had been hitherto undescribed. These specimens were obtained at the end of May 1886 by Mr. C. M. Woodford, at North-West Bay, Malcita Island, one of the Solomon group.—Mr. E. B. Poulton read a paper containing an account of his experiments on the protective value of colour and markings in insects (especially in Lepidopterous larvæ) in their relation to Vertebrata. It was found that conspicuous insects were nearly always refused by birds and lizards, but that they were eaten in extreme hunger: hence the unpleasant taste failed as a protection under these circumstances. Further, conspicuous and unpalatable insects, although widely separated, tended to converge in colour and pattern, being thus more easily seen and remembered by their enemies. In the insects protected by resembling their surroundings it was observed that mere size might prevent the attacks of small enemies. Some such insects were unpalatable, but could not be distinguished from the others. In tracing the inedibility through the stages, it was found that no inedible imago was edible in the larval stage; in this stage therefore the unpleasant taste arose.—Mr. G. A. Boulenger read a paper descriptive of the fishes collected by the late Mr. Clarence Buckley in Ecuador. The set of all the species in the collection acquired by the British Museum in 1880 contained a large number of highly interesting and well-preserved specimens. Amongst them were representatives of ten species described as new to science.—Mr. Richard S. Wray, read a note on a vestigial structure in the adult Ostrich representing the distal phalanges of the third digit.—Mr. John H. Ponsonby communicated (on behalf of Mr. Andrew Garrett) the second and concluding part of a paper on the Terrestrial Mollusks of the Viti or Fiji Islands.—Mr. Edgar A. Smith gave an account of a small collection of shells from the Loo-Choo Islands, made by Mr. H. Pryer.

Geological Society, February 18.—Annual General Meeting.—Prof. J. W. Judd, F.R.S., President, in the chair.—Having presented the various medals, and the proceeds of the Donation Funds in the gift of the Society, the President read his Anniversary Address, which we have already printed.—The ballot for the Council and Officers was taken, and the following were duly elected for the ensuing year :—President: Prof. J. W. Judd, F.R.S. Vice-Presidents: H. Bauermân, Prof. T. G. Bonney, F.R.S., A. Geikie, F.R.S., Henry Woodward, F.R.S. Secretaries: W. T. Blanford, F.R.S., and W. H. Hudleston, F.R.S. Foreign Secretary: Warington W. Smyth, F.R.S. Treasurer: Prof. T. Wiltshire. Council: H. Bauerman, W. T. Blanford, F.R.S., Prof. T. G. Bonney, F.R.S., A. Champernowne, Thomas Davies, Prof. P. M. Duncan, F.R.S., A. Geikie, F.R.S., Henry Hicks, F.R.S., Rev. Edwin Hill, W. H. Hudleston, F.R.S., J. W. Hulke, F.R.S., Prof. T. McKenny Hughes, Prof. T. Rupert Jones, F.R.S., Prof. J. W. Judd, F.R.S., R. Lydekker, J. E. Marr, E. T. Newton, Prof. H. G. Seeley, F.R.S., Warington W. Smyth, F.R.S., J. J. H. Teall, Prof. T. Wiltshire, Rev. H. H. Winwood, Henry Woodward, F.R.S.

February 23.—Prof. J. W. Judd, F.R.S., President, in the chair.—The following communications were read :—On the origin of dry chalk valleys and of Coombe rock, by Mr. Clement Reid. Whilst engaged in examining the Pleistocene deposits of Sussex, for the Geological Survey, the author observed that the Coombe rock differs from anything commonly seen in the strongly glaciated districts of the Yorkshire and Lincolnshire Wolds. As in these localities, the seaward slope of the South Downs is broken by the line of a partially buried sea-cliff before passing under the low-lying drift areas. Subsequent to the formation of this sea-cliff a mass of angular flint and chalk detritus spread out from the Downs over the low lands, being seldom found far up the valleys. This is the Coombe rock, which passes further on into a worthless mixture of angular flint and loam, and at a still greater distance into almost clean brick-earth. It is not of glacial origin, neither is it marine, nor is it a gravel formed by ordinary fluviatile action. The rolling outline of the Downs, and the steep-sided dry valleys point to conditions which have passed away. However much rain may fall, the upper parts of these valleys are always dry, and no running water can be found where the incline of the bottom of the valley exceeds the slope of the plane of saturation—never more than 60 feet per mile. The author discussed the various explanations which have been offered. In suggesting an origin for the dry valleys and Coombe rock, he considers that the fauna and flora, both at Fisherton and Bovey Tracey, point to a great degree of cold, from 20° to 30° lower than what now prevails in the South of England. The ground would thus be frozen to the depth of several hundred feet, and the drainage system of the chalk entirely modified. There would be no underground circulation. The summer rains would immediately run off any steep slope, often in violent torrents. These would tear up the layer of rubble already loosened by the frost, carrying down masses of unthawed chalk too rapidly for solvents to have much effect. No Coombe rock is found in valleys that have a greater slope than 100 feet per mile. There is no need of excessive rainfall; it might have been a dry period corresponding to that of

the loess. If the time had not been short, all soft rocks in the South of England would have been planed down to one gently undulating surface like the plains of Russia and Siberia. Such tundra-conditions may have occurred more than once.—Probable amount of former glaciation of Norway, as demonstrated by the present condition of rocks upon and near the western coast, by Mr. W. F. Stanley.

Mathematical Society, March 10.—Sir James Cockle, F.R.S., President, in the chair.—The following communications were made:—A metrical property of plane curves, by R. Lachlan.—Note on the Weierstrass functions, by Mr. A. G. Greenhill.—Second paper on the change of the independent variable; with applications to some functions of the reciprocant kind, by C. Leudesdorf.—A note on knots, by Mr. A. B. Kempe, F.R.S.

Chemical Society, March 3.—Dr. Hugo Müller, F.R.S., President, in the chair.—The following papers were read:—Tartaric and racemic acids and the magnetic rotatory power of their ethyl salts, by Dr. W. H. Perkin, F.R.S.—Anhydracetonebenzil, by Mr. Francis R. Japp, F.R.S., and Mr. Cosmo Innes Burton.—Condensation compounds of benzil with ketones, by the same.—Constitution of glycosine, by Mr. Francis R. Japp, F.R.S., and Mr. E. Cleminshaw.—Diphenylglyoxaline and methyldiphenylglyoxaline, by Mr. Francis R. Japp, F.R.S.—Dehydracetic acid, by Dr. W. H. Perkin, Jun.—The colouring-matter of *Drosera Whittakeri*, by Prof. E. H. Rennie.—Further notes on the di-haloid derivatives of thiocarbamide, by Dr. George McGowan.

Anthropological Institute, March 8.—Mr. Francis Galton, F.R.S., President, in the chair.—Mr. A. L. Lewis read a paper on stone circles near Aberdeen. In this paper Mr. Lewis described in detail two circles near Dyce and Portlethen respectively, and drew particular attention to the fact that they differ in two important particulars from the circles of Southern Britain. In former papers on stone circles the author had insisted on the presence of a special reference to the north-east, but in these circles the main direction is north and south. They are further distinguished from the southern circles by the existence of an oblong stone flanked by two upright stones, which is indeed their principal feature, and which exists nowhere except in the Aberdeen district, where it is almost universal. Mr. Lewis regarded the Aberdeen circles as having more affinity to the "giants' graves" found in the north of Ireland, than to the English circles to which it has always been sought to ally them.—The following papers were also read:—Palæolithic implements from the drift-gravels of the Singrauli Basin, South Mirzapore, by Mr. J. Cockburn.—Stone implements from Perak, by Mr. Abraham Hale.

Entomological Society, March 2.—Dr. D. Sharp, President, in the chair.—Mr. Slater exhibited, with the object of showing the effect of food in causing variation in Lepidoptera, two specimens of *Arctia caja*, one of which was bred from a larva fed on lime-leaves, and the other from a larva fed on low plants, the ordinary pabulum of the species.—Capt. H. J. Elwes exhibited a large number of Lepidoptera-Heterocera, caught by him at Darjeeling, in Sikkim, at an elevation of 7000 feet, on the night of August 4, 1886, between 9 p.m. and 1 a.m. The specimens exhibited represented upwards of 120 species, belonging to [illegible]ces, Noctuæ, Geometræ, Crambidæ, &c., many of which [illegible]lieved to be undescribed. Capt. Elwes stated that Mr. [illegible]Wallace's observations on the conditions most favourable for [illegible]ecting moths in the tropics were fully confirmed by his own experience during four months' collecting in Sikkim and the Khasias. The conditions referred to were a dark wet night in the rainy season; a situation commanding a large extent of virgin forest and uncultivated ground; and a whitewashed veranda with powerful lamps in it. He also made some remarks on the Khasia Hills, the southern slopes of which he believed to be the true habitat of the greater part of those insects described many years ago by Prof. Westwood and others as coming from Sylhet. A discussion ensued, in which Mr. McLachan, Dr. Sharp, Mr. Champion, Mr. Kirby, and others took part.—The Rev. W. W. Fowler exhibited a specimen of *Cathormiocerus socius*, taken at Sandown, Isle of Wight.—Mr. S. Stevens exhibited specimens of *Cathormiocerus maritimus* and *Platytarsus hirtus*.—Mr. F. Grut said he was requested by M. Péringuey, of Cape Town, to announce that the latter was engaged on a monograph of the genus *Hipporrhinus*, and that he would be glad to receive specimens and other assistance from British entomologists.—Mr. Gervase F. Mathew, R.N., communicated a paper entitled "Descriptions of new species of Rhopalocera from the Solomon Islands."—Mr. G. T. Baker communicated the following papers: "Description of a new species of the Lepidopterous genus *Carama*, together with a few notes on the genus"; and "Description of a new genus of Rhopalocera allied to *Thecla*."

Institution of Civil Engineers, February 22.—Mr. Edward Woods, President, in the chair.—A paper was read on irrigation in Lower Egypt, by Mr. William Willcocks.

March 1.—Mr. Edward Woods, President, in the chair.—A paper was read on dredging-operations and appliances, by Mr. John James Webster. The author described the objects for which dredging-operations are generally carried out, and spoke of the advantage of obtaining the aid of natural scour, when possible, for supplementing or dispensing with dredging. The various kinds of appliances used were fully described.

March 15.—Mr. Edward Woods, President, in the chair.—A paper was read on the treatment of gun-steel, by Colonel Eardly Maitland, R.A.

PARIS

Academy of Sciences, March 14.—M. Janssen, President, in the chair.—Reply to M. Houzeau's additional note, by M. Lœwy. It is argued that M. Houzeau's mistake lies in the arrangement proposed by him in 1871, which is practically that of a sextant with fixed opening. The principle of the sextant is based on the combination of two mirrors, which in virtue of known optical conditions must give it an undoubted superiority over M. Houzeau's apparatus, which is provided with only one mirror.—On a problem relating to the theory of minima surfaces, by M. Gaston Darboux. To the different solutions of the problem given in vol. cii. of the *Comptes rendus* (1886), is here added another which rests on a new genesis of minima surfaces proposed in an important memoir by M. Ribaucour.—On the great movements of the atmosphere, and on M. Colladon's note of March 7, by M. H. Faye. The paper deals with M. Colladon's suggestion, based on M. Weyher's recent experiments, that rotatory movements with vertical axis may have both an ascending and a descending direction, thus presenting a middle term between the extreme views of M. Faye and his opponents.—On the artificial production of the ruby, by M. Fremy. Some remarks are presented on the two processes elaborated by MM. Fremy and Feil, in connexion with the recent death of M. Feil. A third method is referred to which has since been brought to great perfection with the co-operation of M. Verneuil. A paper followed, by MM. Fremy and Verneuil, on the action of the fluorides on alumina in connexion with the same subject.—The small *Ursus spelæus* of Gargas, by M. Albert Gaudry. A description is given of this species of cave-bear, a skeleton of which, made up with the bones of several individuals, has just been mounted in the new room for palæontological specimens in the Natural History Museum.—Details collected from various sources on the earthquake of February 23, by M. F. Fouqué. An account is given of the vibrations recorded at the Observatories of Lisbon, Wilhelmshafen, and Seville; the general conclusion being that the magnetic disturbances were not the cause, but rather the effect, of the shocks.—Report on MM. Guyou and Simart's memoir on the development of naval geometry as applied to the question of the stability of vessels, by the Commissioners, MM. Phillips, Lévy, Sarrau, and de Jonquières. The report speaks favourably of MM. Guyou and Simart's studies, which greatly reduce the elaborate calculations hitherto required to be worked out in determining questions of stability from the theoretical and practical stand-points.—Experiments on the effects of the transfusion of blood into the heads of decapitated animals (second note), by MM. G. Hayem and G. Barrier. The experiments show that the time is limited to about ten seconds, during which it is possible by transfusion of arterial blood to momentarily revive the action of the sensor and motor cortical centres.—On a correlation between earthquakes and the declinations of the moon, by M. H. de Parville. A systematic study of lunar and terrestial phenomena continued for a quarter of a century leads the author to infer a distinct relation between lunar declination and earthquakes, the general law being that the disturbances occur either at the equilune, the lunistice, or exactly when the sun and moon have the same declination.—On the variations in the absorption-spectra of didymium, by M. Henri Becquerel. Fresh experiments here described confirm the previous conclusion of the

author regarding the presence of foreign substances in didymium, as revealed by its absorption-spectra. Some of these bodies may possibly be diverse combinations of the same with another substance or with itself, such combinations being so stable that it has hitherto been impossible to transform one into the other. —On the specific heat of a salt-solution, by M. P. Duhem. The method employed by the author to find the expression of the heat of solution is here shown to lead also to the expression of the specific heat of a salt-solution.—On a standard pile, by M. Gouy. The author describes a convenient standard of electromotor force, formed with zinc, sulphate of zinc, mercury, and dioxide of mercury.—Researches on the application of rotatory force to the study of certain compounds produced in the solutions of tartaric acid, by M. D. Gernez.—On a general method of forming the manganites from the permanganates, by M. G. Rousseau. The metallic permanganates are transformed to manganates at a temperature ranging from 100° to 150° C., and as the law of decomposition here formulated is applicable to the compounds of the whole series, it is proposed as a general method for obtaining most of the metallic manganates.—On the reticulated structure of the protoplasm of the Infusoria, by M. Fabre-Domergue.

BERLIN

Physiological Society, February 25.—Prof. Munk in the chair.—The President communicated two treatises sent, for publication in the Proceedings of the Society, by Prof. Kronecker, of Berne. In the first, Prof. Kronecker had, in conjunction with Fraulein Popoff, examined the formation of serous albumen in the intestinal canal. As reagents they made use of the hearts of frogs and tortoises, void of blood, which were stimulated to contraction only when blood or a solution of serous albumen was poured through them, but under every other albuminous or saline solution remained inactive. Stomachic peptone was incapable of nourishing the heart. When, however, the peptone was kept for some time in the stomach or in an intestinal coil connected with the mesentery, then it acted on the heart in the same way as did serous albumen. Pancreatic peptone was incapable, either of itself or after remaining in the stomach or the intestine, of stimulating the heart to contraction; by exposure for a considerable time to the air, the peptone likewise became nutritious to the heart.—In the second treatise, containing an investigation by Prof. Kronecker and Fräulein Rink, it was demonstrated that in peptone solution two kinds of Bacteria are developed in the presence of air: *Bacillus restituens*, which transformed the peptone into serous albumen, exactly in the same way as did the living mucous membrane of the stomach; and *Bacillus virescens*, which liquefied the alimentary gelatine and imparted a deep blue colouring to all sterilised substrata when exposed to the air. This latter Bacillus operated poisonously on the heart. —Dr. Benda spoke of the function of the cross-striped muscle substance. By anatomical investigation of the muscles of the river crayfish he had arrived at the conviction that it was only the cross striped substance which generated the contraction, while it was in the highest degree probable that the protoplasm discharged the office of mediation between the ends of the motory nerves and the contractile substance.—Prof. Ewald described some comparative experiments performed on three patients to ascertain the amount of nourishment with different commercial peptones, with eggs, and with eggs to which were added pepsine and hydrate of chlorine. The nutritive fluids were supplied *per enema*, and the individually very changeable nitrogenous transpositions were determined by careful analyses of the ingesta and egesta.

Meteorological Society, March 1.—Prof. von Bezold in the chair.—Dr. Kremser communicated the results of an investigation into the variability of atmospheric temperature in Germany. Variability he understood, in accordance with Hann's definition, to be the difference between the mean temperature on two consecutive days. Such variability was found by Dr. Kremser to attain its greatest magnitude in the mountains and in the eastern provinces, and its least range along the coasts of the Baltic and North sea, and on the islands. The maximum was in the Riesengebirge, 4°·3 F., the minimum on the islands of the North Sea, 2°·3. If the monthly means were arranged in chronological sequence for the year, there was presented an annual march of temperature with a chief maximum in December and a secondary in June. The variability of temperature at each of the different hours, 6 a.m., 2 p.m., and 10 p.m., yielded values differing from those of the variability of the daily means of temperature. Yet the yearly march of variability of each of the different hours already specified was similar to the yearly march of variability of the daily means. The greatest change of temperature affecting an individual period of twenty-four hours was observed in Clausen, amounting to 68° F. In Berlin, the greatest change to which the same period was liable was 24°·7; in Munich it was 30°·6. A variability of 18°·0 affecting a period of twenty-four hours might be expected in the course of a year in the east and south, but along the North Sea coast only in a period of three years. As the basis for the above conclusions, Dr. Kremser had made use of the observations of ten years.

BOOKS, PAMPHLETS, and SERIALS RECEIVED

Gairloch: J. H. Dixon (Edinburgh).—Catalogue of Siwalik Vertebrata contained in the Geological Department of the Indian Museum, Calcutta; part 1, Mammalia; part 2, Aves, Reptilia, and Pisces: R. Lydekker (Calcutta). —Catalogue of Pleistocene and Prehistoric Vertebrata contained in the Geological Department of the Indian Museum, Calcutta: R. Lydekker (Calcutta).—Memoirs of the Geological Survey of India. Palæontologia Indica, ser. xiii. Salt Range Fossils: W. Waagen; ser. xii. The Fossil Flora of the Gondwana System, vol. iv. part 2, The Fossil Flora of some of the Coal-Fields in Western Bengal: O. Feistmantel (Trübner).—*Challenger* Reports, vol. xviii., 3 parts.—Science of Thought: F. Max Müller (Longmans).—Le Commozioni Telluriche il Terremoto del 23 Febbraio, 1887 (Roux, Torino). —On Over-work and Premature Mental Decay, 4th edition: C. H. F. Routh (Baillière, Tindall, and Cox).—Geological History of Lake Lahontan: J. C. Russell (Washington).—Transactions of the Academy of Science of St. Louis, vol. iv. No. 4 (St. Louis).—Proceedings of the American Philosophical Society, vol. xxiii. No. 124 (Philadelphia).—Essentials of Histology, 2nd edition: E. A. Schäfer (Longmans).—Natural History Transactions of Northumberland, Durham, and Newcastle-upon-Tyne, vol. viii. part 2 (Williams and Norgate).—Verhandlungen des deutschen Wissenschaftlichen vereins zu Santiago, 3 Heft (Valparaiso).—A Plea for a Midland University: H. W. Crosskey (Cornish, Birmingham).—Proceedings of the Academy of Natural Sciences of Philadelphia, part 3, October to December 1886 (Philadelphia).—American Naturalist, January (Lippincott).—Annalen der Physik und Chemie, No. 4, 1887; Beiblätter der Physik und Chemie, No. 2, 1887 (Barth, Leipzig).

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THURSDAY, MARCH 31, 1887

A UNIVERSITY FOR LONDON

WE have from time to time informed our readers of the progress made in the attempt to organise the capacities for teaching and learning in London into a more complete and more efficient shape. The movement is most natural and admirable. What we have desired is to warn those interested in it not to lose sight of the full result obtainable while busied in their attempts to remove a particular grievance or further a particular interest. Each constituent of the future University—the Colleges and professional schools, the teachers and the students, the medical corporations, and the Senate and Convocation of the existing University of London—each is indispensable. Any one of these can block the way for the rest. Together they make up amply sufficient elements for the foundation desired, and this foundation would not be strengthened, but weakened, by attempts (which can never be realised) to bring in such heterogeneous elements as the British Museum or the Royal Society, the Government technical schools or the Corporation of the City and its Companies.

The present state of affairs is, we believe, pretty much as follows. The Convocation of the present University, [illegible] the first efforts towards its reform began some [illegible] seven years ago, rejected a scheme presented to it by a Committee of forty of its most distinguished members, of which Lord Justice Fry was the chairman. Among them were the present Home Secretary, the President of the Royal College of Surgeons, Mr. Justice Wills, Sir Joseph Lister, Dr. Wilks, Prof. Michael Foster, Dr. Bristowe, Mr. Power, Mr. Howse, Dr. Ord, Prof. Unwin, Mr. Thiselton Dyer, Mr. Anstie, Prof. Carey Foster, the Rev. Dr. Dale, and Mr. Cozens-Hardy. A second and much smaller Committee was then constructed by Mr. (now Sir Philip) Magnus, who had taken the lead in opposing some of the provisions of the previous scheme, and this Committee brought up, on report, a second and modified plan of reform, which passed Convocation last May, not without opposition, but by substantial majorities and with only minor alterations. This second Committee laid the amended scheme before the Senate and remain [illegible] charge of it. Meantime the Senate had appointed a Bom[illegible] were [illegible] mittee of its own members, who have for several A[illegible] been elaborating a scheme of their own, who h[illegible] already conferred both with the Committee of Convocation and with one appointed by the Teaching University Association, and who have now presented their Report to the Senate. Some opportune vacancies, which occurred in the latter body during the last two or three years, have led to the presence of Lord Justice Fry himself, and of Dr. Wilks, Dr. Pye Smith, and Prof. Carey Foster. It seems probable that a scheme of reform will be accepted both by Senate and Convocation, which will go as far as most who are sanguine could expect, and farther than most who are timid will approve. The Convocation of graduates will gain more direct representation, and the teachers of the Colleges which send up men for the University degrees will probably be also directly represented on the Senate. But a more important improvement, one that would be useful even if the Senate were to remain exactly as it is, will almost certainly be the institution of Boards of Studies, which will represent the teachers and probably the examiners in each Faculty, much like the standing Committees which sit under the same name at Oxford. The general body of teachers which would elect these Boards would include provincial as well as London Professors, and would more or less correspond to the Congregation of Oxford, but it would probably seldom meet, except for the purpose of election of the representative Boards of Studies.

The Association for Promoting a Teaching University held a general meeting several weeks ago, and admirable speeches were made, especially those of Mr. Marshall and Mr. Bryce, but it lacked the enthusiasm given by numbers. After communicating with the principal London Colleges and Medical Schools, the Council of the Association propose to apply either to the Crown or to Parliament, probably with the object of securing a Royal Commission on the whole question.

University College, after coquetting with the Victoria University (which has apparently not welcomed with great warmth the proposal of accepting so large and distant a Society as its daughter), is now engaged in direct negotiations with King's College, with a view to agreement upon a common plan of action. This is a prudent course, for if the reform of the University of London should prove unattainable or inadequate, the two chief Colleges, by acting together, would be far more likely to obtain the privileges which they then would rightly seek.

Meantime the great medical corporations have become tired of waiting. They represent the most urgent grievance, and are fully justified in pressing for its redress. They appear likely to ask for power to grant degrees to their own licentiates, though under what authority and on what terms, either of examination or of residence, they have not yet determined. They have the advantage of practically undivided counsels, of knowing what they want, and of having an indisputable cause of complaint. They are naturally supported by the whole influence of the medical schools of London, and it adds not a little to the complexity of the situation that those connected with University and King's Colleges prefer to throw in their lot with the other professional schools rather than to hold aloof and unite with the other Faculties of their own Colleges.

Of the several bodies concerned, it is possible that the Senate, or at least the Convocation, of the existing University may fear that the just value of its degrees, attained by fifty years' efforts, will be compromised by allowing teachers to have a voice upon the Senate. But they must see that if the University is forsaken by its two most important London Colleges after the secession of its only important provincial one (Owens College), and if the medical schools of London, which have supplied nine-tenths of its graduates in that Faculty, also forsake it, its position will be untenable. Even if it were suffered to exist as a degree-conferring machine for unattached and imperfectly-taught students all over the kingdom, it would become what its worst enemies have called it, a mere Government Board, and could scarcely keep the title of a University, still less of the University of London, when it

had been stripped (or rather had stripped itself) of both characters. Moreover, Convocation would lose all importance, and could not possibly retain the only powers it at present possesses, of nominating certain members of the Senate and accepting new charters. The Senate would do its sole work, of choosing examiners and revising their lists, as a small body of salaried Government officials (probably in South Kensington), and no claim would remain for the unconnected waifs and strays who passed the examinations to take any part in the matter. No charters would be requisite, nor any apparatus of library or Senate House, laboratory or lectures. In fact all the efforts of the past twenty years would be thrown away.

Nevertheless, if the two original Colleges of the University secede, they will find the name, the prescription and the influence of the Senate too strong for them to, wrest its powers from the present holders.

The medical corporations have far more influence and far stronger grounds; for the three or four strongest of them are organised as complete Colleges in their own Faculty, and give a more academic training to their students in medicine than either University or King's College does to students in arts, science, or laws. They might, perhaps, succeed in gaining power to grant degrees where the others failed, but this could only be by showing that no reasonable concessions were made to their just demands by the existing University.

Hence it will be seen that the present University of London, its two original Colleges, and the principal medical schools, have each of them the power of checking, if not of checkmating, each other's plans. Even if they agreed to urge their several objects without opposition to each other, the result would be three Universities existing together in London. One would have become a mere examining Government Board; another would consist of two ill-endowed and ill-consorted Colleges, without residence, with slender endowments, and compelled to extend their proper functions by attempting the instruction of partial students; the third would be a combination of two large professional corporations with Colleges in one faculty only, two or three well equipped, several very poorly furnished, and all of necessity rivals, scattered over the country, none of them endowed, and only able by the terms of their existence to give a second-rate degree.

What hope would there be of any one of these three so-called Universities even approximating to what a University of London should be? Each would be strong enough to prevent the others succeeding; none would be strong enough to absorb its rivals. Meanwhile the higher education would deteriorate rather than improve, endowments would be indefinitely postponed, and the prospects of the University laboratories, museums, and libraries of London sending out worthy contributions to the progress of human knowledge would become poor indeed.

When the several separate movements now in progress are checked by the necessity of obtaining the sanction if not the support of Government, we may hope that broader views will be taken of what is best for the community, and more sober views of what is practically attainable. Believing in the public spirit and the good sense of our countrymen, we have little fear but that, with patience and mutual concessions, a combined result will be obtained which will benefit all the parties to the new confederation, and promote the only interests with which this journal is concerned—the national interests of learning and of science.

A JUNIOR COURSE OF PRACTICAL ZOOLOGY

A Junior Course of Practical Zoology. By A. Milnes Marshall, M.D., D.Sc., M.A., F.R.S., Professor in the Victoria University, assisted by C. Herbert Hurst. (London: Smith, Elder, and Co., 1887.)

NOTICE will be found in the columns of this journal (vol. xxviii. p. 242) of the second edition of a small laboratory hand-book by the senior author of the above-named work, entitled "The Frog; an Introduction to Anatomy and Histology." In the preface to that we read: "The second instalment of the work, containing directions for the examination and dissection of a number of animals chosen as types of the principal zoological groups, is in active preparation, and will be published shortly." The author further acknowledges "valuable help from Mr. C. H. Hurst, Assistant Lecturer in Zoology in the College." Mr. Hurst now appears as junior author, and, although the work here under review differs in some important respects from its predecessor above referred to, we presume that it is the promised "second instalment."

The volume opens with an introduction, confined to the consideration of practical hints as to methods of working and manipulation; then follow fifteen chapters, each devoted to some one type of organisation, and the whole closes with an appendix, dealing with the uses and methods of preparation of reagents. We have, in all, a most successful and important book of 421 pages.

The work is largely akin, in its more salient features, to many of its predecessors; but it stands alone in respect of certain methods of treatment, to which we shall refer duly. Thick type has been employed throughout for the various headings, and the authors adopt the plan, introduced in the aforenamed smaller work, of printing the directions for dissection in italics. In dealing with the complications of the vertebrate skeleton, they have availed themselves of the printer's art, by way of restricting descriptions of homologous sets of elements to corresponding and distinct types.

The introduction is a model of perspicuity, and so well set as to render it impossible for the veriest tyro to obtain anything but full benefit therefrom. The advice given is sound in the extreme, and such as could only have embodied the results of a long and well-tried experience. The directions for injecting blood-vessels are, perhaps, a little too elaborate, being worthy of the *préparateur's* art, rather than of the ordinary beginner; this, however, is a small defect on the right side. We note that under the section on microscopical examination all reference to the micrometer has been omitted. Directions for measuring objects under observation should certainly be added to the next edition.

The several chapters into which the book is subdivided differ most conspicuously from those of certain earlier works in the fact that the more general statements made are diffused throughout the whole, except so far as they serve to define an animal under consideration, or to set

forth the predominant characters of a given system of parts. The chapters on Protozoa and the Leech may be consulted as fair examples. In the latter, advantage is taken of this method to force upon the student, somewhat prematurely, the fact that (p. 36) "the segmental arrangement affects in a marked manner the nervous, excretory, and reproductive systems, and, to a less degree, the circulatory and digestive organs," and the deduction that "it appears to result from a definite arrangement of parts which, in the ancestors of the leeches, were scattered irregularly through the body, much as in *Fasciola*" (dealt with in the previous chapter).

By way of contrast with its predecessor on the Frog, this volume is shorn of much that is histological. In the earlier work a special feature was made of this branch, but here it by no means receives that amount of attention which its importance demands. A start in this direction might well be made with the lung-structure of the bird and mammal, especially in view of the statement made (p. 389) concerning the mechanism of respiration in the former.

The detailed descriptions of the various animals chosen are, for the most part, exceedingly well rendered. A slight ambiguity has crept in in one or two places, and the descriptions of the vascular systems of the mussel and snail might well be amplified.

No portions of the descriptive text stand more in need of revision than those relating to the digestive glands. These are, in Anodon, Helix, Astacus, and Amphioxus, designated under the old term "liver." A certain amount of justification is forthcoming in the last-named case, in view of its blood-supply; but in the three first-named the striking results of recent research, which call for no comment here, ought at least to be suggested in the term "digestive gland" or "hepato-pancreas." While we would see, thus, the substitution of a modern term for one well-nigh obsolete, we would desire the withdrawal of the terms "kidney" and "ureter" as applied to the excretory organs of the Invertebrata. In the case of the mussel, in which a portion of that which our authors term "ureter," is glandular and secretory, the terminology as restricted by them becomes misleading.

Conspicuous among the novelties offered us are certain words new to students' books. The volume is fully up to date, and its authors are to be congratulated on having produced the first book for students in the language, which describes the receptaculum ovorum of the worm. As regards pure nomenclature, it is worthy of note that they have embodied, in describing the pterylosis of the bird's wing (p. 386), that introduced by Prof. Flower so recently as February 1886, in a lecture delivered at the Royal Institution; and necessitated by the splendid work in which he is being assisted by Mr. R. S. Wray. (The description of the barbules on the same page is in error.)

In dealing with the appendages of the insect, the nomenclature customarily applied to the crustacean limb is utilised. To this extension we heartily assent. On turning to the crustacean itself, we meet with an innovation far less deserving of support. Our authors, faithful to precedent, reduce the body of the decapod crustacean to twenty segments; but in so doing they discard the ophthalmic somite of their seniors, and press the telson into the service. This introduces a serious difficulty when the nervous system is taken into consideration, and a still more formidable one as concerns the homology of the eye-stalk. That is passed over in comparative silence, and, although we are not told so in as many words, it is clear that they regard it as in no way serially homologous with the appendages. The condition of the visual organ in the lower Crustacea and other arthropods, taken in conjunction with the facts adduced by Brandt and others in the morphology of the insect's eye, render it probable that the above view may turn out to be correct. Nor must it be forgotten that Boas has challenged (*Morpholog. Jahrbuch*, vol. viii.) the accepted interpretations of the antennule. There are, however, two sides to this question, and it is important to observe that M. Alphonse Milne-Edwards has recently described a decapod (*Palinurus penicillatus*, *Comptes rendus*, vol. lix., 1864), in which one ophthalmite was for the most part multiarticulate and antenniform. This remarkable fact is the more striking in view of the reversion to the antenniform type of certain post-oral appendages, seen in *Mastigopus* and *Apseudes* among the Crustacea, and so well known in the scorpion-spiders; whatever may be its precise significance, it is clear that the question of general homology of the eye-stalk, with which we are here especially concerned, is far from settled. The introduction of so sweeping a change into a book for juniors without due comment is, under these circumstances, a false step, especially when it is considered that the precise converse is stated in all other books current.

Equally unjustifiable, in that it affects another debatable question, is the statement (p. 379) that the bird's pre-pubic process corresponds to the pubis of mammals. Clear proof of this is not forthcoming. The student's hand-book is not the place for such dogmatisms: if asserted, they should be well qualified, and put as alternatives.

The retention of the old nomenclature for the bird's air-sacs, with its atrocious "*thoracic*" element, is disappointing; the substitution (p. 220) of "pericardio-*cœlomic*" for the well-tried pericardio-peritoneal canal of the fish is as misleading as it is misjudged; while that of "*connective*" for the time-honoured commissure is, on the whole, inadvisable. We live in a word-mongering age. New terms which do not mark a turning-point in advance, or at least the era of a new discovery, are stumbling-blocks, unless introduced by way of replacing irrelevant or absolutely fantastic precursors. Such is not the case with those here under consideration. Our position is somewhat that of the port-bound crew, in dread of being stranded on their own beef-bones.

Attention has been already directed to the diffusion of the more general matter throughout the text. This has been effected very successfully, and in well-chosen language deserving of the greatest praise; but we dissent from the method adopted. It will be generally admitted that Huxley and Martin's "Elementary Biology" dissipated for students of the subject, once and for ever, the subtle "cram"; and subsequent writers working along similar lines have, as was to be expected, attempted to improve upon the plan therein created, each after his own lights. Messrs. Marshall and Hurst have aimed at producing a work which they hope "may meet the wants

of those who desire to obtain a practical acquaintance with the elements of animal morphology, and who find the existing manuals insufficient for their purpose." It is to be assumed that they have been especially mindful of the needs of their own College, but the work also covers most of the requirements for the elementary examinations of other schools, and we presume the authors would wish it a general circulation among pure devotees. This said, we proceed to inquire into the method of treatment, and find with much regret that, at the outset, such deductions as are incorporated in the text almost invariably precede the description of those facts upon which they are based. For example: on p. 141, the alimentary canal of the crayfish—itself complicated—is ushered in with the words that it is "a tube running in a nearly straight line from mouth to anus. Of this tube, the middle portion, or mesenteron, which is very short, is alone formed from the primitive alimentary tract of the embryo, and the 'liver' is an outgrowth of it. The stomatodæum, or anterior portion of the canal and the proctodæum, or hind portion, which together form almost the whole length of the canal, are both formed by invagination of the external surface of the body; and both have a chitinous lining which is continuous, at the mouth and anus respectively, with the chitinous external covering of the body." Then follows the detailed description. Again, the podical plates of the insect are twice mentioned before the student is told how to find them. The tympano-Eustachian passage of the bird is (p. 414) similarly treated; and here the generalisation given should, if introduced at all, have been rather inserted when dealing with the mammal, on the supposition that, as can hardly be doubted, the authors would have the student work over the animals in the order of presentation. In such cases as the dogfish skeleton (p. 198), the limbs of the mammal and bird (pp. 287 and 376), and the enumeration of the differences between Amphioxus and the higher Vertebrata (p. 168), the system is tolerable, by way of clearing the ground and exciting interest. When, however, as in the first-cited instance, the crowning triumph of the student's labour is thus anticipated and his reward forestalled, deduction on reflection upon his work falls flat, and one of the chief aims of the whole system is lost. This, to our thinking, constitutes the gravest defect in this valuable work.

In describing the rabbit's liver (pp. 306-7), the lobes are rightly enumerated, but the student is not informed upon what grounds the customary nomenclature is adopted. In this, and one or two other instances, explanatory clauses are needed, but not given.

The illustrations are excellent, reflecting the greatest credit upon all concerned, and artistic merit such as that of Fig. 28 cannot fail to strike the reader. Fig. 27 is unnecessarily complicated, too much having been attempted. The beautiful new figures of Amphioxus are especially deserving of praise; but more of them are wanted, in order to do justice to the excellent description which they illustrate. Comparison of this chapter with that on the liver-fluke calls for this increase in number, in view of the relative chances of the student's procuring specimens.

Being mindful of the difficulties of preservation of Amphioxus, it is to be regretted that, while full directions are given for cutting sections, those for preservation, which have led up to the splendid results incorporated in this work, should have been omitted. This, the more so, as the animal is to be obtained in the Channel Islands, and is therefore within reach of the native student (a fact which should be mentioned in the text).

In dealing with the higher vertebrates, the authors follow one of their predecessors in first describing the skeleton. We doubt the advantages of this system, especially as in this work we have an "almost entire omission" of the muscular system, held to be "of subordinate educational value." The book, taken as a whole, is highly welcome and most admirable. It is provided with an exceedingly good index, and presented in a form demanding our sincere thanks alike to authors, printers, and publishers. Taking it, in conjunction with its predecessors, into account, we have to congratulate the student of zoology upon his accessions. This volume yields ample return for the immense labour which its authors have bestowed upon it; it is well worthy of the school which they represent, and of its prototype above named.

It is significant that the only typographical errors which we have detected should be the occasional absence of i and r. This fact might repay a careful research at the hands of the printer.

The authors state in their preface that "corrections or suggestions from those who use the book will be very gratefully received." Having dealt above with the more important matters which occur to us, we append comments on some of the more obvious among those of wholly minor importance, noted in perusing the volume.

Before proceeding to do this, we wish to call attention to two matters of exceptional note: the first, the respiratory folds of the lining membrane of the fish's mouth; the second, the attachment of the styloid element of the rabbit's hyoid-arch to the paramastoid process. It is indeed remarkable, seeing that these structures are of such common occurrence, and that they have been presented to every native student of recent years, that there is not yet a text-book in the language, or out of it for the matter of that, in which they are described. This is the more surprising in the case of the respiratory folds, in consideration of their general development among the gnathostomatous fishes.

The Hydra. We cannot accept the description of the supporting lamella as the "mesoderm"; it is misleading if not erroneous.

The Leech. There is no mention of the intermediary nerve.

The Earthworm. The description of the histology of the nervous system needs amplification, especially as concerns the distribution of the nerve-cells, by way of bringing out the nature of comparison with the other types. The account given of the blood-vessels is incomplete; the sub-intestinal trunk (described by Horst, *Niederland. Tidschr.* vol. xxxvii., and others) is not mentioned, that term being applied, in error, to the supra-neural vessel.

We strongly dissent from the description given of the œsophageal glands. Further investigation is necessary before we can accept their subdivision into the two categories here proposed. By our contemporaries, as by ourselves, much variation has been observed in their number and relationships, and we have seen examples in which all contained calciferous concretions and opened into the gut.

The Edible Snail. In describing the liver, the terms left and right have been transposed. Mention should be made of the salient features, in structure and distribution, of the teeth of the radula.

The Lancelet. To the description of the supposed excretory canals of Lankester (p. 178) there should be added that of the much more likely one of Hatschek (*Zool. Anzeiger*, vol. vii.). We accept the senior author's views on oviposition, but Quatrefages' observation should have been mentioned unless finally disproved.

The Dogfish. The remarks on ossification (p. 194) are erroneous. The statement (p. 211) that the labial cartilages probably "belong to the same category as the extra-branchials" is unfortunate, in view of Dohrn's discovery that the latter are displaced rays of the gill-septum.

In describing the relative positions of the roots of the spinal nerves (p. 252) the terms dorsal and ventral have been transposed. The description is irreconcilable with Fig. 36.

The Rabbit. The description of the shoulder-girdle needs revision, with respect to the coracoid element and the relations of the clavicle. The statements concerning the morphological value of the pisiform would be better free of bias, in view of the tendency of current research. In describing the pelvic girdle, mention of the cotyloid bone has been omitted, and consequently we find the statement that the pubis forms a portion of the acetabulum (cf. Parker, P.Z.S., 1882; also Leche and Krause, *Internat. Journ. of Anat. and Hist.*, vols. i. and ii.). The Eustachian cartilage is deserving of note.

The structural differentiation of the lining membrane of the stomach and base of the rectum need description. The duct of the infra-orbital gland is insufficiently noted; the description of the cæcum needs revision. It is interesting to find that the authors have not discovered the ducts of the rectal glands.

The statement explanatory of the uterus masculinus must be withdrawn or considerably modified, in face of Kolliker's belief that it is a derivative of the Wolffian ducts ("Entwickelungsgesch.," 2nd edition, p. 981). Its structural features and relationships are much more intelligible on this view.

The description of the fifth ventricle needs modification, and that of the spiral valve of the portal vein might well be inserted (Hyrtl, *Sitzb. Akad. Wien.*, 1879).

The Fowl and Pigeon. Note of the more important muscles of the syrinx, as also of the larynx of the mammal, might advantageously be added.

The ventricle of the olfactory lobe is not mentioned, either in the bird or rabbit.

In conclusion, we would wish to draw attention to the satisfactory manner in which the authors have apportioned the several chapters of this successful volume in accordance with their respective value—no light task of its kind. The thoroughness of the book is one of its most striking features.

G. B. H.

EMBRYOGENY OF THE ANTHROPOID APES

Recherches Anatomiques et Embryologiques sur les Singes Anthropoïdes. By J. Deniker. (Paris, 1886.)

THIS work was presented to the Faculty of Science of Paris as a thesis for the degree of Doctor of Natural Science, and was approved of by it as sufficiently meritorious to warrant the bestowal of that degree on the author. It consists essentially of a comparison of the fœtus of the gorilla and of the gibbon with that of man, and also with young and adult anthropoids.

The embryogeny of the anthropoid apes, notwithstanding the great interest which it presents, is unfortunately little known, probably owing to the difficulties of obtaining embryo specimens. The author has therefore done well to utilise the opportunity which presented itself to further our knowledge of the subject, by publishing the descriptive anatomy of the fœtus of the gorilla and the gibbon which he has had the opportunity of studying. His account of the anatomy of these specimens is rendered more valuable by the comparison he has made between them and the human embryo, and between them and the adult animals of their respective species.

The work begins by a careful description of the external characters of the embryo gorilla and gibbon: the attitude, external form, coloration, and integumentary characters are respectively detailed with much care. The placenta and fœtal membranes were fortunately preserved with the fœtus of the gibbon, and their characters are described and figured, but unfortunately these parts were not obtained with the young gorilla, and so could not be described. A *résumé* is given of the observations of Owen, Huxley, Turner, and others on the placentation of apes and monkeys. The next section contains an account of the weight and dimensions of the various parts of the body of the respective fœtûs. Of the former little can be said on specimens preserved in alcohol, but the dimensions of the entire body, the head, trunk, and extremities, are carefully detailed in a tabular form, with the corresponding measurements in the human fœtus at the fourth and fifth month, and of the adolescent gorilla. A second table shows the relations which the dimensions of the several parts bear to the length of the body, and a third table those between the trunk and the extremities, and between the different segments of the latter. These tables show several interesting points in regard to the proportions which the various parts of the body bear to one another in the course of development. During the second half of intra-uterine life the upper extremity in the anthropoids is much shorter in relation to the length of the trunk than in the adult, and the same relation holds good with respect to the length of the fore-arm as compared with that of the upper arm. In the human fœtus of the same age, on the other hand, the upper extremity presents almost the same proportions that it does in the adult. The relative length of the superior extremity as compared with that of the inferior changes likewise considerably in the course of development. Thus in man during the earlier stages of embryonic life the lengths of both extremities are almost equal, but in the anthropoid apes, at an early period even, the length of the superior limb exceeds that of the inferior.

The skeleton of the fœtus is next compared with that of the adult anthropoids. In treating this part of the body the author naturally devotes considerable attention to the various parts of the skull, and has drawn up several valuable tables of its measurements in the fœtus and adult. The second chapter on the skeleton is devoted to a description of the vertebral column, and the limb bones; while the third treats of the dimensions of the individual bones. The points of ossification of the skull are found to be the same in man and the anthropoid monkeys, but the rate of their development in the monkeys in many important respects differs from what obtains in man. In general it may be stated that the frontal region ossifies more rapidly, whereas the occipital

and petro-mastoid regions ossify more slowly than in man. The cranial sections unite probably in the same order as in man, but generally at an earlier age, nevertheless there are certain exceptions to this which are pointed out. The brachycephaly of the skull of young anthropoids diminishes as age advances. Elongation of the facial part of the skull occurs much more rapidly than that of the antero-posterior diameter of the cranial part, until the eruption of the teeth. Passing on to the osteological characters of the rest of the skeleton, we find that the points of ossification of the borders of the vertebræ in the fœtus of the anthropoids do not appear in the same order as in man, as they seem to form simultaneously in all the regions of the vertebral column. The points of ossification of the pleurapophyses of the cervical and sacral vertebræ appear later than in man. This is especially the case in the sacral region of the gibbon. The spinous processes of the cervical vertebræ are shorter in the fœtus and young gorilla than in the adult. In the former the sacrum is broader, the coccyx longer, and the sternum larger, than in the latter. The different segments of the upper and lower limbs, except the carpus, ossify more rapidly in the anthropoid monkeys than in man; the lower limb ossifies, however, more slowly than the upper.

The muscular anatomy of the young and adult anthropoids is fully described and compared, and presents many points of considerable interest. Contrary to the opinion of Bischoff, the muscles of the face are found by the author to be very distinct, not only in the adult but even in the fœtal state. The arrangement of the muscles of the neck, fore-arm, leg, hand, and foot are particularly noteworthy, especially when compared with those in man.

The encephalon of the fœtal gorilla was found to weigh 28 grammes, and equalled a sixteenth part of the entire weight of the body. In the fœtus of both the gorilla and the gibbon the cerebellum is very small, and is completely covered by the cerebrum. The relative and absolute dimensions of the brain of the fœtal gorilla correspond to those of the human fœtus at the fifth month, but in its convolutions it was equivalent to those of the human fœtus at the sixth month, while the frontal lobe corresponds to that of a seven-months child.

The heart of the fœtal gorilla, though absolutely smaller than that of the human, is much greater in proportion to the size of the animal: it is also more voluminous than that of the adult of the same species.

The form of the hyoid bone of the anthropoid apes resembles that of man more nearly in the fœtus than in the adult. Its ossification takes place earlier than in man. The ventricles of the larynx of the fœtal gorilla resemble those of man, and are not continued into the laryngeal sacs.

The development of the dentary follicles of the gorilla and gibbon takes place earlier than in man. The eruption of the milk-teeth occurs in the same order as in man, except that in the gorilla the teeth of the upper jaw appear before those of the lower, that is to say, the reverse of what generally obtains in man. The cæcal appendages increase relatively to age in the gorilla, while in man the contrary appears to be the rule. The spleen of the fœtal gorilla differs in form from that of other anthropoids and from that of man, and resembles more nearly the spleen of a carnivore. The liver of the gorilla has the four-lobed type-form common to the majority of mammals, and in this respect differs from that of man and the other anthropoids.

The work concludes with a chapter on the general result of the author's observations, in which he confirms the statement made several years ago by Huxley that the structural differences between man and the Primates which approach nearest to him are not greater than those which exist between the latter and the other members of the order of the Primates.

OUR BOOK SHELF

The Geographical and Geological Distribution of Animals. By Angelo Heilprin, Professor of Invertebrate Palæontology at, and Curator-in-charge of, the Academy of Natural Science of Philadelphia. (London: Kegan Paul, Trench, & Co., 1887.)

THE author of this book tells us that, while anxious to present to the student a work of general reference, wherein the more salient features of the geography and geology of animal forms could be sought after and readily found, he also wished to call attention to the more significant facts connected with the past and present distribution of animal life, so as to lead to a correct conception of the relations of existing faunas. The need of such a work will be generally acknowledged, and, without doubt, this little volume of some 400 pages does to a great extent supply the need; but it may be that the time has not quite arrived for the appearance of a perfectly satisfactory work on the subject. Though the record of both geographical and geological distribution is a vast one, still there is a vast deal more of the record yet to come, and the very pages of Prof. Heilprin's work show what immense additions to the facts and the deductions drawn from these are based on the as yet incomplete publication of the results of the *Challenger* Expedition. When the author has these results to rely on, we find a certainty of fact and a sureness of deduction which give confidence to a general reader or to a student.

The volume consists of three parts. In the first part the distribution of animals throughout space is treated of; in the second the succession of life, the faunas of the different geological periods, and the appearance and disappearance of species are dealt with; in the third the present and past distribution of individual animal groups is considered. On the many still debatable points the author is always judicious, giving when necessary the opinions both for and against; nor, as far as we have been able to judge, does he fail to call attention to difficulties that surround many of the problems he has to refer to. In reference to the subject of the appearance of species, we observe that he regards the once burning question of the animal nature of Eozoon as settled "through the negative researches of King, Rowney, Julien, and Möbius, the elaborate memoir of the last-named being conclusive."

For the class of readers for whom this work is meant, a glossary of the technical terms employed would have been very useful. Most of them can be learned on reference to original sources, but it would have been convenient to have them within the same cover.

Life-Histories of Plants. By Prof. McAlpine. (London: Swan, Sonnenschein, Lowrey, & Co., 1887.)

THIS book may be dealt with in a very few words. It professes to give the essential features in the life-histories of a considerable number of types. The descriptions are extremely scanty, but in spite of this, room has been found for many very doubtful statements. Thus we have Dodel-Port's speculations as to the fertilisation of red seaweeds

by the agency of small animals quoted as if they were well-established facts (p. 184). Chara is spoken of as "a sort of transition stage" between the red and brown seaweeds (p. 199). We fail to find any grounds for this extraordinary statement. We are informed that in Selaginella "the rain or dew will settle in the hollow of the leaf, and help to float the zoosperms; but in Pinus their dry and motionless representatives are more exposed to the wind on the outer surface of the leaf" (p. 279). It would be difficult to frame a sentence more hopelessly inaccurate than this.

The following passage from the introductory chapter is worth quoting: "Morphology by itself is thus seen to be a matter of mechanism, revealing nothing higher than a combination of mechanical movements, harmonious in action and beautiful in execution; but physiology, dependent on structure for the interpretation of the phenomena of life and the causes thereof, seeks to reveal the inner life as well as the outward expression of it" (p. 10). It will probably be new to most of us to learn that morphology reveals movements at all, mechanical or otherwise.

At p. 179 "apogamy" and "self-fertilisation" are used as equivalent terms; at p. 138 Spirogyra is said to produce gonidia, and at p. 25 reproduction in Selaginella is said to take place by means of a true seed.

We have only cited a few examples of positive errors, but throughout the book the terminology is strange and confusing, even where not absolutely incorrect.

The book is presumably intended for students "cramming" for examinations, but even for this purpose we fear that it will prove worse than useless. D. H. S.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Vitality, and its Definition

IT is perhaps desirable that I should offer a few words of explanation, by way of reply to several of your correspondents, who have commented upon certain statements in my recent address to the Geological Society.

In the first place, I think that any candid reader of that address will acquit me of being guilty of such presumption as to make a statement, on my own authority, concerning the vitality of seeds. My object was to contrast the greater stability of mineral structures with the lesser stability of animal and vegetable structures. Consequently I selected what I thought would be regarded as the *extreme* examples of prolonged vitality in the animal and vegetable worlds respectively. It was quite sufficient for my purpose that competent botanists have cited the case of the germination of seeds taken from ancient Egyptian tombs as authentic, and that a botanist of such eminence as A. de Candolle should assure us that it is "not impossible." As a matter of fact, I have been informed, however, by a reliable authority that experiments on the germination of seeds taken from mummies have very recently been conducted to a successful issue.

With respect to Mr. Herbert Spencer's definition of life, my object was not to find fault with it but to show that the differences between "organic" and "inorganic" matter are of so shadowy a kind as to defy definition. Even straining the meaning of the word "correspondence" so as to give it the force implied in the passage cited from the "Principles of Biology" by your correspondent Mr. Collins, I maintain that in those changes undergone by minerals to which I apply the term "physiological" there is a complete "correspondence with external sequences." When the temperature of a crystal is altered through a certain range, expansion and contraction take place unequally in accordance with the molecular structure of the mass. In consequence of this unequal expansion and contraction, stresses are produced and the crystal undergoes an internal molecular rearrangement, which is determined by a latent "organisation," though it can only be detected, perhaps, by its action on the light-waves. But now let another set of forces come into play, namely, the chemical action of liquids containing gases in solution, and immediately the effects of the former change are seen in the manner in which the crystal yields to the new forces operating upon it. This *secondary* change is in fact only rendered possible by the primary one having taken place. But the changes produced by solvent action in turn weaken the stability of the whole mass, permitting other chemical affinities to assert themselves, in consequence of which the crystal enters upon a long series of metamorphoses which terminate in the complete "dissolution" of the ties that held together its molecules; it thus becomes a pseudomorph, a sort of mineral corpse, with the external form of the original crystal only, but without any of that capacity for undergoing a wonderful cycle of changes which was its original endowment. After this the materials of the "dead" crystal may be used up to form the substance of new ones.

It is scarcely necessary to add that I had no serious intention of asserting that minerals do actually live, in the sense in which "living" is popularly understood. All I care to insist upon is that minerals, like animals and plants, go through definite cycles of change, dependent on their environment, and that the distinction between "organic" or "living" matter and "inorganic" or "lifeless" matter is therefore not a fundamental one. Surely no better proof of this can be adduced than the fact that the more exact we try to make our definitions of the terms "life" and "organisation," the more shadowy and intangible become the distinctions upon which we are driven to depend. I am perfectly satisfied with Mr. Herbert Spencer's admission of "insensible modifications and gradual transitions which render definition impossible." But if this be the case, it is surely not wise to maintain that the science of "non-living" beings must differ totally in its aims and its methods from that of "living" beings. To bring out into clear relief the analogies between the science dealing with the mineral kingdom and those concerned with the animal and vegetable kingdoms was the main object of my address.

JOHN W. JUDD

March 28

"The *Gecko* moves its Upper Jaw"

THUS by the substitution of one reptile for another—of the gecko for the crocodile—the well-remembered zoological statement in Arnold's Greek prose is at length put upon a satisfactory foundation. In the spring of 1886, I captured a small gecko (*Tarantola mauritanica*) at Rome, and I have hitherto succeeded in keeping it alive and in health. One of the first things I noticed about it was the extraordinary vigour with which so small an animal would bite one's finger. And the effect produced was certainly rather due to the lizard's expression of intense ferocity during the process than to the pinch which it was



FIG. 1.—The Tarantola in the normal position of rest.



FIG. 2.—The Tarantola prepared to bite, with the upper jaw raised.



FIG. 3.—The Tarantola biting,—a common position, in which the upper jaw is depressed below the normal.

able to give. The expression chiefly depends upon two things—the fact that the anterior part of the head may be bent downwards, and that the eyes are retracted into the head. Examining the former movement more carefully, it was seen that in opening the mouth the upper jaw is distinctly although slightly raised above the normal, so that the profile of the upper surface of the head becomes almost straight (compare Figs. 1 and 2). In biting fiercely it is common for the upper jaw to be depressed below the normal, as is plainly seen in a profile view (compare Fig. 3), although in other positions the curvature of the head is

normal, and again in others the profile may remain straight in biting (as in Fig. 2). As far as I could observe in Tarantola, the upper jaw was always raised in opening the mouth, and the profile of the head straightened from its normal curve when at rest, but on closing the mouth in biting the movement of the upper jaw depended upon the relative position of the animal to the object which it was biting. This depression of the upper jaw may be also often witnessed when the mouth is closed, and it may be produced by applying slight pressure to the head. The animal seems to make the most of its powers of expression, for on provocation it opens its relatively huge mouth with the greatest readiness, and will keep it open for a considerable time, during which its appearance is sufficiently awe-inspiring. The fact that the anterior part of the skull is not co-ossified with the posterior part is well known. Thus in Huxley's "Anatomy of Vertebrata" (1871, p. 225) the following statement is made concerning the geckos: "Neither the upper nor the lower temporal arcades are ossified, the post-frontal being connected with the squamosal and the maxilla with the quadrate by ligament;" and Mr. Boulenger informs me that had he been asked whether the upper jaw of such lizards is moved in biting, he would have been inclined to answer in the affirmative, reasoning from the well-known condition of the skull. But I believe it has not been hitherto actually observed that such movable articulations possess a functional value in the living animal, and that the geckos must be added to the well-known instance of the parrots as Vertebrata which move the upper jaw in biting. It is extremely probable that the same observations will be found to hold for other families of lizards. EDWARD B. POULTON

Wykeham House, Oxford, March 1

Weight and Mass

TILL some quite new facts are discovered, such as shall force us to reconsider our convictions (which have not been lightly formed), I do not think it profitable to accept a quasi-metaphysical challenge from my friend Prof. Greenhill. He has at heart, as strongly as I have, the cause of *definiteness* and *accuracy*:—and if he, as is natural for one in his position, feels inclined to sympathise with the "vernacular" of Engineers rather than object to it as I do, there is nothing for it but to agree to differ. My remarks on this aspect of the subject were of the most cursory and general character; and I went so far as to say that, as the book in question was written by a practical man for practical men, "perhaps we ought not to complain."

I cannot, however, go *so much further* as to allow, with Prof. Greenhill, that it is "perfectly correct" to use the words pound or ton "side by side in two senses." As regards this practice I, in turn, must quote from an unpublished letter of Clerk-Maxwell's. [The passage purports to be part of a (reported) speech by a well-known Evolutionist.]

"He regretted that so many . . . . were in the habit of employing the word in a sense *too definite and limited* to be of any use in a complete theory. . . . . He had himself always been careful to preserve that largeness of meaning which was too often lost sight of in elementary works. This was best done *by using the word sometimes in one sense and sometimes in another*; and in this way he trusted he had made the word occupy a sufficiently large field of thought."

I have three other remarks to make upon Prof. Greenhill's letter:—

(1) He shows the absurdity of defining the weight of a body as "the force with which it is attracted by the earth." Of course such a definition must necessarily be absurd provided it comes *after* an explanation (given by Prof. Greenhill) that "weight" is to be understood in the sense of "mass." But from this explanation itself it would unfortunately follow that *a body has weight even when it is no longer heavy*; as, for instance, when it is in a (supposed) cavity at the centre of the earth! Prof. Greenhill says that "weight" is "used in ordinary language in most cases" in the same sense as "mass." Surely the great majority of men regard weight from the point of view of the sublime Porthos:—

"Ma vaisselle d'argent . . . . qui doit peser de mille à douze cents livres, CAR je pouvais à grande peine soulever le coffre qui la renferme, et ne faisais que six fois le tour de ma chambre en le portant."

(2) He also speaks of certain difficulties imposed by the "rules of language." I do not ascribe to them so lofty an origin. They are the offspring of the dogmatic ignorance which has peopled the realms of science with Centrifugal Force and its fellow monsters.

(3) He has commented solely on a passing remark in my article, and says nothing as to its main purpose. I hope, however, that he will eschew "statical" measures of force, and give his hearty aid as well as his good wishes in the war of extermination which must perpetually be waged against the too luxuriant undergrowth of the scientific garden:—the circle-squarers, the perpetual-motionists, and (in the case before us) *the measurers of potential energy in terms of horse-power*.

P. G. T.

An Error in Maxwell's "Electricity and Magnetism"

IT may be allowed to me to remark that the error mentioned on pp. 172 and 223 of NATURE has its origin really in Helmholtz's renowned paper ("Ueber die Erhaltung der Kraft," 1847), p. 67), and that it thence found its way into most of the text-books on electricity. It has sometimes been detected and hinted at; for the first time, I believe, in C. Neumann's paper published in the *Ber. d. k. sächs. Ges. d. Wiss*, at Leipzig (1871), "Elektrodynamische Untersuchungen mit besonderer Rücksicht auf das Princip der Energie." There we find (p. 436) the formula—

$$T\nabla + T_1\nabla_1 = T^2w + T_1^2w_1 - TT_1\frac{dV_{01}}{dt} + \frac{dF}{dt},$$

which is identical with the equation of energy given in NATURE, p. 223, if we put—

$$\nabla_1 = A_1,\ w_1 = K_1,\ -TT_1V_{01} = T_w,\ F = T_r,\ \&c.$$

The formula is followed by the remark that it agrees entirely with the formula given by Helmholtz, the only difference being the last term $\frac{dF}{dt}$, which in the latter is wanting; thus we may say that by Helmholtz the potential energy of the system variably is expressed by zero.

Being formerly unaware of Neumann's researches, [illegible] another way, came to the same results, see the paper "Das Princip der Energie in seiner Anwendung auf die ponderomotorischen und elektromotorischen Wirkungen des elektrischen Stromes," published in the *Sitzber. d. k. böhm. Ges. d. Wiss*, (*vide* NATURE, vol. xxxii. p. 308). In this paper I have hinted at *one* probable cause of this and similar mistakes and their relatively difficult discovery, of which the repetition of the error in the *best text-books* is a decisive proof. This cause I believe to be the trivial circumstance that there is no consistent and generally accepted notation of the different forms of potential and energy. This renders the comparison of different writings on this subject sometimes quite perplexing. When, for example, two authors denote the *same thing*, the one by V, the other by $-V$, and when the first writes the expression $d(T_1T_2V)$ in the form—

$$T_1T_2dV + T_2VdT_1 + T_1VdT_2,$$

the other the *identical* expression $-d(T_1T_2V)$ in the form—

$$T_1T_2dV - T_2d(T_1V) - T_1d(T_2V),$$

it may happen that they themselves and also other readers overlook the difference of sign, and that they continue to reason as *if their* V *were identical*. Such mistakes occur oftener than is supposed. See the interesting note at the end of Sir W[illegible]m Thomson's paper on "Capillary Attraction," NATURE xxxiv. p. 369.

Could there not be found a means of avoiding the inconveniences caused by such mistakes and the loss of labour spent in detecting them? I dare not hint at the possibility of an international system of notations of the most important physical quantities; thoroughly consistent, and recommended by the highest scientific authorities; for the realisation of such a system would probably meet difficulties quite insurmountable.

Prague University, March 12 A. SEYDLER

Tabasheer

MR. DYER in his article on "Tabasheer" in NATURE of February 24 (p. 396), throws out the suggestion that the silica deposited in the joints of bamboo may have undergone a process of dialysis. It may be of some interest to him, and to your readers generally, to learn that plates of transparent compact silica, SiO_2, may be formed by dialysing the basic soda silicate. Four or

five years ago I discovered this, and succeeded in producing plates a quarter of an inch in thickness and four inches in diameter, by placing the basic silicate of soda within a dialyser, which was floated on dilute sulphuric acid, 1 part to 20. The plate of silica was formed in the floated vessel. A similar result may be obtained by placing in a wide test-tube a portion of basic silicate. Taking care that the upper portion of the tube is quite free from adhering silicate, the dilute acid should be poured on to the surface of the silicate without disturbing it. After a few hours the silica is eliminated in a crystalloid form.

Possibly the first process may help us to understand how tabasheer may have been deposited, while the second may throw some light on the formation of raphides, carbonic or some other acid being the active agent.

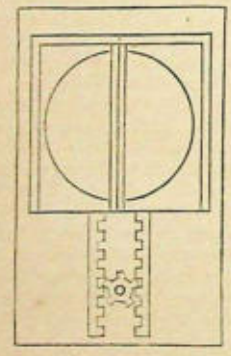
16 Sayile Street, Hull, March 15 THOMAS ROWNEY

A Method of Illustrating Combinations of Colours

IN NATURE, vol. iv. p. 346, there is a description by Mr. Allen, of Sheffield, of some methods of showing the combination of various colours on a screen. He used a biunial or "dissolving view" apparatus to produce overlapping disks of colours, and also three lenses mounted close together in place of the ordinary single lantern objective, and giving images of three apertures in a lantern slide, close to which were placed cells of coloured liquids.

His experiments suggested to me the following method, which I have used for some years past, and for which only the ordinary single optical lantern is required.

A lens 10 cm. in diameter and 15 cm. focus is cut in half, and the two halves are mounted in frames so as to be capable of sliding past each other precisely in the same way as the divided object-glass of a heliometer. The motion is given by a pinion acting on racks in the same way as in the ordinary double-action air-pump.



In the frames which carry the semi-lenses are cut grooves in which slips of coloured glass, or gelatine, or cells of coloured liquids may be placed; and the whole is fitted on the nose of the lantern in place of the usual objective, a diaphragm with round aperture about 3 cm. in diameter being put into the slide.

It is, when the two semi-lenses are so placed as to have their optical axes coincident, they act as a single lens and form one image of the aperture on the screen: but when they are moved past each other by turning the pinion, two disks of light are shown which can be separated entirely or made to overlap to any required extent. If, then, glasses or liquids of any given colours are placed in front of the semi-lenses, the compound colour produced by their union can be easily shown, either simultaneously with the component tints, or alone by accurately superposing the disks, thus avoiding any disturbing effect of the intrusion of other colours upon the eye.

It is in this way easy to show, taking four prominent colours, blue, green, yellow, and red, that blue + yellow = white; blue + red = purple; green + red = yellow, &c.

In place of coloured liquids, which are "messy" and liable to change, I almost always use coloured glasses, either singly or superposed (cobalt-blue, for instance, cemented to "signal-green" glass gives a good pure blue). Such glasses can by patient and careful selection be obtained of almost any required tint and intensity. H. G. MADAN

Eton College, March 26

Ice-Period on the Altai Range

IT is generally assumed that in the Altai Range there are no traces of so-called ice-ages. Hitherto, however, only ridges on the borders of the Altai Mountains have been examined. The geological phenomena of the mid-Altaic regions are still almost quite unknown. In the course of last summer it happened to me to visit some parts of the south Altaic regions—the Narim Range in the vicinity of Altaiskaia, Stornitza, or Koton Karagay, the neighbourhood of the Cossack settlement Oorool, then the so-called Katoon's Pales with their snowy giant Belooha. Subsequently I travelled in the valleys of the Belaia and Chernaia Berels, and visited the valley of the Arassan lakes and some other places. Everywhere I was struck by many and various traces and remnants of a large icy cover, which has left either strong glacier deposits, or abundant remains of moraines, or pieces of granite covered with lines. The valleys, too, bear on them the indubitable signs of glacial origin. In a word, there can be no doubt as to the existence of a large ancient icy cover here. Were these glaciers contemporaneous with the ice-age of Europe and North America, or do they present themselves as a quite independent system? My own observations convince me of their independence. The Altaic ice-period had, I think, its own causes. The Altaic system of mountains is of great antiquity; and its ridges were probably much higher at one time than they are now. Perhaps the whole system rose far above the line of eternal snow, although at present this line is reached only by some of the highest summits. It is probable, too, that in those very remote times the meteorological conditions of the country were far harsher than at present, because glaciers were more numerous and descended lower, digging the V-shaped valleys of the Katoon River, of the White and Black Berels Rivers, of Chindagatooy, &c.

The question of the periodicity of glacier-ages has again been raised lately, and perhaps it is from the Altai and from the Blue Alps that we may obtain the solid data for the complete solution of this very important question. A. BIALOVESKI

Oostkamenogorsk, November 1, 1886

A Claim of Priority

J'AI eu récemment l'occasion de lire dans le *Philosophical Magazine* (Août 1886) la description très-intéressante d'un "intégrateur sphérique," combiné par Mr. Frederick John Smith, et qui semble être une modification de celui du Prof. Hele-Shaw. Mais l'idée première de ces appareils, et c'est sur quoi je dois appeler votre attention, m'appartient sans doute, car dans le No. 630 du journal anglais NATURE (Novembre 24, 1881) j'ai donné la description d'un "Anémomètre Intégrateur," fondé sur le même principe, et qui a été plus tard cité dans le *Quarterly Journal of the Royal Meteorological Society* (No. 43, 1882), par Mr. Laughton ("Historical Sketch of Anemometry and Anemometers").

La modification imaginée par Mr. F. J. Smith, tendant à supprimer ou à amoindrir, autant que possible, le moment d'inertie de la sphère, me paraît excellente, surtout s'il fallait transmettre des vitesses quelque peu considérables. Mais quand il s'agit simplement d'enrégistrer celle du vent sur une échelle modérée, je crois que la forme primitive suffit, et, d'après plusieurs essais que j'ai faits, une bille d'ivoire roulant sur des cylindres de bronze c'est ce qui donne les meilleurs résultats.

Je vous prie, Monsieur le Directeur, de vouloir bien faire constater dans votre estimable journal cette réclamation de priorité, ainsi que d'agréer mes plus sincères remercîments et l'assurance de ma considération très-distinguée.

Observatoire de Madrid, le 12 Mars V. VENTOSA

Oktibehite or Awaruite?

IN the notice of the proceedings of the Geological Society of London (NATURE, December 23, 1886, p. 190) the discovery in New Zealand of a nickel alloy allied to *oktibehite* appears to be claimed by Prof. Ulrich, of Dunedin. This requires explanation, as the mineral was first determined, and named *awaruite*, after the locality, by Mr. W. Skey, Analyst to the N.Z. Geological Survey Department on September 28, 1885, and described by him in a paper read on October 25, 1885, and published in the local papers at the time, as well as afterwards in the Transactions of the N.Z. Institute, vol. xviii., issued May 1886. A notice of it is also given in my twenty-first annual Museum

and Laboratory Report, June 1886, of which I inclose a marked copy. It will be observed that while Ulrich accepts the identity of the New Zealand alloy with *oktibekite*, Skey's analysis shows that its formula is 2Ni + Fe, while that of the latter mineral is Ni + Fe.

JAMES HECTOR

N.Z. Geological Survey Office, Wellington, N.Z., February 9

AËRIAL VORTICES AND REVOLVING SPHERES

A STRIKING series of experiments on aërial vortices and revolving spheres has lately been made by M. Ch. Weyher, one of the directors of the important establishment for mechanical constructions at Pantin. An account of these experiments, with illustrations, appeared in a recent number of *La Nature* (February 26). As the results obtained by M. Weyher are very interesting, we reproduce the more important figures, and translate the descriptions given by our French contemporary.

Fig. 1.—*Aërial Vortices.*—A glass cylinder of about 0·40m. in diameter by 0·70m. in height, has an upper cover, pierced by a hole through which passes the shaft of the drum, the latter being formed of one or two paddles of cardboard put cross-wise upon the vertical shaft.

The cylinder contains some sawdust, or, better still, some oatmeal. If the oatmeal is put at first so as to form

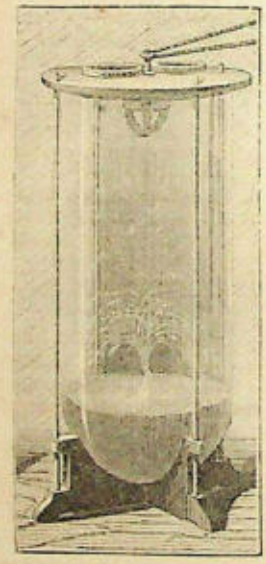


FIG. 1.

a cone or mound, and if the drum is turned round, a little waterspout can be seen forming at the top of the mound. Gradually the mass of oatmeal sinks into a hemisphere.

The matter runs without ceasing into spirals from the circumference to the centre; there it forms at first the lower cone, and then the upper reversed cone, in which the particles of oatmeal describe spirals, going from the centre to the circumference.

The whole system describes a primary general sphere, more or less distorted, the centre of which (where the two cones meet) is more or less deranged by the earth's gravity. If this is looked at from above, a hollow funnel is seen upon the axis: it is there that the air is most rarefied by rotation, and it is there that the finest particles come.

Substituting for oatmeal in the apparatus small light balloons inflated with air, the general movement can be followed. When the balloons are on the exterior circumferences, they fall in slow spirals; when they reach the circumferences nearer the axis of rotation, they rise rapidly upon a helix at a much more extended pace. In short, the experiment shows that, given a mass of air, if a

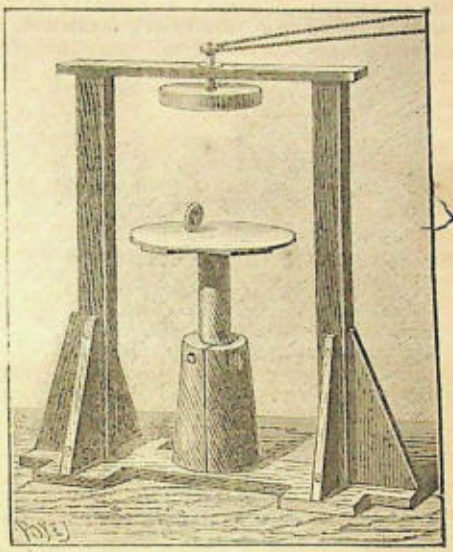


FIG. 2.

movement of rotation round a vertical axis is im[illegible] it this air falls constantly by the exterior circumfe[illegible]ences, and rises by the interior circumferences, and the *whole* volume passes unceasingly through the centre of

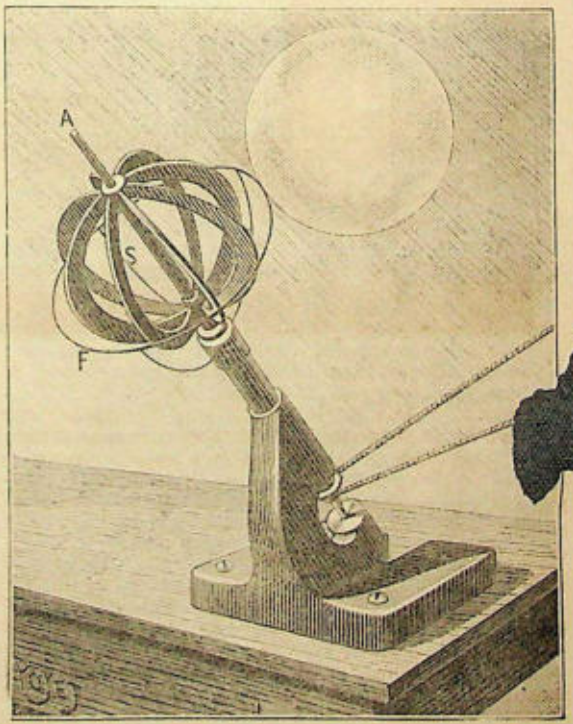


FIG. 3.

the vortex, drawing into its movement the substances or particles therein immersed.

Fig. 2.—A plate of glass or any other material is placed below a drum with paddles; when this drum is put in

motion, we immediately place upon the plate a disk or a coin, to which the fingers give a first movement of rotation round one of its diameters.

The hand being quickly drawn back, the aërial vortex continues to make the coin turn round like a top, and absolutely keeps it captive in its radius of action. The coin, while turning upon one of its diameters, makes a sphere, and a later experiment will show that a revolving sphere constitutes a centre of attraction.

Fig. 3.—*Equilibrium of Revolving Spheres.*—A free sphere keeps itself in equilibrium, and turns round another sphere, to which a rapid movement of rotation is imparted.

The apparatus consists of a pin, A, which is able to turn in a support, and has a pulley, made to receive a transmitted movement. Upon the pin A is placed a sphere, S, composed of from eight to ten flat circular pieces (these may be either flat disks, or disks cut into a crescent shape; it does not matter which). The pin may be at any angle whatever to the horizon; in this experiment it is inclined at 45°, but it may be horizontal

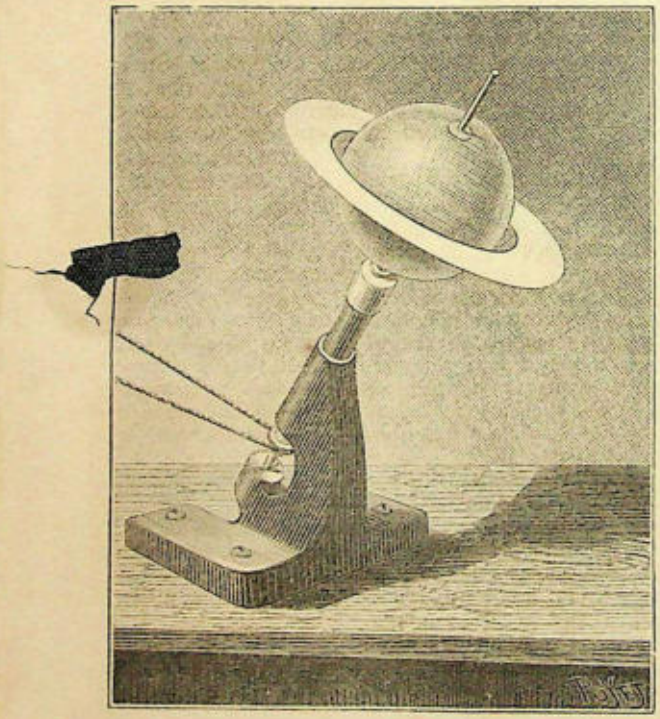


Fig. 4.

or vertical. The angle of 45° was chosen because it seemed to be most difficult for the experiment, which would therefore be the more conclusive. When the sphere S is turned round rapidly, you feel on the hand a strong blast which escapes all around from its equator. Bits of paper which are placed near it are thrown far away. Nevertheless, if a balloon is put near this blast, it is quickly attracted towards the revolving sphere, and describes orbits round it in the plane of the equator. As the experiment took place in a room, where there were obstacles producing eddies, and as also gravity has too much effect by reason of the proximity of the ground, it is very difficult to obtain a regular movement. The balloon comes easily in contact with the revolving sphere, and is then driven away by the collision too far to be caught again. A very simple contrivance consists in placing round the sphere S a wire guard or circle of iron, F, 1 millimetre in diameter, attached to the support by three similar wires.

The balloon will then keep on turning round the motive sphere, even ceasing to touch the guard in the lower part under the action of gravity. The experiment can be made in different ways, and the guard may even be suppressed, but these variations teach us nothing new.

In studying the vortex movements which the sphere imparts in the medium in which it is plunged, we easily calculate the ratio of the attraction which it exercises on the balloon.

Fig. 4.—The guard of the revolving sphere is taken away, and we place parallel to its equator a circle of paper with an interior diameter greater than the exterior diameter of the sphere; the circle is caught into the movement of rotation, and maintains itself strongly in the plane of the equator.

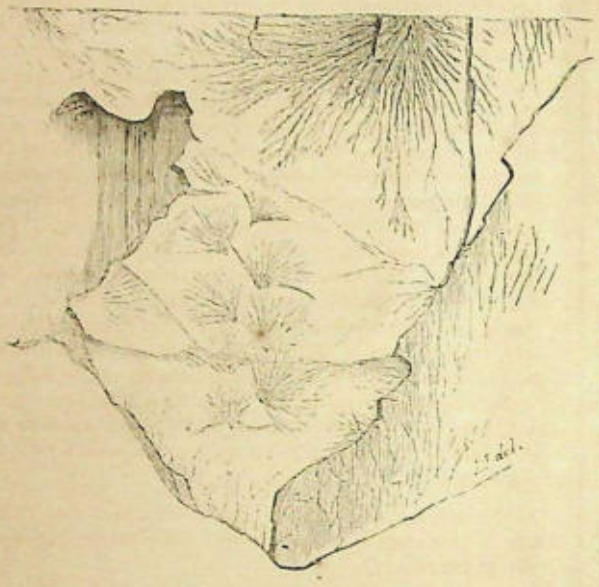
ON OLDHAMIA

THE organic origin of Oldhamia has often been disputed. Originally described by Edward Forbes from specimens found at Bray Head, near Dublin, in rocks of the Cambrian formation, it has been found in a few other localities in Ireland, in rocks of a similar formation. In the dispute the weight of the evidence has seemed to be in favour of the views of Forbes, Jukes, Harkness, and Kinahan, that this lowly form is a fossil probably belonging to the Polyzoa, or to the Sertularian Polyps. So the matter has stood for a long time. A recent paper by Prof. W. J. Sollas, published in the Proceedings of the Royal Dublin Society for January 1st, once again opens the discussion. In the hope of throwing light on this problematical structure, thin slices for microscopic examination were cut, both parallel and transverse to its planes of cleavage. When these were placed under the microscope, all trace of the Oldhamia structure appeared to have vanished. An examination with the unaided eye showed, however, that it was still there, presenting itself as narrow, undulating, and branching bands of a lighter colour than the surrounding matrix. Its appearance, moreover, varied in an extraordinary manner according to the direction in which it was viewed. Looked at obliquely in a strong light, the thread-like bands are brilliantly illuminated, and appear faintly coloured with spectral tints; looked at directly, the bands become fainter, and are less clearly distinguishable from the matrix. In certain positions the slice taken at right angles to the bedding has an appearance somewhat suggestive of shot-silk, and, from the planes of cleavage, markings which remotely resemble in form the dendritic markings of Sutton stones extend into the surrounding matrix.

These appearances suggest the presence of some mineral possessing high reflection or refraction arranged in more or less parallel planes. Mr. Teall, in the same paper, gives full details of the mineral characters of the rock. Aided by these, Dr. Sollas finds that the lighter-coloured bands, which correspond to the Oldhamia markings, owe their distinction from the surrounding matrix to the presence of an excess of sericite scales; and that the curious shot-silk appearances are produced by the local deflections of these scales from parallelism with the cleavage planes into directions tangential to curves, which are probably transverse sections of those long ridges which, when seen on the exposed surface of a cleavage plane, are recognised as the usual form of Oldhamia. It would appear possible that these ridges are wrinklings of the cleavage planes produced during the shearing which led to their formation. These observations were made on the form known as *O. radiata*, and in some supplementary remarks Dr. Sollas adds that when Oldhamia is present it shows itself on the surface of the laminæ as rounded discontinuous ridges, which are without definite boundaries, and have the appearance of fine wrinkles. When the phyllode is fractured obliquely to the cleavage laminæ, the Oldhamia markings are found to extend through the rock as fine ridges or wrinkles

which mark the surface of oblique fracture in a similar manner to those of the cleavage face. In fact, the appearances are remarkably similar to those of *ausweichungs-clivage*, described by Heim in his "Gibergsbildung"; but the observations throw no light on the remarkable radiate form sometimes assumed by the structure. In a paper in the same journal Mr. Joly mentions that, in examining specimens of *O. antiqua* and *O. radiata*, he detected the following peculiarity: a sunken or depressed delineation of one form accompanied a raised or relieved delineation of the other form. Thus, if on any specimen *O. antiqua* appeared as a depression, on that same surface the *O. radiata* appeared in relief.

From this observation it appeared probable, if any meaning was to be attached to the relation, that a further



relation would be found to obtain between the mode of delineation and the position in the rock. This, a further examination revealed; in this order: on the upper surface, or what was most probably the surface of deposition (the cleavage of the Cambrian slate of Bray Head coincides generally with the plan of bedding), the *O. radiata* appeared invariably as a depression, the *O. antiqua* in relief.

When fragments were peeled off the slate, the marks were found to be transmitted, or extending to the layers beneath, so that lines on the upper are seen as continued on the adjacent lower layer, this, too, for thicknesses exceeding a millimetre. The accompanying woodcut recalls the appearance of a surface of rock in which this is fairly well shown.

ON THE DISTRIBUTION OF TEMPERATURE IN THE ANTARCTIC OCEAN[1]

IN the regions of the Antarctic Ocean where icebergs are numerous, and where in winter the sea-water freezes, the distribution of temperature in the deeper layers of water is peculiar. The facts are detailed in the "*Challenger* Narrative" (vol. i.). The general result of her observations went to show that, from the most southerly station, a wedge of cold water stretches northwards for more than 12° of latitude, underlying and overlying strata at a higher temperature than itself (p. 418).

Although the conditions and facts likely to throw light upon the cause of the existence of this cold intermediate or superficial stratum overlying water which at any rate in its upper layers has a temperature higher than that of freezing distilled water are discussed, no satisfactory explanation of the phenomenon is given. One important fact is noticed at page 421. "The fact that the cold wedge above referred to extended north just as far as the icebergs did in March 1874 points to there being some connexion between the temperature and the presence of melting icebergs." It is well known that icebergs consist of land-ice, which is as nearly as possible pure frozen water, and melts in the air at 32° F. It was thought that the effect of immmersion of such a substance in a medium having a temperature 3° F. lower than its melting-point would be to indefinitely preserve it, that in fact only the lower surfaces of the icebergs large enough to reach to a depth of 300 fathoms would suffer any melting at all. The existence of the cold stratum was ascribed wholly to the cold brine, separated from the ice on the freezing of the sea-water, sinking downwards with an initial temperature of from 28°·5 to 29° F. This cause, though existing and in operation, is quite inadequate to produce the effect observed. In Dr. Otto Pettersson's admirable work "On the Properties of Water and Ice," undertaken in connexion with the work of the *Vega* Expedition, there is a footnote at page 318 where he says: "As a thermometer immersed in a mixture of snow and sea-water *which is constantly stirred* indicates − 1°·8 C., we may regard this as the upper limit of the freezing and the nether limit of the melting temperatures of sea-water." In a r[illegible] of Dr. Pettersson's work in NATURE (vol. xxviii. [illegible] expressed doubt of the accuracy of this observ[illegible] on repeating it I found it to be confirmed. It [illegible] complete explanation of the cold wedge of water in the Antarctic Ocean and the dependence of its thickness on the range of icebergs. These enormous islands of ice, a a very large proportion of which rise in tabular form to a height of 200 to 300 feet above the sea, float in many cases with their lower surfaces at a depth of from 250 to 300 fathoms. The warmer and denser water coming from lower latitudes (see "*Challenger* Narr." vol. i. p. 428) bathes these lower surfaces, the temperature of the mixture at the surface of contact falls, the heat abstracted from the sea-water melts a corresponding amount of the ice of the iceberg, and a saline solution is produced, less salt and therefore lighter than the water away from contact with the iceberg, and having a temperature which depends immediately on the strength of the resulting solution. Being lighter than the surrounding water, this resulting solution necessarily flows up along the sides of the berg to the surface, and its place is taken by fresh undiluted sea-water which in its turn is cooled, diluted, and transferred to the surface. The result is the production of a most energetic engine of circulation and means of cooling and equalising the temperature of the water within the reach of icebergs. As there is continual renewal o[illegible]e ocean water brought into contact with the ice, and [illegible]s composition is constant, the temperature produce[illegible]s practically constant, namely 28°·8 to 29°·0 F., or − 1°·7 to − 1°·8 C. The layer of lighter water from 50 to 80 fathoms thick at the surface is due principally to this melting of land-ice, though it is also due in very small proportion to the melting of sea-ice.

Table giving the temperature at which ice melts in sea-water containing different percentages of chlorine

Temp. C.	1°·0	1°·1	1°·2	1°·3	1°·4
Per cent. Cl... ...	1·040	1·131	1·222	1·313	1·404
Temp. C.	1°·5	1°·6	1°·7	1°·8	1°·9
Per cent. Cl... ...	1·495	1·586	1·678	1·769	1·880

This table is taken from a paper on ice and brines, communicated to the Royal Society of Edinburgh on March 21, 1887.

[1] Abstract of a paper read by Mr J. Y. Buchanan before the Royal Society of Edinburgh, March 21, 1887.

The density (at 15°·56 C.) of the sea-water which comes in contact with the lower surfaces of the icebergs is 1·0255, which represents a chlorine percentage of 1·90. Ice actually *melting* in this water would produce a temperature of −1°·92 C. When ice is *immersed* in this water it lowers its temperature, and a portion of the ice is melted, producing dilution. The concentration, therefore, or chlorine percentage, which will determine the melting temperature of the ice, will be a little lower than that of the original sea-water. From the *Challenger* observations we see that, on the confines of the pack-ice the cold stratum of water has a uniform temperature of 29° F. (−1°·67 C.). Ice melts at this temperature in sea-water containing 1·65 per cent. of chlorine. In this process ice is melted, so that 100 grammes pure warm sea-water become 119 grammes of diluted cold sea-water. It will be observed that the ice which has been formed in the atmosphere at a temperature of 32° F. comes in this way to be melted at a temperature of 29° F.; and the pressure exerted by the 300 fathoms of sea-water, though it may assist in the lowering of the melting temperature, is insufficient to account for the amount.

TO FIND THE DAY OF THE WEEK FOR ANY GIVEN DATE

HAVING hit upon the following method of mentally computing the day of the week for any given date, I send it you in the hope that it may interest some of your readers. I am not a rapid computer myself, and as I find my average time for doing any such question is about 20 seconds, I have little doubt that a rapid computer would not need 15.

Take the given date in 4 portions, viz. the number of centuries, the number of years over, the month, the day of the month.

Compute the following 4 items, adding each, when found, to the total of the previous items. When an item or total exceeds 7, divide by 7, and keep the remainder only.

The Century-Item.—For Old Style (which ended September 2, 1752) subtract from 18. For New Style (which began September 14) divide by 4, take overplus from 3, multiply remainder by 2.

The Year-Item.—Add together the number of dozens, the overplus, and the number of 4's in the overplus.

The Month-Item.—If it begins or ends with a vowel, subtract the number, denoting its place in the year, from 10. This, plus its number of days, gives the item for the following month. The item for January is "0"; for February or March (the 3rd month), "3"; for December (the 12th month), "12."

The Day-Item is the day of the month.

The total, thus reached, must be corrected, by deducting "1" (first adding 7, if the total be "0"), if the date be January or February in a Leap Year: remembering that every year, divisible by 4, is a Leap Year, excepting only the century-years, in New Style, when the number of centuries is *not* so divisible (*e.g.* 1800).

The final result gives the day of the week, "0" meaning Sunday, "1" Monday, and so on.

EXAMPLES

1783, *September* 18

17, divided by 4, leaves "1" over; 1 from 3 gives "2"; twice 2 is "4."

83 is 6 dozen and 11, giving 17; plus 2 gives 19, *i.e.* (dividing by 7) "5." Total 9, *i.e.* "2."

The item for August is "8 from 10," *i.e.* "2"; so, for September, it is "2 plus 3," *i.e.* "5." Total 7, *i.e.* "0," which goes out.

18 gives "4." Answer, "*Thursday*."

1676, *February* 23

16 from 18 gives "2."

76 is 6 dozen and 4, giving 10; plus 1 gives 11, *i.e.* "4." Total "6."

The item for February is "3." Total 9, *i.e.* "2."

23 gives "2." Total "4."

Correction for Leap Year gives "3." Answer, "*Wednesday*."

LEWIS CARROLL

NOTES

IN the Report submitted yesterday at Edinburgh to the half-yearly general meeting of the Scottish Meteorological Society, the Council state that the work at the Ben Nevis Observatory continues to be carried on by Mr. Omond and the assistants in the same highly satisfactory manner as has been recorded in previous Reports. In addition to the laborious work of observing at all hours of the day and night, of reducing the observations, and forwarding copies for the Society and the Meteorological Council, the staff of the Observatory has given very effective assistance in the preparation of the tables of the meteorology of Ben Nevis now in the press. Several interesting researches are being conducted at the Observatory, the results of which will be communicated to a future meeting. The Directors took steps last autumn to raise subscriptions to clear off the debt on the institution, and to establish a low-level station at Fort William, at which hourly observations may be made for comparison with those at the Observatory. It is only by two sets of observations at the top and bottom of the mountain that the Ben Nevis Observatory can be utilised, with the desired success, in the furtherance of meteorological science, but particularly in that branch of it which concerns the improvement of the system of forecasting the weather of the British Islands.

ON Tuesday evening last the Lord Advocate stated in the House of Commons that the Scottish Universities Bill would shortly be introduced.

THE Paris Medical Faculty has decided to alter considerably the mode of competition for its Fellowships. The general object of the changes is to secure more original workers. The thesis (which has usually been the work, not of the candidate himself, but of his friends) is to be suppressed. Each candidate will henceforth have to deliver a lecture on his own scientific researches.

THE French Chamber of Deputies has decided that the buildings of the College of France shall be considerably enlarged. Fifty years ago, when this institution had only seventeen professors, its present buildings were sufficient; but now, when it has forty-one professors, they are very inadequate. It is to have four new lecture-rooms, a geological gallery, a set of rooms for other collections, a library, a meeting-room for professors, and eight laboratories. These additions will cost over 9,000,000 francs.

THE Anatomical Society, founded last September at Berlin, will hold its first general meeting at Leipzig on April 14. The Society has now over 170 members in England, Germany, Austria, Hungary, Switzerland, Holland, Belgium, Scandinavia, France, Russia, Italy, and North America.

DR. HANS REUCH, who has lately devoted much time to the study of earthquakes in Norway, has issued a tabulated circular, which has been reproduced in the entire Norwegian Press, requesting that reports of any phenomena observed in connexion with earthquakes may be sent to him. By Government permission all such reports may be transmitted through the post free of charge. Dr. Reuch asks especially for information

on the following points: exact time of occurrence of the earthquake; the time compared with that of the nearest railway or telegraph station; locality of occurrence, and whether felt indoors or in the open; nature of soil; what the observer was occupied with; how many shocks were felt; nature of motion, undulating or oscillating; from what direction the shock came; whither it went; how long the motion lasted; what were its effects; did the shock resemble others experienced by the observer; was there any sound; was the sound heard before or after the earthquake; what was the interval between the shocks; were phenomena of restlessness in animals, or peculiarities of the weather, observed; if near sea or lake, were there any strange motions in the same; the names of any other persons who are known to have noticed the earthquake. Earthquake phenomena having been more than usually frequent in Norway during the past year, it is believed that Dr. Reuch's circular may be of considerable service to science.

AT a meeting of the Japanese members of the Seismological Society of Japan held at the Imperial University on January 20 (according to a report in the *Japan Weekly Mail*) two papers were read in Japanese. The first was by Mr. Kikuchi, on the geology of Corea. In it the writer described the geological map made by Prof. Gottsche, who visited that country after leaving Japan. The paper also gave a description of the geological formations and the minerals found in the different provinces of Corea, and showed that Corea differs from Japan in the fact that these formations in the former country are much older, and on that account more stable, than those in the latter. This, Mr. Kikuchi thought, might account for the comparative absence of seismological phenomena in Corea. The second paper, by Mr. S. Sekiya, was on recent destructive earthquakes. The writer described in succession the causes and effects of the earthquake which occurred in Japan on February 22, 1880; the earthquake at Ischia in 1883; the shock of October 15, 1884, in Japan; the earthquakes in Spain in 1884; those of the United States of last year; and the shock of January 15 in Japan. It was pointed out that the three earthquakes mentioned as occurring in Japan were very similar in their intensity, and that they extended over nearly the same area; but, with regard to their place of origin, the writer said the first two shocks originated in Tokio Bay, or in the ocean beyond the peninsula, while that of the present year originated in a spot to the south-west of the two previously mentioned. A third paper on the meteorology of Tokio was postponed. It appears from this and other reports which we have published from time to time that the Japanese Section of the Seismological Society, where the papers are read in the Japanese language, is, like the parent Society, in a very flourishing condition. It evidently supplies a demand for this department of science amongst Japanese who know no language well except their own.

AT the first meeting of the London Commission for the Melbourne Centennial International Exhibition, held on Thursday, the 24th inst., the chairman, Sir Graham Berry, said that the proposed buildings of the Exhibition would cover an area of more than 1,000,000 feet. It was decided that a deputation should ask Sir Henry Holland to take steps for the appointment, in connexion with the Exhibition, of a Royal Commission for the United Kingdom, and that the Foreign Office should be requested to communicate on the subject of the Exhibition with foreign Powers, India, and colonies other than Australasia.

ON Saturday evening last, a lecture on "The Habits of Ants" was delivered by Sir John Lubbock in the theatre of the Working Men's College, Great Ormond Street. The lecturer gave an interesting account of some of the results of his own observations, and brought forward much evidence to prove that ants possess "something more than mere instinct."

BY an Order in Council, dated March 7, Her Majesty has declared that the following antiquities shall be protected by the Ancient Monuments Act: (1) Little Kit's Coty House, or the countless stones of Tottington, at Aylesford, in Kent; (2) the chambered tumulus at Buckholt, in Gloucestershire; (3) the Druid's circle and tumulus on Eyam-moor, in Derbyshire; (4) the Pictish tower of Carloway, in Ross-shire; (5) the Ruthwell Runic cross in Dumfriesshire; and (6) St. Ninian's Cave, at Glasserton, in Wigtownshire. The Order will not come into force until it has lain for forty days before both Houses of Parliament.

IN the so-called Seelberg, where in 1816 the mammoth group which is the chief ornament of the Stuttgart Museum was found, further excavations are being made under the direction of Dr. Fraas. Many skeletons, weapons, and implements have been discovered, and Dr. Fraas is of opinion that the mammoth group found seventy years ago was artificially put together by prehistoric artists.

IN the *American Naturalist* there is an article by Mr. John Murdoch on what he calls "some popular errors in regard to the Eskimos." One of these "popular errors" is the notion that the Eskimos pass the winter "in a sort of hibernation, in underground dens, living in enforced idleness and supporting life by stores of meat laid up in less inclement seasons." Mr. Murdoch, who spent two winters at Point Barrow, says this is a wholly mistaken impression. In spite of the extreme inclemency of the climate, the winter, he asserts, is passed by the Eskimos "in one continued round of activity," and he gives a very interesting description of the manner in which they occupy themselves. Another "popular error" on this subject is the idea that the Eskimos always eat their food raw, and devour enormous quantities of blubber. At Point Barrow, Mr. Murdoch found that food was habitually cooked, although certain articles, like the "black skin" of the whale, were usually eaten raw. Taking into account the fact that the Eskimos have no butter, cream, fat, bacon, olive-oil, or lard, he doubts whether much more fat is consumed by them than by civilised peoples. At Point Barrow the fat of birds and the reindeer was freely partaken of, but comparatively little actual blubber either of the seal or whale was eaten. "Seal or whale blubber was too valuable,—for burning in the lamps, oiling leather, and many other purposes, especially for trade."

A BOOK on "Sensation and Movement," by M. Ch. Féré, of Paris, has just been published. The author tries to show how different sorts of sensations react upon the vasomotor and motor phenomena, as indicated by pletysphygmograph and dynamometer.

IN a work on "The Nationalities of Bohemia," lately published, Dr. L. Schlesinger shows that 37·11 per cent. of the population of that country are Germans, and 62·83 are Czechs. The limits within which the languages of the two races are spoken are generally very sharply drawn. There are 13,184 inhabited places in Bohemia, and in 4304 of them German alone is spoken, in 8473 the Czech language alone. In only 407 places are both languages used.

THE death is announced of Prof. Simon Spitzer, Professor of Analytical Mechanics at the Technical High School of Vienna, the author of various well-known mathematical works. He died on March 16 at the age of sixty-one.

THE new University building at Upsala is approaching completion. It has been in course of erection since 1879, and will be one of the finest University buildings in Europe. It will be opened with great ceremony on May 18 next by the King of Sweden, in presence of delegates from the principal foreign Universities.

LAST week the American Government forwarded another consignment of whitefish ova to the National Fish-Culture Association. These have been taken from late spawners, and appear more healthy than the batch sent in January. The ova are well "eyed," and in some cases are on the point of incubation. A consignment of the Californian trout ova, viz. the Rainbow (*S. iridens*), has likewise been received by the Association from the American Government. This variety is likely to become highly popular in England on account of its unique colour and form and its capacity of gaining flesh rapidly.

WHEN the South Kensington Aquarium was closed, the sea-trout which had been maintained there were transferred to ponds in the Delaford Park Fishery; and in February last many ova were taken from them and crossed with the *S. fario*, as in previous years. There are now a large number of hybridised examples of *S. trutta* in the ponds produced from ova shed in the South Kensington Aquarium and crossed in a similar manner. The two-year-old specimens are now about 7 inches long, their size being much smaller than that of other trout of the same age. None of the fish have spawned.

THE meaning of the word "scientist" seems to be rather vague in the country in which it originated. In his annual address as President of the Philosophical Society of Washington, lately published, Mr. John S. Billings says the word was a coinage of the newspaper reporter, and, "as ordinarily used, is very comprehensive." Webster defines a scientist as "one learned in science, a *savant*." Mr. Billings, however, thinks that the suggestion conveyed by the word "is rather that of one whom the public suppose to be a wise man, whether he is so or [illegible] of one who claims to be scientific." In his address, the subject of which is "Scientific Men and their Duties," he himself uses the term "in the broadest sense, as including scientific men, whether they claim to be such or not, and those who claim to be scientific men, whether they are so or not."

PROF. SARGENT, Director of the Arnold Arboretum of Harvard College, estimates that five foreign trees are planted in New England to one native. Yet, of all foreign trees introduced into America, the willow alone, he thinks, has qualities not possessed in a greater degree by some native. The European oak is perhaps the most unsatisfactory deciduous tree that has been experimented upon: it grows rapidly when young, but fails, when about twenty years old, from the cracking of the main stem, and then, after dragging out a wretched existence a few years longer, it miserably perishes. The Scotch pine dies long before reaching maturity, and the Austrian and the Corsican pine seem to be no better. The Norway spruce, which has been for many years the most widely cultivated foreign tree in Massachusetts, becomes decrepit and unsightly just at that period of life when trees should become really handsome in full development.

THE Sonnblick Observatory, in the province of Salzburg, Austria, is the highest in Europe, being 10,177 feet above the level of the sea. It was established chiefly through the exertions of M. Rojacher, proprietor of the mines in that district, in conjunction with the German and Austrian Alpine Club, and the Austrian Meteorological Society. Telephonic communication was established with Rauris, a distance of 15½ miles, and observations were commenced in September 1886. Observations at such elevated stations offer much that is of interest to science generally, and more especially as regards those problems of meteorology which relate to the variations of pressure, temperature, and humidity in the upper regions of the atmosphere. In the *Meteorologische Zeitschrift* for February last, Dr. Hann gives an interesting account of the first three months' observations. The mean temperature in October was 25°·9 F.; in November 15°·3, and in December 8°·1. In October, the decrease of temperature with height during the barometrical minima was, generally, rapid. But during the barometrical maxima it was very slow in the lower strata, up to about 5900 feet; then an increase of temperature with height frequently occurred. The periods of high pressure were generally warm intervals on the Sonnblick, and the periods of low pressure were cold intervals. It is noteworthy, however, that the change of temperature with height, in the strata between about 5900 feet and the summit, was almost independent of the conditions of weather, being nearly constant during the whole month, and amounting to about 1°·3 F. per 328 feet (100 metres); while in the lower regions, from about 1300 feet to 5900 feet, it varied between 0° and 1°·1. And, generally speaking, the same rates of decrease of temperature obtained in November and December. During the period of high pressure, on October 1 to 5, which was the warmest part of the month, the march of relative humidity showed a great contrast at the high stations and at the valley stations, humidity being greatest at noon at the high stations, and lowest in the valleys. As regards wind, it may be remarked that early in November the anemometer became a shapeless mass of hoar frost. It remains to be shown what use can be made of the observations on such elevated stations for the practical work of weather-forecasting. The observers of the Pic du Midi claim to have foretold, from the conditions at that Observatory, the disastrous floods that occurred in the South of France at the end of June 1875, and thereby to have rendered important services by their timely warning.

THE Norwegian Government has taken another step towards discovering the origin and nature of the terrible disease leprosy, which is so common on the west coast of Norway, by despatching Dr. G. A. Hansen, Director of the Leprosy Hospital at Bergen, to North America, for the purpose of inquiring into the heredity of the disease among Scandinavian emigrants to the United States.

SOME interesting statistics concerning the libraries of the United States have been printed in America from advance sheets of the forthcoming Report of the Bureau of Education. There are in the United States 5338 libraries, each with 300 volumes or over. Of these, 2981 have each 1000 volumes or over. Forty-seven have each over 50,000 volumes; and among the forty-seven are the public libraries of Boston, Chicago, and Cincinnati, and the libraries of Harvard, Columbia, Yale, Cornell, and Brown Universities. These forty-seven libraries aggregate 5,026,472 volumes; and the whole list of 5338 libraries aggregates 20,622,076 volumes, or one volume to every three persons in the country. In round numbers the United States has one library to every 10,000 of population, though in many States the proportion is far greater. New Hampshire, for example, has a library to every 2700 persons. Massachusetts and Connecticut furnish a library to every 3134 and 3479 persons respectively. California, Colorado, Wyoming, and Michigan, are well up on the list. Arkansas, which stands lowest, has one library to every 50,158 of population.

SOME time ago we reviewed a little book entitled "A Year with the Birds," by an Oxford Tutor. A second edition has now been issued. The author has added a chapter on the Alpine birds, and has also made a considerable number of additions and corrections in the original chapters.

THE annual general meeting of the Linnean Society of New South Wales took place on January 26. The usual address was delivered by the President, Prof. W. J. Stephens, who presented a general summary of all the scientific work included in the year's Transactions. He also drew attention to the labours of other scientific Societies of Australasia during the preceding year, and concluded with some observations on scientific teaching in general schools.

THE additions to the Zoological Society's Gardens during the past week include a Malayan Bear (*Ursus malayanus*) from Malacca, presented by Mrs. Bingham; a Common Squirrel (*Sciurus vulgaris*), British, presented by Mr. H. B. Meadows; two Tree Pipits (*Anthus arboreus*), British, presented by Mr. W. B. Tegetmeier; two Dwarf Chameleons (*Chamæleon pumilus*), two Robben Island Snakes (*Coronella phocarum*), a —— Toad (*Bufo angusticeps*) from South Africa, presented by the Rev. G. H. R. Fisk; two Pondicherry Vultures (*Vultur calvus*) from India, two Ocellated Sand Skinks (*Seps ocellatus*), South European, purchased; two Black Lemurs (*Lemur macao*), a White-fronted Lemur (*Lemur albifrons*), born in the Gardens.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1887 APRIL 3-9

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on April 3

Sun rises, 5h. 33m.; souths, 12h. 3m. 22·6s.; sets, 18h. 34m.; decl. on meridian, 5° 18′ N.; Sidereal Time at Sunset, 7h. 21m.

Moon (Full on April 8) rises, 12h. 29m.; souths, 20h. 12m.; sets, 3h. 44m.*; decl. on meridian, 15° 47′ N.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury ...	4 57 ...	10 50 ...	16 43 ...	2 13 S.
Venus	6 26 ...	13 53 ...	21 20 ...	15 46 N.
Mars	5 44 ...	12 22 ...	19 0 ...	6 44 N.
Jupiter... ...	20 16* ...	1 22 ...	6 28 ...	11 12 S.
Saturn... ...	10 13 ...	18 22 ...	2 31* ...	22 29 N.

* Indicates that the rising is that of the preceding evening and the setting that of the following morning.

Occultations of Stars by the Moon (visible at Greenwich)

April	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image ° °
7 ...	46 Virginis	... 6	... 21 23	... 22 6	... 351 275
7 ...	48 Virginis	... 6	... 22 59	.. 0 2†	... 28 271
8 ...	B.A.C. 4647	... 6	... 19 57	near approach	302 —
9 ...	94 Virginis	... 6	... 1 12	... 2 22	... 59 273

† Occurs on the following morning.

April	h.	
3 ...	13 ...	Mercury stationary.
9 ...	3 ...	Jupiter in conjunction with and 3° 20′ south of the Moon.

Saturn, April 3.—Outer major axis of outer ring = 41″·9; outer minor axis of outer ring = 17″·5; southern surface visible.

Variable Stars

Star	R.A. h. m.	Decl. ° ′		h. m.	
S Persei	2 14·8	58 4 N.	Apr. 9,		*M*
ζ Geminorum ...	6 57·4	20 44 N.	,, 4,	22 0	*M*
S Cancri	8 37·5	19 26 N.	,, 9,	21 57	*m*
V Bootis	14 25·2	39 23 N.	,, 9,		*m*
δ Libræ	14 54·9	8 4 S.	,, 6,	21 55	*m*
U Coronæ	15 13·6	32 4 N.	,, 6,	20 26	*m*
S Coronæ	15 16·8	31 47 N.	,, 6,		*M*
S Scorpii	16 10·9	22 37 S.	,, 4,		*M*
R Ursæ Minoris ...	16 31·5	72 30 N.	,, 5,		*M*
U Ophiuchi... ...	17 10·8	1 20 N.	,, 3,	1 52	*m*
		and at intervals of		20 8	
U Sagittarii... ...	18 25·2	19 12 S.	... Apr. 5,	3 0	*m*
			,, 8,	2 0	*M*
R Scuti	18 41·5	5 50 S.	,, 8,		*m*
β Lyræ... ...	18 45·9	33 14 N.	,, 3,	21 0	*m*
			,, 7,	2 0	*M*
η Aquilæ	19 46·7	0 43 N.	,, 6,	22 0	*m*
R Sagittæ	20 8·9	16 23 N.	,, 8,		*M*
δ Cephei	22 25·0	57 50 N.	,, 4,	2 0	*m*
			,, 7,	20 0	*M*

M signifies maximum; *m* minimum.

GEOGRAPHICAL NOTES

THE new number of the *Mittheilungen* of the Vienna Geographical Society contains several letters written by Dr. O. Lenz during his journey from Kasonge, on the Upper Congo, and the Shiré River, to the south of Lake Nyassa (June to December 1886). These letters are, to a large extent, occupied with details of the troubles which Dr. Lenz had with his men. Kasonge is a most unhealthy town. Bohndorf, Lenz's companion, was struck down with fever, and had to be carried most of the way, while small-pox broke out among his men, seriously hampering the proper work of the Expedition. Lenz left Kasonge on June 30, and reached the Island of Kavala, off the west shore of Lake Tanganyika, the head-quarters of Capt. Hore, on August 7. On the route he passed many villages recently built by Zanzibaris, the native population having retired into the forests and mountains. The region is mainly an open table-land, sometimes of a beautiful park-like aspect, and with the river-valleys thickly wooded. As Tanganyika was approached, the plateau rose to a height of 3000 to 4000 feet, with mountains rising from its surface to an equal height. The chief rock was granite, with crystalline slates, and wooded spurs. After staying a few days with Mr. Hore, Dr. Lenz crossed to Ujiji, which he reached on August 15. Here he found himself compelled to give up his proposed journey to Emin Pasha, and in a large boat he and his men sailed down the lake to the south shore, which he reached on September 27. Mr. Hore informed him that the Lukuga River now flows with a strong current out of Lake Tanganyika to the Lualaba. Mr. Hore, who has known the lake for ten years, assured Dr. Lenz that during that time its level has fallen 15 feet, and as the latter sailed down the lake he saw clearly enough the marks of the old shore-lines. With difficulty Dr. Lenz obtained assistance on the inhospitable south shore to continue his journey onwards to Lake Nyassa. This route has been traversed several times, and Dr. Lenz does not in these letters add much to our knowledge. It is a plateau with mountains rising from it to a considerable height, and to the south-west of Lake Tanganyika he came upon the sources of the Chambeze, which, flowing into Lake Bangweolo, may be said to form the remotest sources of the Congo. On October 17 he reached Nkonde, on Lake Nyassa, a station of the African Lakes Company, and thence made his way down the lake and on to the River Shiré, whence his last letter is dated, in December 1886.

IN the same number will be found the conclusion of Herr Glaser's paper on his journeys in South Arabia, in which he gives some important information on the various classes of the population. He speaks in the worst possible terms of the climate of the region: highland and lowland are equally bad, and deadly for Europeans.

THE leading paper in the last number of the *Verhandlungen* of the Berlin Geographical Society is Dr. Wolf's account of his important exploring work on the Sankuru, the great southern tributary of the Congo. This he navigated upwards from the Kasai, exploring its three great sources, the Lomomi, the Lussambo, and the Lubi. It is on the whole a magnificent water-way, its banks in many parts thickly wooded and densely populated. He gives much information concerning the two leading peoples here, the Bakutu and the Baluba, both of them evidently intruders on the Batua, the pygmy people referred to in our last number, the former coming from the north-west and the latter from the south-east. Herr Stäudinger adds considerably to our knowledge of the Niger region in his narrative of his journey from Loko, on the Binué, to the kingdoms of Saria, Kano, Sinfarra, Sokoto, and Gando.

HERR FERDINAND SEELAND contributed to a recent meeting of the Austro-German Alpine Club some useful data on the rate of movement of the Pasterz Glacier. On October 3 last he found the glacier entirely free from snow, and he was lucky enough to find six pegs which he inserted in 1882 near the Hofmann Hut straight across the glacier to the base of the Glockner, and also two stones which he laid down in 1884. In the four years 1882-86 the first peg had moved downwards 121·5 m. (*i.e.* at the rate of 3·5 mm. per hour), the second 162 m. (4·6 mm.), the third 175·5 m. (5 mm.), the fourth 192·3 m. (5·5 mm.), the fifth 201·5 m. (5·8 mm.), and the sixth 198·6 m. (5·7 mm.). Of the stones, in the two years one had moved 104·2 m. (5·9 mm.), the other 100·7 m. (5·8 mm.). According to these results (in the direction from the north edge of the glacier towards the centre), the mean rate of

movement on a slope of 4 to 5 degrees is 5·23 mm. per hour, or 125·1 mm. per day. Herr Seeland left the pegs and stones where they were, and laid down other marks for future measurements.

Lieut. Wissmann, who has already done so much good exploring work in the Congo region, started in November last on a fresh expedition, from Luluaburg, the station on the River Lulua, an affluent of the Kasai. Wissmann goes first to the junction of the Lubi with the Sankuru, the great southern tributary of the Congo. Thence he will endeavour to push northwards and explore the unknown country in which the Lulongo, the Chuapa, and the Lomami take their sources. He will then seek to reach Nyangwé, when he will make up his mind either to proceed northwards to the Muta Nzigé, or south to explore the Lanji, the Lukuga, and the Upper Lualaba.

The paper at Monday's meeting of the Royal Geographical Society was by Mr. J. T. Wills, on the region between the Nile and the Congo. It was a summary of all that we know of the region, and places us in a position to appreciate the value of any exploring work which may be done by Mr. Stanley. It deals succinctly with all recent explorations of the Upper Nile region, and with the intervening country between that and the Middle Congo. The valuable work of Dr. Junker, as well as that of Emin Pasha, receives special prominence. Mr. Wills rightly dismisses the Shari hypothesis in connexion with the Welle-Makua, and insists on the identity of the Makua and Mobangi. The Mobangi is known to be a waterway not inferior to the main Congo for practical purposes; deep, never less than 600 yards wide, even in February, when the Kuta Makua certainly (and it too apparently) is at its lowest level; and navigable at all times from Stanley Pool 650 miles thence straight north-north-east to lat. 4° 20′ N. beyond the limit which the Congo State, by private treaty with Germany, has placed to its future "sphere of operations," and beyond the limits which the French will probably occupy if they win in their dispute with the Congo State as to which of the two shall not operate in the Mobangi basin. It is then found to turn sharply to the east, flowing from the east through a gap it has cut in a line of quartz and red clay hills 1000 feet high, hills which may be continuation of the hilly watershed between the Makua at Ali Kobo and the sources of the Ngala. One would expects rapids at such a place, but there is only a good current and some awkward rocks; after reconnoitering in a boat, Mr. Grenfell got the *Peace* through easily, in February. Where we know the Kuta Makua next, they are placid and colossal; the Shinko at Marra is still 90 yards wide, 20 to 35 feet deep in October, and only 1980 feet above the sea. The average fall thence to Stanley Pool (1070 feet above the sea) is by this only some 9 inches to the mile, and the main Congo appears to nearly maintain this slope up to Bangala, beyond the Mobangi mouth.

BIOLOGICAL NOTES

Injurious Fungi in California.—The following facts recorded by Prof. W. G. Farlow are not without interest in Europe: *Nicotiana glauca*, abundant in Mexico, attracts attention by its pleasing foliage and graceful habit; it is a native of Buenos Ayres, but is acclimatised in Mexico. Within the last few years it has escaped from cultivation in California, and is now a common weed by the roadsides. At San Diego Prof. Farlow noticed that the leaves were badly attacked by a fungus which formed large, grayish-black spots on both sides of the leaves. Examination proved it to be *Peronospora hyoscyami*, De Bary, which was first found on *Hyoscyamus niger*, L., in Europe, where it does not appear to be at all common. Since it is well known that the species of Peronospora attack different species of flowering plants which belong to the same natural order, it is much to be feared that the disease which now attacks *N. glauca* may sooner or later extend to the cultivated tobacco, which belongs to the same genus. If this were to happen, the injury to the tobacco would be very great, since, by causing large spots on the leaves to rot, they would become worthless for manufacturing purposes. The question of the possible spread of the disease is one of importance, for it would be a very serious thing if it were to reach the great tobacco-growing regions of States like Virginia.

Fertilisation of Cassia marilandica.—The relation of insects to flowers continues to be a question of profound interest, but Mr. Meehan thinks that the dependence of a plant on insect aid is rather an indication that, instead of any material aid to its race being gained, its race is nearly run; he thinks that the opposite assumption has been an injury to the study of the main questions on fertilisation, and that the statements of Darwin and Asa Gray do not warrant the generalisations that have been drawn from them. In *C. marilandica* the phenomena attending pollen-formation are curious and apparently little known. The stamens are arranged in different sets. There are three beneath the pistil—the two lateral ones are very strong and equal the pistil in length, the central one immediately beneath the pistil is as long as those on each side, but more slender. Immediately above the pistil are four stamens, with short stout filaments, the anthers being perfectly formed and nearly as long as in the lower set. Above are three petaloid stamens. All the stamens have long black anthers, full of pollen, but which seems never to burst the anther cases. The only opening is at the apex, and this opening is covered by a membrane—never opening except by insect agency. As soon as the flower expands it is freely visited by humble-bees, and, as their loaded thighs evidence, for the pollen. To collect this they alight on the anthers of the long and lower stamens, as on a platform, make an opening in the apex of each of the four shorter ones, and then rifle them of their contents. A mass of plants containing eighty-eight flower-stems was watched on July 30, and the same lot for an hour on August 6, but no attempt was seen to be made by the bees to get the pollen from the longer anthers, or to use them in any way but as a platform. It would be very difficult for the bees to stand anywhere so as to have power to pierce the apical membranes of the longer stamens. When the flowers matured, and the anthers were ready to fall, they were examined, the four short ones were empty sacs, the three lower ones were full of pollen. These latter served no visible object to the flower or its insect visitors. While, however, no pollen could be detected on the stigmatic surfaces, still three out of every twelve flowers yielded a pod, and panicles of flowers covered so as to prevent egress of insects, neither produced fruit nor did a single anther open at its apex. In this case it would appear as if the fertilisation depended on the accident of the extracted pollen escaping from the insect to the stigma, and yet to an ordinary observer this plant would seem one specially arranged for cross-fertilisation. (Proc. Acad. Nat. Sci. Phil. 1886, p. 314.)

Variations in the Nerve-Supply of the Lumbricales Muscles in the Hand and Foot, with some Observations on the Perforating Flexors.—Dr. H. St. John Brooks has lately investigated the subject of the varieties in the nerve-supply of the lumbricales. He finds—(1) Discrepancies in the statements of English and Continental anatomists. All these writers appear to be in error about the normal or commonest arrangement of the nerves to these muscles in the foot, and they appear never to have noticed a *double* supply to the third lumbrical in the hand. (2) Varieties of innervation that the author has observed in man, with an account of the nerve-supply in the orang, gibbon, and macaque monkey. He has discovered nerves entering the deep surface of the second (or indicial) lumbrical muscle in both hand and foot; these nerves, he believes, have never before been described: the latter, however, has been seen by Prof. D. J. Cunningham in the foot of a negro, and is recorded by him in his notes (as yet unpublished) of the anatomy of the negro foot. The following statistical table is compiled from the author's notes:—

Table of Variations in the Innervation of Lumbrical Muscles

HAND

	Cases
First and second by median; third and fourth by deep ulnar	9
Third by median and deep ulnar (others as before) ...	6
Second and third by deep ulnar	1
First, second, and third by median (deep dissection not carried out)	2
Total	18

FOOT

First by internal plantar; second, third, and fourth by deep external plantar	8

In the orang, gibbon, and macaque, the second lumbrical of the foot was supplied as in the above table. (3) Prof. Cunningham (*Challenger* Reports, vol. xvi.) has shown that, in Thylacinus

and Cuscus, the lumbricals of the manus are all supplied on their superficial surface; a similar arrangement is found in the pes of the fox-bat; here, however, the deep external plantar also furnishes twigs to the two outer lumbricales. (4) It appears probable from these facts that the lumbricals were all originally supplied on their superficial surface: the deep nerve (ulnar in hand, external plantar in foot) is, on this hypothesis, gradually displacing the superficial (median; internal plantar). This invasion of the deep nerve has advanced further (in the case of the lumbricals) in the human foot than in the hand. The reverse is the case with the innervation of the short muscles of the pollex and hallux. (5) There is a general correspondence between the innervation of a particular lumbrical muscle and that belly of the long perforating flexor of which it is a part; this fact is best made out in the case of the first or indicial lumbrical of the hand and the indicial belly of the flexor perforans, which are both supplied by the median; it is also seen in the fourth lumbrical and the belly of the long flexor ending in the tendon to the little finger (both by ulnar); also in the third lumbrical and annular belly (both of which have typically a double nerve-supply). In the foot and leg this part of the investigation presents special difficulties, which have, however, in a measure been overcome by minute dissections of the posterior tibial nerve and its branches, conducted under water. (*Dublin University Reports.*)

ON CERTAIN MODERN DEVELOPMENTS OF GRAHAM'S IDEAS CONCERNING THE CONSTITUTION OF MATTER[1]

I.

THERE is a certain fitness in our selecting this place to do honour to-night to the memory of Thomas Graham. For was in the chemical laboratory of this Institution that Graham carried out, upwards of half a century ago, the experimental investigations which culminated in his memorable discovery of the law connecting the rate of movement of a gas with its density. This law, combined with that of Boyle, which connects the volume of a gas with its pressure, and with the law of Charles, which expresses the relations of the volumes of gases to heat, has done more to give precision to our knowledge of the constitution of matter than all the speculations of twenty centuries of schoolmen.

Graham was made Professor of Chemistry in the Andersonian Institution in 1830, and it was from here that he gave to the world his classical paper "On the Law of the Diffusion of Gases," read before the Royal Society of Edinburgh, December 19, 1831. I am fully conscious that my only claim to be regarded as worthy to pronounce this eulogium of Graham arises from the circumstance that I also have had the good fortune to hold the Lectureship of Chemistry in this place; and with forerunners like Birkbeck, Gregory, and Graham, I may well be proud of an honourable and distinguished ancestry. This association with the Andersonian Institution naturally quickened my interest in Graham and his works, and my frequent opportunities of conversation with the late Dr. James Young, of Kelly, who for so many years was its President, and who was, as we all know, also one of Graham's discoveries, and for a long time, both here and in London, one of his most trusted assistants, enabled me to learn much of Graham's personal character and mode of work. On the occasion of the gift of Brodie's fine statue of Graham to the city by Dr. Young it fell to my lot to prepare the short biographical notice of my distinguished predecessor, which, with other papers relating to the matter, is, I understand, deposited in the archives of your Corporation. And I may be pardoned, perhaps, for recalling with what mingled feelings of pride and trepidation I set myself to the execution of that task.

In the preface to the admirable reprint of Graham's papers which we also owe to the filial piety of Dr. Young, the late Dr. Angus Smith has indicated in precise and even luminous language Graham's position in that chain of thinkers which includes Leucippus, Lucretius, Newton, and Dalton. Indeed, of all Angus Smith's papers with which I am acquainted there is none, to my thinking, more charming than this little introductory essay of a dozen octavo pages, in which, with unwonted perspicacity, he has defined Graham's place in the history of speculative philosophy. Angus Smith has here crystallised out, as it were, the thoughts of a life-time of literary research and meditation. Probably, no man—certainly no contemporary of Graham's—was better fitted by knowledge and by sympathy to form a sound critical estimate of such a position than the biographer of John Dalton. Angus Smith's mind was simply steeped in the old Hellenic philosophy. To him even Kapila was more than a name, and the atomic systems of India matters of more than conjecture or of passing interest. There was much in Smith's intellectual nature to make such inquiries congenial to him. With all his leaning towards objective science he had a Highlander's love of the mystical and a Lowlander's passion for metaphysics. And yet nothing is more admirable than the manner in which, in this essay, these qualities and this wealth of learning are subordinated and held in check, and nothing more striking than the way in which, in a few graphic strokes, done with a master hand, lightly yet firmly, with a consciousness of power and a sense of restraint, Graham's place in the evolution of the atomic philosophy is set forth.

It is here claimed for Graham that he was a true descendant of the early Greeks, and that to him belonged as of right the mantle of Leucippus. Atoms and eternal motion were as much fixed articles of his creed as they were of that of Heraclitus. But with no one of the older Greeks was Graham's thought more in harmony than with that of Leucippus. He, with his wider knowledge of the so-called "elemental" forms of matter, and of the persistency with which the specific properties which we associate with our "elements" are retained, could yet share with the old Greek his conceptions of the essential oneness of matter. It was with Graham, as Smith says of Leucippus, that "the action of the atom as one substance taking various forms by combinations unlimited, was enough to account for all the phenomena of the world. By separation and union, with constant motion, all things could be done."

In one respect Graham's position as an atomist is unique: no man before him had dedicated his life to the study of atoms and atomic motion. These fundamental ideas are intertwined to make up, so to say, the silver thread which runs through the work of forty years. They were the dominant conceptions of his life. Even in his earliest paper, published when he was just twenty-one, in which he treats of the absorption of gases by liquids, we are able to detect in the phraseology employed that his mind had been already permeated by the notion of atomic movement. That he should be familiar, even at this time, with the conception of atoms in the Daltonian sense is hardly surprising when we remember that he had already come under the influence of Thomas Thomson, whose place in the history of science is probably that of the first great exponent of Dalton's theory of chemical combination. But the idea of motion was never with Dalton an integral part of his theory, nor, in so far as it was necessary as serving to explain the phenomena of chemical union, was it held by Thomson. And this is the more remarkable when we remember that Dalton had discovered for himself the fact of the molecular mobility of a gas, and that his first glimpses of the truth of his great law were obtained by the study of chemical combination among gases. Graham was doubtless cognisant, in a general way, of the speculations of the early Greeks, but there is no evidence in any of his writings, nor has anything been preserved in the reminiscences of his friends and contemporaries, to indicate that he was knowingly influenced by them.

This continuity of idea is indeed the most striking characteristic of Graham's labours; all his work seemed to centralise round this fundamental conception of atomic motion. "In all his work," says Smith, "we find him steadily thinking on the ultimate composition of bodies; he searches after it in following the molecules of gases when diffusing; these he watches as they flow into a vacuum or into other gases, and observes carefully as they pass through tubes, noting the effect of weight and of composition upon them in transpiration. He follows them as they enter into liquids and pass out, and as they are absorbed or dissolved by colloid bodies, such as caoutchouc: he attentively inquires if they are absorbed by metals in a similar manner, and finds the remotest analogies, which, by their boldness, compel one to stop reading and to think if they be really possible. He follows gases at last into metallic combination, and the lightest of them all he makes into a compound with one of the heavier metals, chasing it finally through various lurking-places until he brings it into an alloy and the form of a medal, and puts upon it the stamp of the Mint. Indeed he is scarcely satisfied even with this, and he finds in bodies from stellar places—in meteoric iron—this same metallic hydrogenium which he draws out from its long prison in the form of a gas. . . If we examine his work on Salts and on Solutions we have a similar train of thought. One

[1] The Triennial "Graham Lecture," given in the Hall of the Andersonian Institution, Glasgow, on March 16, by Prof. T. E. Thorpe, F.R.S.

might have slighted the importance which he attached to the water of salts and the temperature at which it was reduced, but in his hands it was a revelation of some of the most mysterious internal phenomena of these bodies.

"A chemist must take great pleasure in following Graham when he seeks the laws of the diffusion of liquids and traces their connections, especially when they lead to such results as he expressed by dialysis, a process founded on a new classification of substances, and promising still the most valuable truths. We see in the inquiry how Graham thought on the internal constitution of bodies, by examining the motion of the parts, and from the most unpromising and hopeless masses under the chemist's hands—amorphous precipitates of alumina or of albumen—brought out analogies which connected them with the most interesting phenomena of organic life. Never has a less brilliant looking series of experiments been made by a chemist, whilst few have been so brilliant in their results or promise more to the inquirer who follows into the wide region opened."

In a short paper entitled "Speculative Ideas respecting the Constitution of Matter," originally published in the Proceedings of the Royal Society for 1863, Graham has left us his Confession of Faith upon the subjects to which he had devoted the whole of a thoughtful life. He conceives that the various kinds of matter now recognised as different elementary substances may possess one and the same ultimate or atomic molecule existing in different conditions of movement. Graham traces the harmony of this hypothesis of the essential unity of matter with the equal action of gravity upon all bodies. He recognises that the numerous and varying properties of the solid and liquid, no less than the few grand and simple features of the gas, may all be dependent upon atomic and molecular mobility. Let us imagine, he says, one kind of substance only to exist—ponderable matter; and further that matter is divisible into ultimate atoms, uniform in size and weight: we shall have one substance and a common atom. With the atom at rest the uniformity of matter would be perfect. But the atom possesses always more or less motion, due, it must be assumed, to a primordial impulse. This motion gives rise to volume. The more rapid the movement the greater the space occupied by the atom, somewhat as the orbit of a planet widens with the degree of projectile velocity. Matter is thus made to differ only in being lighter or denser matter. The specific motion of an atom being inalienable, light matter is no longer convertible into heavy matter. In short, matter of different density forms different substances—different inconvertible elements as they have been considered.

It should be said that Graham uses the terms "atom" and "molecule" in a wider sense than that which the limitations of modern chemistry have imposed upon them, and that he is referring to a lower order of molecules or atoms than those which more immediately relate to gaseous volume. The combining atoms of which he conceives the existence are not the molecules of which the movement is sensibly affected by heat with gaseous expansion as the result. According to Graham, the gaseous molecule must itself be viewed as composed of a group or system of the inferior atoms, following as a unit laws similar to those which regulate its constituent atoms. He is in fact applying to the lower order of atoms ideas suggested by the gaseous molecule, just as views derived from the solar system are extended to the subordinate system of a planet and its satellites.

We cannot as yet fix any limit to this process of molecular division. To Graham the gaseous molecule is a reproduction of the inferior atom on a higher scale. The diffusive molecules, the molecules or systems which are affected by heat, are to be supposed uniform in weight but to vary in velocity of movement in correspondence with their constituent atoms. Hence the molecular volumes of different elementary substances have the same relation to each other as the subordinate atomic volumes of the same substances.

On this basis Graham builds up a conception of chemical combination. He points out, in the first place, that these more and less mobile or light and heavy forms of matter have a singular relation connected with equality of volume. Equal volumes of two of them can coalesce together, unite their movement and form a new atomic group, retaining the whole, the half, or some simple proportion of the original movement and consequent volume.

Chemical combination thus becomes directly an affair of volume and is only indirectly connected with weight. Combining weights are different because the densities, atomic and molecular, are different. The volume of combination is uniform, but the fluids measured vary in density. This fixed combining measure—Graham's *metron* of simple substances—weighs 1 for hydrogen, 16 for oxygen, and so on with the other "elements."

Graham, however, points out that the hypothesis admits of another expression. Just as in the theory of light we have had the alternative hypotheses of emission and undulation, so in molecular mobility the motion may be assumed to reside either in separate atoms and molecules, or in a fluid medium caused to undulate. A special rate of vibration or pulsation originally imparted to a portion of the fluid medium enlivens that portion of matter with an individual existence, and constitutes it a distinct element or substance.

The idea of the essential unity of matter finds its analogy, to Graham's thinking, in the continuity of the so-called physical states of matter. He clearly perceived that there is no real incompatibility in the different states of gas, liquid, and solid. These physical conditions are, indeed, often found together in the same substance. The liquid and the solid conditions supervene, as Graham puts it, upon the gaseous condition rather than supersede it. They do not appear as the extinction or suppression of the gaseous condition, but as something superadded to that condition. Graham conceives that the three conditions (or constitutions) probably always co-exist in every liquid or solid substance, but one predominates over the others, just as the colloidal condition or constitution which intervenes between the liquid and crystalline states extends into both, and probably affects all kinds of solid and liquid matter in a greater or less degree. Hence, to Graham's thinking, the predominance of a certain physical state in a substance appears to be a distinction analogous to those distinctions in natural history which are produced by unequal development. Liquefaction or solidification does not involve the suppression of the atomic or molecular movement but only the restriction of its range.

Such then are Graham's ideas, formulated in 1863, respecting the probable constitution of matter. I have purposely stated them in great detail, and for the most part in Graham's own words. The paper is very short, but it has evidently been put together with great care. It is impossible not to be struck with the evidence it affords of Graham's insight, his grasp of principles and power of co-ordination. Consider, for example, what he says respecting the continuity of the so-called physical states of matter, and bear in mind upon what an extremely small experimental basis it rested at that time. The observations of Caignard Latour were almost forgotten, or at all events their significance was not understood. The classical work of Andrews was not yet published. And yet this work and that of a dozen experimentalists in France, Russia, and Germany, has only served to confirm and expand Graham's fundamental conception. The whole paper shows Graham in a very different light from that in which the student of to-day might be apt to regard him. The greater number of his memoirs are mainly the records of measurements, but Graham was not a great measurer in the sense in which we apply that term to such men as Regnault, Magnus, or Bunsen. Very little of his work was done by his own hands, and it must be confessed that the earlier experimental portion was occasionally intrusted to apparently inexperienced assistants. Graham had, however, the *forscherblick* which characterises the true investigator, and he possessed a really marvellous faculty of sifting out the small grain of fact which often lay hidden beneath a mass of imperfect observation. And yet he was in no hurry to theorise. He patiently added fact to fact, repeating and verifying his observations long after he had got an inkling of the truth towards which they were tending. He laboured like Faraday, *ohne Hast, ohne Rast*, and his work is a monument of patient, concentrated thought, and of a singleness of purpose which never swerved.

"Experimentarian philosophers" of Graham's type (to use a phrase which Hobbes of Malmesbury once flung at the progenitors of the Royal Society) have very similar intellectual tendencies. One is insensibly led to compare Graham with the greatest of our English atomists—John Dalton. If you will turn to Dr. Henry's "Life of Dalton," and read the charming analysis of Dalton's mental characteristics, made by one who knew him well and who had studied him carefully, you will find that practically all that is there stated is equally applicable to Graham. Both men were pre-eminently endowed with the faculty of contemplating abstract relations of space and number, and each began his researches with the expectation that all empirical phenomena were to be brought under the control of mathematical laws. Thus Dalton strove to prove that the

changes produced in the gaseous and liquid states of matter vary as the square, cube, or some other simple function of the temperature; Graham, in like manner, sought to show that the movement of his diffusive molecules, whether in liquids or in gases, was related to some equally simple function of their mass. Henry says of Dalton that "his inmost mental nature, and all its outward manifestations were in the language of the German metaphysicians, emphatically subjective. Thus in special or objective chemistry he has left absolutely no sign of his presence; no great monograph on an individual body and its compounds; no memorable analysis of a substance deemed simple into yet simpler elements; no new element—no Neptune—added to the domain of chemistry." Every word of these sentences could be applied with equal truth to Graham. The tendencies of both men were essentially introspective. Each was capable of the most patient concentrated thought and of steady prolonged attention, wholly abstracted from external objects and events. I have heard the late Dr. Young narrate the most extraordinary instances of Graham's power of mental abstraction. Dalton said of himself that, "If I have succeeded better than many who surround me, it has been chiefly, nay, I may say, almost solely, from unwearied assiduity. It is not so much from any superior genius that one man possesses over another, but more from attention to study and perseverance in the objects before them, that some men rise to greater eminence than others."

It seems like a contradiction in terms when we reflect for a moment upon the characteristic features and tendency of his work, to say that Graham, like Dalton, was utterly devoid of the quality we call imagination. Henry says of Dalton that imagination had absolutely no part in his discoveries; except, perhaps, as enabling him to gaze, in mental vision, upon the ultimate atoms of matter, and as shaping forth those pictorial representations of unseen things by which his earliest as well as his latest philosophical speculations were illustrated. Graham would not allow his fancy even that amount of play. Even in the speculative essay from which I have quoted so largely, it seems as if every word had been weighed and every sentence put together with slow laborious thought. This passionless aspect of his work seems to have greatly impressed Angus Smith, himself a man of lively sympathy and of quick susceptibility. "His works," says Smith, "are full of care, but not of joy."

(*To be continued.*)

SCIENTIFIC SERIALS

American Journal of Science, March.—On the absolute wave-length of light, by Louis Bell. The experiments here described were undertaken with a view to check the results obtained by C. S. Pierce for Prof. Rowland's great map of the solar spectrum, and to furnish a value of the absolute wave-length as nearly as possible commensurate in accuracy with the micrometrical observations. For the wave-length of D, at 20° C. and 720 mm. pressure, Mr. Bell obtains 5896·08, or *in vacuo* 5897·71, as compared with 5896·22, Rowland's micrometer measure from Pierce's preliminary result, and 5895·89, Thalèn's correction of Ångström, both in air at ordinary temperature and 760 mm. pressure. But neither of these was corrected for errors in the gratings; hence, obviously, the cause of the discrepancy.—On the relative wave-length of the lines of the solar spectrum, by Prof. Henry A. Rowland. This measurement of the relative wave-lengths of the spectrum and its reduction to absolute wave-lengths by some modern determination has been undertaken in connexion with the photographic map of the solar spectrum on which the author has been engaged for several years, and which is now finished from the extreme ultra-violet wave-length 3200 down to wave-length 5790. Appended are tables of coincidences and of wave lengths of standard lines.—The norites of the "Cortlandt series" on the Hudson River, near Peakskill, New York (continued), by G. H. Williams. Here are studied the mica norites, the augite norite (hyperite), pyroxenite, and the iron ore and emery in the Cortlandt norite. Owing to incipient alteration, easily visible under the microscope, the West-Chester County emery appears to be of less commercial value than that of Asia Minor.—Natural solutions of cinnabar, gold, and associated sulphides, by George F. Becker. In the course of investigations on the geology of the quicksilver deposits of the Pacific slope, the author has made some studies, here detailed, on the question of the state of combination in which quicksilver is dissolved in natural waters. The solubility of zincblende, pyrite (marcasite), copper sulphides, gold, and other associates of cinnabar, is incidentally examined, the quantitative analysis involved in the process being made by Dr. W. H. Melville.—Fluviatile swamps of New England, by N. S. Shaler. In examining the fresh-water swamps of this region, the author has carefully studied the geographical distribution of those formed along the banks of rivers. Although the inquiry is mainly limited to the post-glacial changes in the valleys trending northwards, much light is incidentally thrown on the pre-glacial altitude of the continent. It is made evident that these valleys could not have been excavated by streams of their present slope; hence the inference that the descent of the northward flowing rivers must have been more rapid in pre-glacial times than at present; in other words, this part of the continent was at that time relatively less elevated in its northern parts than it is at present.—On the Mazapil meteoric-iron which fell on November 27, 1885, by William Earl Hidden.—On observations of the eclipse of August 18, 1887, in connexion with the electric telegraph, by Prof. David P. Todd. Referring to his remarks in the Proceedings of the American Academy of Arts and Sciences for 1881, p. 359, the author points out how the proposed method of telegraphic transmission of important observations might be adopted during the eclipse of August 18 next.—On two new meteorites from Carroll County, Kentucky, and Catorze, Mexico, by George F. Kunz. The Kentucky iron has some ethnological interest in connexion with the ornaments of meteoric iron occurring in the mounds of the Little Miami Valley, Ohio, all apparently belonging to one and the same meteoric fall. The Catorze mass, weighing 92 pounds, was found near Catorze, San Luis, Potosi, in 1885. It is one of the caillite group of Stanislas Meunier, and shows the Widmanstätten lines very finely. Analysis: Fe 90·09; Ni and Co 9·07; P 0·24; with specific gravity 7·509.

Rivista Scientifico-Industriale, February.—On the cause of the electric discharge accompanying thunderstorms, by Prof. G. Guglielmo. The views of Ermann and Peltier are here subjected to close scrutiny, and shown to be inadequate to account for these electric phenomena.—On the variations in the electric resistance of antimony and cobalt in the magnetic field, by Dr. G. Faè. The author's researches show that, apart from the intensity of the observed effects, antimony behaves in the way determined by Righi for bismuth, and cobalt in the way determined by Thomson for iron and nickel.

Rendiconti del Reale Istituto Lombardo, February.—Summary of the meteorological observations recorded in the Brera Observatory, Milan, during the year 1886, by E. Pini. The daily, monthly, and annual means are tabulated for the atmospheric pressure, temperature, rainfall, velocity, and direction of the winds throughout the year.—Meteorological observations for the month of January, 1887, at the same Observatory.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, March 10.—"Note on Induction Coils or 'Transformers.'" By John Hopkinson, M.A., D.Sc., F.R.S.

"Note on the Theory of the Alternate Current Dynamo." By John Hopkinson, M.A., D.Sc., F.R.S.

March 17.—"The Embryology of Monotremata and Marsupialia." Part I. By W. H. Caldwell, M.A., Fellow of Gonville and Caius College, Cambridge. Communicated by Prof. M. Foster, Sec. R.S. (Abstract.[1])

(1) *The Egg-membranes.*—In Monotremata, in very young ova, a fine membrane exists between the single row of follicular cells and the substance of the ovum. This membrane, which I will call *the vitelline membrane*, at first increases in thickness with the growth of the ovum, and through it pass numerous fine protoplasmic processes connecting the protoplasm of the follicular cells with that of the ovum, and serving to conduct food granules, which, appearing in the neighbourhood of the nuclei of the cells, travel thence to the ovum; food granules also appear in the neighbourhood of the germinal vesicle, and travel away from it: hence the horseshoe-shape of the yolk-mass as seen in section.

[1] The author being at the present time in Australia and so unable to correct the proof of this abstract, I have undertaken this duty. In doing so I have ventured, for the sake of what appeared to be increased clearness, to introduce into § 1 some modifications of the author's manuscript, being guided therein by the author's more detailed account given in the fuller paper.—M. FOSTER, Sec. R.S.

The time during which food granules are thus passing from the follicular cells to the ovum may be called "the yolk forming period."

It is succeeded by a period during which the vitelline membrane again becomes thin, the follicular cells are reduced to a single layer, and the cells are very thin and flat. This period may be called the "absorption of fluid period," since during it the ovum absorbs large quantities of fluid through the thin vitelline membrane and single layer of thin follicular cells, and thereby increases largely in size.

This is in turn succeeded by a third period, during which the follicular cells again become active, multiply, increase greatly in size, and give rise between themselves and the vitelline membrane to a deeply standing homogeneous layer, which I will call *the chorion*. This period may hence be called "the chorion forming period." All these three periods are gone through while the ovum is still in the follicle.

After the bursting of the follicle and the reception of the ovum in the Fallopian tube, a few of the follicular cells remain attached to the chorion; the majority are left behind within the burst follicle.

During the passage along the Fallopian tube, the vitelline membrane again increases in thickness, and the chorion, also increasing in thickness, absorbs fluid and becomes *the albumen layer*. Outside this now appears a new structure, *the shell* or shell-membrane, of tough parchment-like consistency,[1] not staining with reagents. I have not yet traced the deposition of the shell to the activity of any special glands; but I can say that the shell-membrane does not increase at the expense of the chorion or albumen layer.

After reaching the uterus both vitelline membrane and shell-membrane increase in thickness, but the albumen layer diminishes and disappears, serving apparently for the nutrition of the ovum. Immediately beneath the vitelline membrane a new layer is now seen in hardened preparations; but it may be shown that this layer is really fluid, yielding a coagulum which stains deeply with reagents, the fluid being apparently derived, through the membranes, from the uterine glands.

In Marsupialia the history of the vitelline membrane, save that "the yolk forming period" is not marked off from the "absorption of fluid" period, is similar to that in Monotremata. I have not been able to trace the beginning of the "chorion" while the ovum is still in the ovary, in Marsupialia; but in an ovum of Phascolarctos from the uterus, I found a chorion like that of Monotremata, and surrounded moreover by a thin transparent membrane—a *shell-membrane*. Within the uterus the chorion, increasing in thickness, becomes transformed into an albumen layer, and is eventually absorbed, passing through the vitelline membrane to nourish the ovum, so that eventually the vitelline membrane comes to be close to the shell.

As in Monotremata, a coagulable, and, when coagulated, deeply staining fluid makes its appearance between the vitelline membrane and ovum (blastoderm).

The shell-membrane persists until the developing ovum becomes fixed to the walls of the uterus, after which it disappears.

The paper then compares the egg-membranes just described with those of Placentalia, and those of Vertebrata generally.

(2) *Segmentation.*—The telolecithal ova of Monotremata and Marsupialia go through a partial segmentation. The ova of Placentalia segment completely, but the resulting blastodermic vesicle is identical with that produced by partial segmentation in Monotremata and Marsupialia.

In Monotremata there is a posterior lip to the blastopore similar to that of Elasmobranchii. The epiblast grows in so rapidly from the sides, that a primitive streak region is formed in front of the posterior lip long before the epiblast has inclosed the yolk. This uninclosed area in front of the primitive streak probably includes a region where the hypoblast (yolk) has secondarily broken through the epiblast. The existence of such a region would hide the position of the anterior lip of the blastopore. The circumference of the circle made up by the larger arc of the edge of the blastoderm on the yolk, and the smaller arc of the posterior lip of the blastopore, is a measure of the quantity of yolk in a meroblastic ovum.

In Marsupialia the epiblastic growth incloses the hypoblast at a very early age, except over a narrow slit in front of the posterior lip of the blastopore. This slit corresponds to the area inclosed by the circle described above in a meroblastic egg. The primitive streak is not conspicuous at an early age because of the large size of the cells. No hypoblast projects through the epiblast in front of the primitive streak region. I would explain the segmentation and the gastrula of Placentalia in the same way. Balfour's objection ("Comp. Embryol." vol. ii. p. 187) to Van Beneden's original comparison of the blastopore of the rabbit with that of a frog, is explained away by the presence of a posterior lip to the blastopore in Marsupialia. My explanation postulates the existence of a similar structure in the rabbit. The blastopore of the rabbit corresponds therefore to the whole area marked out by the growing epiblast and the posterior lip of the blastopore, before the closing of the primitive streak region, or to this area minus the secondary extension, caused by the projecting yolk, in Monotremata.

[1] In the laid egg of Echidna I have not detected calcic salts, but that of Ornithorhynchus gives rise to gas when treated with dilute acid.

Linnean Society, March 17.—Mr. W. Carruthers, F.R.S., President, in the chair.—A recommendation of the Council to present to the British Museum, Kew, and the Oxford Botanical Gardens, the Society's carpological collection was submitted to the Fellows, but not approved by them.—Mr. C. B. Clarke, F.R.S., was elected into the Council in the place of Dr. H. Trimen, who resigned.—Mr. A. O. Walker read a paper on the Crustacea of Singapore. These were collected by Surg.-Major Archer during 1879-83. The species were chiefly dredged in 15-20 fathoms, or got on shallow banks. A full list is given of all the forms identified, and several new species are described. Among these are: *Doclea tetraptera*, *Xanthe scaberrimus*, *Maii miersii*, and *Caphyra archeri*.—A paper was read by Dr. Geo. King, on the genus *Ficus*, with special reference to the Indo-Chinese species. The genus *Ficus* was founded by Linnæus, and included seven species ("Species Plantarum," 1st ed.) Later editions contained 118 species. Blume described 93 Malayan figs, and Roxburgh 55 Indian species. In the "Hortus Cliffortianus" Linnæus clearly comprehended the difference of the sexes, *i.e.*, Caprifig = male, the so-called Fig = female, and *Erinosyce* = hermaphrodite. Vahl seems to have misunderstood the arrangement of the sexes, and Blume apparently followed him. Roxburgh is the first writer who examined minutely the florets of nearly the whole of the species, finding two androgynous and the majority monandrous. Later on Gasparini and Miquel each made a careful study of the flowers of the genus, and separately gave different classifications of the group. Miquel subsequently altered his arrangement, making divisions into six sub-genera, while enumerating 405 Old World, 128 American, and twenty-two species of doubtful nativity. In the "Genera Plantarum" of Bentham and Hooker four of Miquel's sub-genera are admitted, a fifth considered doubtful, and a sixth rejected. These authors regarded Miquel's divisions as too loosely defined, and recommended a re-working of the group. Dr. King goes into a lengthened description of the structural peculiarities of the flowers of the genus *Ficus*. He specifies (1) male, (2) pseudo-hermaphrodite, (3) neuter, and (4) female fertile flowers. Besides these, he states that there occurs in all the species of *Ficus* a set of flowers originally named by himself "*insect-attacked-females*," but for which he has adopted Count Solms-Laubach's term "*gall-flowers*" (*Bot. Zeit.* 1885); the latter botanist having anticipated him in publication, though King's researches had been commenced earlier. King enters into the question of these gall-flowers, stating that, in the majority, the pupa of an insect is present, and this pupa can usually be seen through the coats of the ovary. The pupa when perfected escapes into the cavity of the receptacle by cutting its way through or by bursting these coats; and fully-developed winged insects are often to be found in considerable numbers in the cavity of the fig. The opening through which each insect has escaped from the ovary in which it has been developed is afterwards clearly visible. The pupa of the insect must become encysted in the ovary of the gall-flower at a very early period, for about the time at which the imago is escaping from the ovary the pollen of the anthers of the male flower is only beginning to shed. Now, there is nothing in itself remarkable in the mere occurrence in the genus of numerous flowers having the general form of females, which yet by reason of certain peculiarities in their structure are incapable of fertilisation by pollen practically barren; while at the same time their structural defects fit them for becoming the nidus for the larvæ of special insects. But, when the manner in which these malformed female flowers are disposed in the receptacle is inquired into, it becomes clear that through the interposition of insects these malformed female flowers may play a most important part in the life-history of many species of the genus *Ficus*. Thus from the peculiarities in the structure and arrangement of

the flowers, Dr. King is of opinion that the evolutionary history of the genus *Ficus* may be traced. On data derived therefrom he arranges the Indo-Malayan species into two great groups, the second of these being again divided into three subsidiary sub-groups as follows:—

Ficus, Linn.	Group I. Pseudo-hermaphrodite.				Palæomorphe
	Group II. Unisexual	Sect. 1			Urostigma
		Sect. 2			Synœcia
		Sect. 3	A	Sycidium	
				Covellia	
			B	Eusyce	
				Neomorphe	

Physical Society, March 12.—Prof. G. Carey Foster, Vice-President, in the chair.—Mr. Shelford Bidwell described some experiments which seem to show that the electrical resistance of suspended copper and iron wires, alters with the direction of the testing current. The apparatus used consisted of a metre bridge with coils of 100 ohms in the gaps adjoining the standard wire, the other two arms being two suspended wires united at the top, to which point one terminal of the galvanometer was joined. A commutator placed in the battery circuit served to reverse the testing current. When a wire is suspended vertically the stress increases from below upwards, and the author believes the observed effects to be due to the absorption of heat by the current as it passes from a stretched towards an unstretched part of a copper wire, and the evolution of heat when it passes from an unstretched towards a stretched part. As the apparatus was arranged the current passed up one side and down the other, heating the one and cooling the other, thus disturbing the position of balance. If iron wires were used the heating and cooling effects were reversed. Prof. S. P. Thompson suggested loading the wires at different points in order to vary the stress without using such long wires, and Mr. C. V. Boys thought still shorter wires could be used by joining the ends to a revolving spindle and stretching them by centrifugal force.—On a lecture experiment in self-induction, by Mr. Shelford Bidwell. A telephone is placed in series with the secondary coil of an induction coil and another coil whose self-induction can be raised by inserting a core of iron wires, or another coil, or both. The effect of introducing the iron core is very marked, reducing the sound enormously. If a coil of wire containing an iron core be inserted, the effect of short-circuiting the coil is to increase the sound in the telephone. The same author also described and showed an experiment due to Dr. Fleming, in which a disk of copper inclined at an angle of 45° to the axis of a coil of wire and suspended bifilarly, is deflected by passing an undulatory current round the coil. In explanation of the former experiment, Dr. Fleming wrote down the formulæ for the effective resistance and self induction of a circuit near another closed circuit, which show that the former is greater and the latter less for undulatory than for steady currents. He had not arrived at any satisfactory explanation of the deflection of the copper disk. Prof. Ayrton exhibited a tuning-fork worked electrically, in which the pitch could be varied by altering the self-induction of the circuit, or by varying the position of the make-and-break screw. Mr. C. V. Boys referred to his experiments, published in 1884, on the impulse given to metal disks suspended in a magnetic field whose strength is suddenly changed, as being of a similar character to that described by Mr. Bidwell, and suggested the use of aluminium instead of copper in future experiments, owing to its conductivity for the same weight being greater. Prof. Thompson said he had recently used a similar apparatus to that described by Mr. Bidwell as an illustration of the effect of self-induction, and pointed out the uses of self- and mutual-induction in multiplex telegraphy and telephony. As an explanation of the deflection of the copper disk by alternating currents, Prof. Foster thought it possibly due to its initial position being that of maximum sensibility, and therefore each impulse had less effect than the preceding one. Mr. W. M. Mordey mentioned a simple arrangement for varying self-induction used by Mr. Ferranti to control the power of incandescent lamps worked by alternating currents, and Prof. Ayrton described a closed magnetic circuit of great self-induction, used to protect voltmeters on the telpher line at Glynde from disastrous inductive effects produced by breaking the locomotive circuit. Referring to tuning-forks, Mr. Bosanquet thought some self-induction was necessary in order that the current should act to the best advantage in attracting the prongs at the proper instant. Further remarks were made by Mr. Boys and Prof. Perry.—On a lecture experiment to show that capacity varies inversely as the thickness of the dielectric, by Profs. W. E. Ayrton and John Perry. The authors consider it easy for students to see that, other things remaining constant, capacity is proportional to area. Taking this as proved, a condenser is arranged such that the area A of the insulated inner coating varies as the thickness t of the dielectric, and the potential difference between the coatings is found by experiment to be constant. Then since capacity $= \frac{\text{quantity}}{\text{potential}}$, and both the latter being constant, therefore the capacity of the condenser is constant. But by the construction of the apparatus $\frac{A}{t}$ is constant, and it is assumed that capacity varies as A, therefore capacity must vary inversely as t.—Note on magnetic resistance, by the same authors. Two iron rings about 6 inches diameter, made from the same bar of best Swedish iron about half an inch in diameter, were wound with insulated wire in two halves, so that a current could be sent round either or both halves, and the resulting induction measured by the throw of a ballistic galvanometer placed in series with a few convolutions of wire wound round the outside of the main winding. One of the rings was continuous, and the other had a small air space of about 0·8 mm. in a plane perpendicular to that of the ring and passing through its axis, as if the ring had been cut by a saw. The primary object of the experiments, which were made by Messrs. Aldworth, Dykes, Lamb, Robertson, and Zingler, of the Central Institution, was to determine whether there was any appreciable "surface magnetic resistance." The results do not show any such resistance, and the relative resistance of air and iron as calculated from the unsaturated parts are about as 1200 to 1, a number agreeing fairly well with those obtained by other experimenters. From this the authors conclude that for small distances magnetic resistance of air is proportional to length. When the magnetising current was passed round the one half of the divided ring on which the test coil was wound, a greater induction could be obtained than by any other way of magnetising, and this the authors do not attempt to explain. Mr. Bosanquet said he had always found greater inductions obtainable in the middle of bar electro-magnets or open magnetic circuits, than could be produced in closed magnetic circuits, and thought the above observations confirmed his own results. A discussion followed in which Mr. C. V. Boys, Mr. W. M. Mordey, Mr. Bosanquet, and Prof. Perry took part.—On account of the late hour the reading of a note on dynamo machines and motors, by Profs. Ayrton and Perry, was postponed till the next meeting.

Zoological Society, March 15.—Dr. St. George Mivart, F.R.S., Vice-President, in the chair.—The Secretary read a report on the additions that had been made to the Society's menagerie during the month of February 1887.—Mr. Howard Saunders exhibited a young male Harlequin Duck (*Cosmonetta histrionica*), shot off the coast of Northumberland on December 2 last, and remarked that it was the second authentic British-killed specimen in existence.—Mr. Oldfield Thomas read a paper on the Bats collected by Mr. C. M. Woodford in the Solomon Islands.—A communication was read from Mr. W. R. Ogilvie Grant, containing an account of the birds collected by Mr. C. M. Woodford at Fauro and Shortland Islands, in the Solomon Archipelago, and in other localities of the group.—A communication was read from Mr. G. A. Boulenger, containing a second contribution to the herpetology of the Solomon Islands.—Mr. Oldfield Thomas read a paper describing the milk-dentition of the Koala (*Phascolarctos cinereus*), which was shown to be in the same state of reduction as had been described by Prof. Flower in the case of the Thylacine.—A second communication from Mr. Boulenger contained a description of a new Gecko of the genus *Chondrodactylus* from the Kalahari Desert, South Africa, based on a specimen which had been presented to the Natural History Museum by Mr. J. Jenner Weir. The author proposed to call it *C. weiri*.

Geological Society, March 9.—Prof. J. W. Judd, F.R.S. President, in the chair.—The following communications were read:—On *Chondrosteus acipenseroides*, Ag., by Mr. James W. Davis.—On *Aristosuchus pusillus*, Ow., being further notes on the fossils described by Sir R. Owen as *Poikilopleuron pusillus*, Ow.; on *Patricosaurus mereoratus*, Seeley, a lizard from the Cambridge Greensand, preserved in the Woodwardian Museum of the University of Cambridge; on *Heterosuchus valdensis*, Seeley, a procœlian crocodile from the Hastings Sands of

Hastings; on a sacrum, apparently indicating a new type of bird (*Ornithodesmus cluniculus*, Seeley), from the Wealden of Brook, by Prof. H. G. Seeley, F.R.S. In the last paper, after some remarks on the characters of the sacrum in birds, Ornithosauria, and Dinosauria, the author proceeded to describe a sacrum composed of six vertebræ in the Fox Collection, now at the British Museum, and then to compare the fossil with the corresponding bones of the three groups named. The resemblance to the Dinosaurian and Ornithosaurian sacral vertebræ was less than those which connected the fossil with birds. From the latter it was distinguished by the smaller number of vertebræ in the sacrum, the absence of sacral recesses for the lobes of the kidneys, and the form of the articular face of the first sacral vertebra. But the small number of sacral vertebræ in *Archæopteryx*, the want of renal recesses in *Ichthyornis*, and the characters of the articulation in the Solan goose showed that these differences were not essential; and the author concluded that the fossil belonged to a true bird, but that it formed a link with lower forms, and approximated more to Dinosaurs than did any other Avian type hitherto described.

Chemical Society, March 17.—Dr. Hugo Müller, F.R.S., President, in the chair.—The following papers were read:—The action of heat on nitrogen peroxide, by Dr. A. Richardson.—Supersaturation of salt solutions, by Dr. W. W. J. Nicol. This paper contains an account of experiments on the physical constants of supersaturated and dilute salt solutions. The solutions were examined in two ways: (1) concentration constant and temperature varying; (2) temperature constant and concentration varying; in this way it was possible to pass from dilute to supersaturated solutions, and to examine the change in the various physical constants. The electric conductivity, specific viscosity and rate of expansion were examined by the first method. The specific viscosity and density by the second. In every case it was found that the curve corresponding to the non-saturated solutions was perfectly continuous with that for the supersaturated solutions. From this the author concludes that the constitution of dilute, saturated, and supersaturated solutions is the same. Supersaturation is explained by the hypothesis that the substance in solution is not the same as that which crystallises out. A supersaturated solution of sodium thiosulphate deposited crystals of the composition $Na_2S_2O_3.H_2O$ when evaporated *in vacuo*, showing that the solution does not contain the pentahydrate. The author believes that the salt in solution is combined with the whole of the water, an opinion based on his experiments on vapour-pressures and molecular volumes. Colour changes in solution are not, he believes, due to hydration, but to rearrangements of the salt molecule similar to that which occurs in the case of chromium sulphate. Dr. Nicol's views were criticised by Mr. Pickering and Dr. Armstrong.—The formation of γ-naphthalenesulphonic acid by means of sulphuric anhydride and on γ-dihydroxynaphthalene, by Dr. Henry E. Armstrong and Mr. W. P. Wynne.—α-Cyanonapthalenesulphonic acid, by Dr. Henry E. Armstrong and Mr. S. Williamson.—Addendum to paper entitled an explanation of the laws which govern substitution in the case of benzenoid compounds, by Dr. Henry E. Armstrong.—The transformation of citric acid into pyridine-derivatives, and on the constitution of pyridine, by Dr. S. Ruhemann.—Silver containing bismuth, by Mr. William Gowland.

Royal Meteorological Society, March 16.—Mr. W. Ellis, President, in the chair.—The following papers were read:—Hints on taking meteorological observations on board ship, by Capt. D. W. Barker. The author makes various suggestions as to the placing of meteorological instruments on board ship with the view of securing uniformity.—Marine temperature observations, by Dr. H. R. Mill. After briefly sketching the principal historical methods of observing temperature beneath the surface of the water, Dr. Mill discussed in some detail the relative merits and defects of the two instruments now in common use for this purpose. The self-registering maximum and minimum thermometer on Six's principle, even with the addition of an outer bulb to protect it from pressure, has certain inherent defects. It merely shows the highest and lowest temperatures passed through, the indices are liable to be shaken from their proper position, and it requires long immersion in order to attain the temperature of its surroundings. Mr. J. Y. Buchanan has shown how, by the use of mercury and water piezometers, the actual temperature at a given point may be obtained, no matter how the temperature between that point and the surface may vary. Such instruments have not been much used, and now a modification of the mercurial outflow thermometer, patented by Messrs. Negretti and Zambra as the "standard deep-sea thermometer," is largely used. When fitted in a frame which admits of the thermometer registering at a precisely known depth, admirable results are obtained by it. The manner of using these thermometers in the Scottish frame and of conducting temperature trips in comparatively shallow water was described; and the best ways of recording the observations and elaborating the results were alluded to; the work of the Scottish Marine Station on the Clyde sea area being taken as an illustration. The importance of marine temperature observations as bearing on submarine geography, on navigation, on the distribution of animal life, and consequently on fisheries, was alluded to. The paper was illustrated by diagrams, and by the exhibition of the apparatus which was described.—After the reading of these papers the meeting was adjourned in order to afford the Fellows an opportunity of inspecting the Exhibition of Marine Meteorological Instruments and Apparatus which has been organised under the auspices of the Society.

Victoria Institute, March 7.—The Rev. Dr. Walker read a paper on insect life in the East, in which he gave a full report of his entomological researches in Egypt and the East, and drew special attention to the very great number of British varieties that he had captured in various parts of the world. During the discussion, Dr. Sydney Klein remarked on the value to science of Dr. Walker's labours, and, in regard to insect life in the East at night, said that when passing a night among the ruins of Ephesus he found its superabundance manifested by the actual roar of chirps, scrapings, rattles, hummings, and cries from the country round, quite equalling his experience in the woods of Central America. Mr. Hastings C. Dent gave an account of his observations in South America and elsewhere.

MANCHESTER

Literary and Philosophical Society, January 17.—Prof. W. C. Williamson, F.R.S., in the chair.—Mr. Henry Hyde exhibited a leaf of *Bryophyllum calycinum*, with young plants growing out of the margin.—Dr. Alex. Hodgkinson read a paper on cavities in minerals containing fluid, with vacuoles in motion, and other inclosures.—Prof. W. C. Williamson, F.R.S., gave a practical demonstration by means of sections, shown by the oxy-hydrogen camera, of the structure and development of young roots. Beginning with those of the maize as they appear within the seed, Prof. Williamson exhibited and explained those of the vine, of the bean, of the crown imperial, and of the several species of cycads, illustrating the changes which roots undergo between the uniform structure seen near the root or tip, to their more advanced condition, as seen first in the roots of endogenous plants, and afterwards in the more complicated ones of exogens.

PARIS

Academy of Sciences, March 21.—M. Janssen, President, in the chair.—On the movement of a solid in a liquid, by M. Halphen. A theoretical demonstration is given of the general proposition that this movement consists of (1) a uniform helicoidal motion round a fixed axis in space; (2) a uniform rotation round a fixed axis in the solid; (3) a periodical movement.—On the great atmospheric movements in connexion with MM. Schwedoff, Colladon, and Lasne's cyclonic theories, by M. Faye. The paper is devoted to a refutation of these various theories, which are stated to be mainly due to the confusion caused by failing to distinguish between movements produced artificially in the air or water by a simple rotatory action, and the natural cyclones, tornadoes, waterspouts, &c.; the two orders of phenomena having only an apparent relation to each other.—Some observations and reflections on the earthquake of February 23 at Antibes, by M. Ch. Naudin. At this point of the coast the sea suddenly retired about 3 feet, soon returning with considerable velocity to its normal level. This and the associated phenomena are attributed, not to any volcanic action or to the gases confined in vast subterranean cavities, but to the resistance offered by certain parts of the terrestrial crust to the electricity generated in the globe itself. It is pointed out that these disturbances occur always in districts destitute of forest growths which might serve to discharge the atmospheric electricity, and on this is founded a fresh argument for replanting lands that have become disafforested.—On the red fluorescence of alumina, by M. Lecoq de Boisbaudran. Some experiments are described leading to the inference that this fluorescence is due to the presence of traces of chromium in ordinary alumina, and cannot be produced by the pure earth itself.—Earthquakes in connexion with fire-damp, by

M. F. A. Forel. It is suggested that the series of slight vibrations almost invariably following the first great shocks may tend to cause the escape of fire-damp in mines, and that the precautions against this danger should consequently be redoubled in mining districts within the range of the general disturbance.—On a possible cause of the earthquakes of 1755, 1884, and 1887, by M. A. Blavier. An attempt is made to associate these occurrences with an abnormal accumulation of ice in the Polar waters, causing a deflection of the Rennel branch of the Gulf Stream, attended by great climatic changes and a slight disturbance of equilibrium in the submarine bed, followed by a possible local fracture along the line of least resistance. The in-rush of cold oceanic waters would appear to be indicated by the disappearance of the sardines from the West Coast of Europe in the years in question.—On the employment of gas as a constant source in experiments on radiation, by M. Edouard Branly. In this communication a comparative study is made of the moderator lamp and gas jet, as two sources of mean temperature in these experiments.—On the tartrate of antimony, by M. Guntz. A process is described for preparing in the pure state the acid tartrate of antimony, which Peligot obtains by alcoholic precipitation of a concentrated solution of the oxide of antimony in tartaric acid.—On the presence and quantitative analysis of alumina in wine and the grape, by M. L. L'Hote. The results are given of experiments made to determine the presence in appreciable quantities of antimony in Burgundy, Roussillon, and some other red wines.—Note on some new syntheses in the fatty series by means of the chloride of aluminium, by M. Alphonse Combes.—On the microbe of yellow fever and its attenuation, second note, by MM. Domingos Freire, Paul Gibier, and C. Rebourgeon. In continuation of their studies on this microbe, discovered by them in 1884, the authors describe a process by means of which the virus may be attenuated and converted into a prophylactic vaccine.—Calorimetric studies on sick children, by M. P. Langlois. The experiments here described show that in chronic disorders with hypothermy there is a diminution of caloric, which increases in maladies with hyperthermy.—On certain characteristics of the pulse in morphiomaniacs, by Messrs. B. Ball and O. Jennings. The observations here illustrated by sygmographic tracings serve both to detect the practice in patients secretly addicted to the taking of morphia and to remove the craving for intermittent doses.—Mineralogical study of the Fort Duncan meteoric iron recently presented to the Paris Natural History Museum, by M. Stanislas Meunier. The analysis of this specimen, found in 1882 near Fort Duncan, Maverick County, Texas, shows a remarkable resemblance to the mass which fell at Braunau, Bohemia, on July 14, 1847. It yielded: iron, 92·02; nickel, with traces of cobalt, 6·10; residuum, 1·80; density 7·699.

STOCKHOLM

Royal Academy of Sciences, February 9.—The following papers were accepted for insertion in the Proceedings of the Academy:—On the so-called anomalous dispersion, by the late Colonel C. E. af Klercker. On benzol and toluol monosulcombinations, by Dr. Mats Weibull.—The Lettersted Prize for 1887 for the best original scientific work was awarded to Prof. F. A. Smitt for his "Critical Index of the *Salmonidæ* in the National Museum," whilst the amount of the same legacy for special scientific work was awarded to Prof. A. G. Nathorst for his researches on the Tertiary flora of Japan.—The Secretary announced that the Proceedings of the Academy for 1886 were completed, and that the first part ("Aurores boreales") of Series II. of the work "Observations faites au Cap Thordsen, Spitzberg, par l'Expédition Suédoise," published at the expense of the Academy, was issued.—The following two papers were also presented by Prof. Berlin:—On six isomeric acids of toluol disulphone, by Dr. P. Klason. On the substitution of the amido group in aromatic combinations for hydrothion as well as oxysulphuryl by means of diazo combinations, by the same.—Prof. Edlund advanced a strictly mathematical demonstration showing the correctness of his theory regarding unipolar induction.—Prof. Gyldén presented the following papers:—Untersuchungen über einen speciellen Fall des Problems der drei Körper, founded on studies at the Stockholm Observatory, by Dr. P. Harzer, of St. Petersburg. On the absolute correctness of terms of expression employed by Prof. Gyldén in order to solve the problems of three bodies, by himself, which paper will shortly appear in the *Acta Mathematica*.—Prof. Smitt announced the appearance of a new edition of the illustrated work "Skandinaviens Fiskar" ("The Fishes of Scandinavia"), in which are a number of original drawings by Herr W. von Wright, belonging to the Academy, which have never been published before. He also presented the first report of the Ornithological Committee appointed by the Academy.—Prof. Mittag-Leffler presented the following papers:—On convergents to definite integrals, by Herr C. B. S. Cavallin. On a treatise by Ascoli relating to the integration of the differential equation $D^n u = 0$ for a given Riemann surface, by Dr. G. Enestrom. Integration der differential Gleichung $D^n u = 0$ in einen beliebigen Riemannischen Fläche, by Prof. Giulio Ascoli, of Milan.—The Secretary presented the following papers for insertion in the Proceedings:—On the influence of chlorium on α-acetic naphthalid, by Prof. Cleve. On naphthalid acids, by Dr. A. G. Ekstrand. On α- and β-naphthamidoxim, by the same. On the resin acids in galipot, by Dr. A. Westerberg. On pteropods in the Zoological Museum of the Upsala University, collected by Capt. G. von Scheele, classified by Dr. H. Munthe. Notes on Permian fossils from Spitzbergen, by Prof. B. Lundgren. Einfluss der Neutralsalze auf die Reactionsgeschwindigkeit der Verseifung von Actylacetat, by Dr. S. Arrhenius.

BOOKS, PAMPHLETS, and SERIALS RECEIVED

Ligaments, their Nature and Morphology: J. B. Sutton (H. K. Lewis.)—School Hygiene: Dr. A. Newsholme (Sonnenschein).—Atlantic Weather Charts, part 1, from August 1 to November 7, 1882 (Stationery Office).—Electrical and Anatomical Demonstrations: Dr. H. Tibbits. (Churchill).—Memoirs of the Literature College, Imperial University of Japan, No. 1: The Language, Mythology, and Geological Nomenclature of Japan, viewed in the light of Aino Studies: B. H. Chamberlain and J. Batchelor (Tokyo).—Verhandlungen des Naturhistorischen Vereines, Zweite Hälfte (Max Cohen, Bonn).—Colonial and Indian Exhibition; Reports on the Colonial Sections: Edited by H. T. Wood (Clowes).—Monthly Results of Observations made at the Stations of the Royal Meteorological Society for the Quarter ending September 30, 1886 (Stanford).—Instantaneous Photography for Amateurs (Sears, Bath).—General Guide to the British Museum, Natural History.—Quarterly Journal of the Royal Meteorological Society, January 1887 (Stanford).—Studies from the Biological Laboratory, Johns Hopkins University, vol. iii. No. 9.

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THURSDAY, APRIL 28, 1887

PRACTICAL ELECTRICITY

Practical Electricity. By W. E. Ayrton, F.R.S. (London: Cassell and Co., 1887.)

PROF. AYRTON'S book on Practical Electricity fills a gap, and is well fitted for the purpose for which its author has designed it. The book comprises the substance of the first year's course for students of electrical technology in the City and Guilds Central Institution at South Kensington, with some additional matter, which is chiefly in small type. The subject of Current is treated first, then comes Electromotive Force or Potential Difference, and afterwards Resistance. This is undoubtedly the logical order, though, as Prof. Ayrton points out, this sequence appears complicated to the minds of learners, from the fact that in the definitions of the Paris Congress the volt is made to depend on the ohm and the ampere. The practical units, ampere, ohm, volt, &c., are used throughout, but a little more space might have been given with advantage to the definitions of these units. Take, for instance, the definition of an ampere,

6. After showing by means of a most instructive and well-arranged experiment (Fig. 1) that a current produces magnetic, chemical, and thermal effects, and further, that the chemical changes are the same in two or more voltameters of the same kind, Prof. Ayrton proceeds:—"We shall therefore *define the strength of a current as being directly proportional to the amount of chemical decomposition produced in a given time; and the current that deposits* 0·00111815 *gramme or* 0·017253 *grain of silver per second on one of the plates of a silver voltameter, the liquid employed being a solution of silver nitrate containing from* 15 *to* 30 *per cent. of the salt*, we shall call an *ampere*,' and take it as our unit current." But frequently a beginner will at once wish to know why these special numbers, which will seem to him unnecessarily complex, should have been taken. Why not select '001 gramme of silver rather than '00111815? will be an obvious question, to which no answer is given. Surely, too, four significant figures would be sufficient. Besides, this is not the definition of ampere adopted by the Paris Congress, and it involves the experiments of Faraday on the electro-chemical deposition of silver. The experiments given in the early part of Chapter I do not need the previous definition of the *unit current*, and from them the fact that a current exerts on a magnet a definite force depending on its strength and (§ 22) on the dimensions and position of its circuit is established. Thence the idea of the current which exerts on a definite magnet a unit force is easily reached, and from this we get the ampere of the Congress definition, which is found, by careful experiment, to deposit so many grammes of silver per second.

So, too, the definition of the "volt" would have been clearer if the excellent illustration of difference of potential given in § 40, Fig. 28, had been carried a little further, and it had been pointed out that, just as the water loses potential energy in falling from one level to another, and that loss is measured by the quantity of water multiplied by the difference in pressure, so the electric current loses energy in passing from one point to another, and that loss is measured by the quantity of electricity multiplied by the difference of electrical potential. But these, perhaps, are points which can be better brought out by a teacher in explaining difficulties to his class.

The book is, we believe, the first in England which accepts distinctly the resolutions of the Paris Congress as a basis. Another novelty to be found in it is the use of the letters P.D. (potential difference) for the old abbreviation E.M.F. This is a change for which, if it can be satisfactorily introduced and accepted, all teachers will be thankful, for it will get rid of the confusion existing between the resultant electrical force at a point, and the electromotive force between two points, which is not a force at all.

The plan of the book has been already indicated. Starting from the definition of an ampere, the various means of measuring currents are described, and full

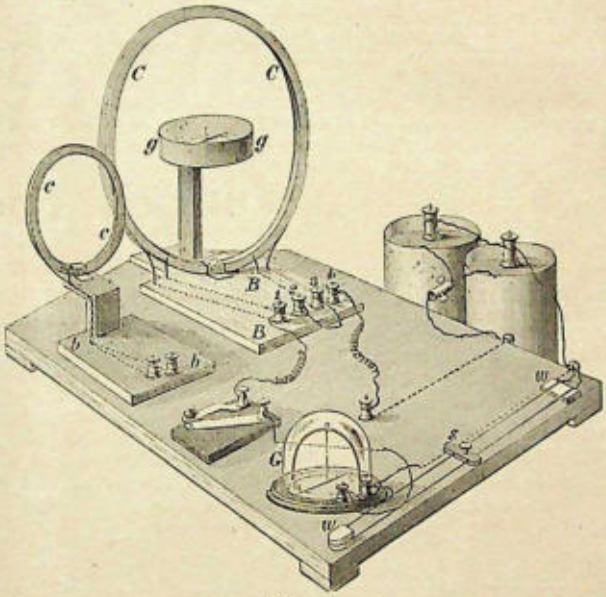


FIG. 15.[1]

details are given of the methods for carrying out the experiments, for recording results graphically and otherwise, and for drawing conclusions from the experiments. The illustrations show clearly the arrangement of apparatus in each case. In Prof. Ayrton's laboratory the apparatus required for any one series of observations is mounted permanently on the same board; the student finds everything ready, and the necessary connexions made when he begins. As to the desirability of this, there will no doubt be some difference of opinion; but with large classes of beginners some such plan is necessary. Thus, Fig. 15 shows the apparatus for investigating the action of a current on a magnet. The large coil C C is so arranged that the current can be made to traverse it eight, twelve, or sixteen times, and its effect on the magnet *g g* observed; or the coil C C can be replaced by *c c* of half the radius, which has four turns on it; or, again, C C can be used simultaneously with *c c*, the current being

[1] We are indebted to Messrs. Cassell for the blocks used to illustrate this article.

sent in opposite directions through the two. $w\,w$ is a resistance by means of which the current may be varied at will, and G a galvanometer.

Chapter III. introduces us to difference of potential, and here the writer describes in a practical form the experiments for the verification of some of the ordinary laws of statical electricity.

Ohm's law and its proof follow in Chapter IV., and it is shown that the resistance of a conductor remains unchanged so long as its other physical conditions are the same. § 80 gives the definition of the "legal ohm." It is not quite accurate to speak of its having been legalised, at any rate in this country; though, as the letter from the B.A. Committee on Electrical Standards, which is printed at the end of the preface, shows, the question of its adoption as a legal standard is now before the Government. Various methods of comparing resistances follow, with full practical details, but the important one due to Prof. G. C. Foster, for comparing two nearly equal resistances, has been omitted from § 97.

Batteries and other forms of current-generators are next considered, with details as to their construction and

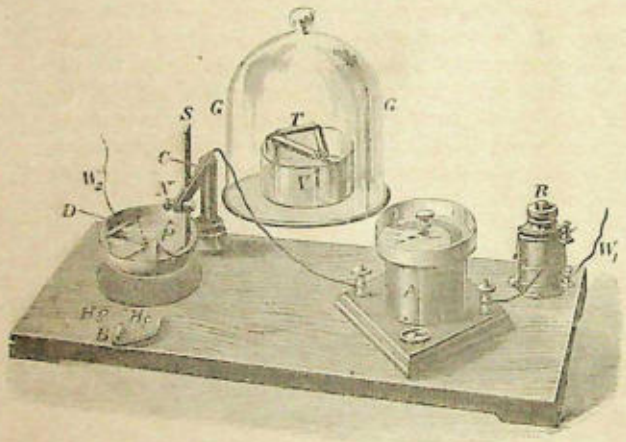


FIG. 157.

use; and an account of the methods of determining thei E.M.F. and resistance is given.

"Insulation" is the title of Chapter VI., and many o the practical hints given under this head are of grea value.

In the next chapter, condensers, and the methods of constructing them and of measuring their capacities, are treated of. We find also a chapter devoted to commercial ammeters and voltmeters, which gives in an easily accessible form particulars as to some of the best known of these instruments, with practical methods of testing and calibrating. In Fig. 157 we have the arrangement of apparatus for comparing an ammeter with a silver-voltameter. R is an adjustable resistance of a useful character, made of a number of washers of carbonised cloth which can be pressed into close contact by a screw. Latimer Clark's cell is described in § 214, in the H form. A simpler pattern consists of a test-tube with a platinum wire sealed through the bottom. The end of this is covered with pure mercury, and above this is a layer of mercurous sulphate, with a saturated solution of sulphate of zinc above all. A rod of clean zinc dips into the zinc sulphate passing through the cork which closes the test-tube, and the whole is kept tight with marine glue.

In an appendix Kirchhoff's laws of divided circuits are considered. The method of treating such problems introduced by Maxwell, and which has recently been illustrated at some length by Prof. Fleming, is also referred to.

Another point of importance which calls for notice is the number of examples introduced by way of illustration; some of these are completely worked out, others left as exercises for the student.

The book concludes with some specimens of the instructions for experiments which are given to students at the City and Guilds Institution, with the apparatus with which each experiment is performed. Of these instructions there are four; and many who use the book will wish their number was larger. We will close this notice by quoting the last of them.

To calibrate an ammeter by means of a silver voltameter (the apparatus required has been figured above):—

"PRELIMINARY.—The voltameter consists of a platinum dish containing a 25 per cent. solution of silver nitrate, and in which a silver plate is immersed. An adjustable carbon resistance is provided, by means of which the current passing through the voltameter can be maintained constant during each experiment, and can be varied in the different experiments.

"EXPERIMENTS.—(1) Carefully clean, dry, and weigh the platinum dish, the *approximate* weight of wh[illegible] grammes.

"(2) Pour the solution of silver nitrate into th[illegible]sh, and place it on the three brass pins provided for its reception, and which are electrically connected with the left-hand binding-screw on the board. Immerse the silver plate in the solution, and clamp it in such a position that its edges are equally distant from the sides and bottom of the dish.

"(3) Turn the small milled head at the top of the ammeter so that the pointer of the ammeter comes opposite the zero on the scale, if not there already. Place the copper connecting-wire in the mercury cups marked A and C (which cuts out the voltameter), and adjust the carbon resistance until a convenient current flows round the ammeter. Remove the connecting-wire.

"(4) Quickly insert the connecting-wire in the mercury cups marked A and B, carefully noting the instant at which the circuit was completed. Allow the current to pass for a convenient time (ten to thirty minutes, accor[illegible]ing to the strength of the current used), and keep[illegible] current constant by the adjustable resistance. No[illegible] temperature of the room during the experiment, a[illegible] the end of the interval decided on, quickly bre[illegible] circuit.

"(5) Empty the solution from the dish into its [illegible]tle, and carefully wash the deposited silver with distilled water. Then fill the dish with distilled water, and allow it to stand ten to fifteen minutes. Again wash with water, alcohol, and ether, dry over the spirit-lamp, and cool in the desiccator.

"(6) Carefully determine the increase of weight due to the silver deposited on the dish.

"(7) Calculate the strength of current used in the experiment, assuming that one ampere deposits 1·11815 milligrammes of silver per second.

"(8) Repeat the experiment with several different strengths of current.

"(9) Tabulate your results in some convenient form, and write them with your name on the card, on which you will find recorded the results of previous experiments."

SPOLIA ATLANTICA

Spolia Atlantica. (1) Contributions to the Knowledge of the Salpidæ, by M. P. A. Traustedt; (2) Remarks on some of the Oceanic Annulata, by G. M. R. Levinsen; (3) Contributions towards the Morphology and Systematic Arrangement of the Pteropoda, by J. E. V. Boas. (Copenhagen, 1885-86.)

THE three monographs which at the instance, and under the supervision, of the Directors of the Zoological Museum of Copenhagen, have been included in one quarto volume under the title of "Spolia Atlantica," originally appeared in the Transactions of the Danish Royal Society of Natural Sciences. But although bound together, each monograph in this *édition de luxe* is complete in itself, with separate title-page, table of contents, descriptive plates, and all other necessary means of separate reference, while the convenience of readers not acquainted with Danish has been amply considered by the addition of Latin and French translations of the descriptions of the animals, and of many other important parts of the text.

The first of this triplet of monographs, which deals with the so-called "aggregate" and "solitary" forms of the several species of Salpæ, is based on a study of the exceptionally complete collections preserved in the Zoological Museum of Copenhagen, for which that institution is mainly indebted to Prof. Steenstrup, at whose suggestion and under whose direction Herr Traustedt compiled his memoir. The monograph presents a clear and comprehensive description of all the well-established species of Salpæ with their distinctive dual forms, and unqualified praise may be given to the care with which the figures have been drawn, and the admirable manner in which, by means of pale blue outlines, the delicacy and transparency of the bodies of the animals have been represented.

In treating of the Salpidæ, it is impossible to forget how much of our knowledge of these curious animals is due to the observations of Chamisso, the clever author of "Peter Schlemihl," who, while serving as naturalist in the exploring expedition of the Russian commander Kotzebue, first discovered that the "aggregate" or chain Salpa and the "solitary" Salpa were not distinct species, as had been supposed, but only parts of the perfect organism of one species. By the discovery of this fact, which Chamisso ingeniously, but, as subsequent investigations have shown, too fancifully, explained on the hypothesis that these animals were subject to a law of "alternation of generations," new and highly important paths of morphological inquiry were opened. Yet, singularly enough, nearly thirty years passed after the publication, in 1819, of Chamisso's treatise "De Animalibus quibusdam e Classe Vermium Linneana (de Salpis)" before his observations were tested by further scientific investigation. About the middle of the century Meyen and Vogt turned their attention to the curious and interesting phenomena connected with the embryonic development of the Salpæ. These inquiries were soon followed by the still more important researches of Profs. Krohn and Huxley, the latter of whom in a paper entitled "Observations upon the Anatomy and Physiology of Salpa and Pyrosoma," which appeared in the Phil. Trans. 1851, has shown that Chamisso erred in his explanation of the nature of a "chain Salpa," which, to use Mr. Huxley's words, "is nothing more homologically than a highly individualised generative organ."

Herr Traustedt does not enter into the question of the embryonic development of the Salpidæ, and hence his work gives no information regarding the physiology of these animals, nor does he in any way refer to the various hypotheses that have been advanced in explanation of the character of the "aggregate" and "solitary" forms. For such information the student must go elsewhere. As a guide to the anatomical structure of both forms in the eleven species described and drawn by the author, the memoir will, however, be found of great service, while it contains much useful information as to the geographical distribution of these animals not to be found elsewhere.

In the treatise on "Some Oceanic Annulata" Herr Levinsen supplies many interesting details regarding various members of the families Alciopidæ and Typhloscolecidæ, together with descriptions of several species of Sagitta, to which are added lists of their geographical distribution. In this, as in the memoir on the Pteropoda, the illustrations are worthy of all praise.

The memoir by Dr. Boas, which constitutes the last and longest of the series, treats at great length of the morphology, systematic arrangement, and geographical distribution of the Pteropoda. The materials employed by the author were derived in part from the extensive collections in the Zoological Museum of Copenhagen made by, or under the direction of, Prof. Steenstrup, and in part from numerous specimens placed at the writer's disposition by Profs. Dohrn, Möbius, Leche, and Spengel. It is worthy of note that a very large proportion of the specimens referred to as belonging to the Museum of Copenhagen were obtained from amateur collectors: Danish naval officers, captains of merchant ships, and travellers having responded with alacrity to Prof. Steenstrup's appeal for help in obtaining samples of these and other animals from remote regions.

OUR BOOK SHELF

Complete Hand-book on the Management of Accumulators. By Sir David Salomons, Bart. Second Edition, revised and enlarged. (London: Whittaker and Co., 1887.)

THE author has for some years past had an installation at his country residence for the purpose of lighting it and for working motors which drive the machinery in his large and well-equipped workshop. He has used accumulators, as he informs us, ever since they may be said to have been produced in commercial form in 1882. No expense nor trouble have been spared in making this installation a model one, and experiments have been made on many points in connexion with the subject. As the whole installation has been made and worked under his immediate personal superintendence, he has acquired a considerable amount of experience, the result of which, as far as it regards the management of accumulators, he places before the public in this work.

After a general description of cells of the E.P.S. and Elwell-Parker type, he proceeds to give directions for setting up and charging them. The causes of, and remedies for, "buckling" and "scaling" are discussed. The harm caused by too rapid a discharge is pointed out, and methods for preventing it are explained, as well as various devices for regulating the E.M.F. of the charging current and that on the line. The method of cleaning and "re-pasting" the plates is explained, and various

hints are given for the management of the battery. In an appendix is a description of the arrangement of his accumulator house, a photograph of the interior of which forms the frontispiece to his book. He also gives a brief account of the history of the installation, from which we learn that the total cost of buildings and installation has been about 6000*l.*, that the number of lamps is about 500 of 20-candle power, but that the greatest number used at any one time has rarely exceeded 200, and that an arc lamp taking 40 or 50 amperes and one or two motors have been used together with them. The expenses—including wages, coal, oil, waste, washers, repairs, lamp renewals, &c.—were, in 1886, 210*l.*, or at the rate of ½*d.* per 20-candle lamp per hour. He does not, however, say anything as to the cost of the accumulators; and as to the length of time which they may be expected to last he only says vaguely that "the cells may last for years in perfect order if all the instructions here given are properly attended to." His present accumulators were only put up in August 1885, those previously erected having proved to be unsatisfactory.

It is a pity that the useful information in this work is not conveyed in better language. In what is intended as a workshop hand-book we do not look for the elegance of an Addison; but we do want plain English. As an example of the language we may quote the following sentence from the preface: "Only cells of the Electrical Power Storage Company, of Messrs. Elwell-Parker, and their type, are dealt with, because at this moment there is probably no other better kind, or largely in use." The meaning of this is clear, though even that is more than may be said of other sentences in the book.

Among minor faults we protest against the coinage of such a hideous word as "acidometer," by which, apparently, is meant the instrument commonly known as a hydrometer; we do not think "s.g." is an improvement on the ordinarily accepted abbreviation for specific gravity; and we object to the plural "dynamos" as against the ordinary rule of our language which gives us "potatoes" and "echoes."

A more serious error is found in the "Index of Terms" on the back of the title-page—

"Watt = volt × ampere = measure of force or energy."

We should recommend the author to get the work revised by some onewho understands the rudiments of science as well as those of the English language.

School Hygiene: The Laws of Health in Relation to School Life. By Arthur Newsholme, M.D. (London: Swan Sonnenschein, Lowrey, & Co., 1887.)

ABOUT the importance of the matters dealt with in this little book there can, of course, be no dispute; and, as Dr. Newsholme points out in his preface, they have engaged the serious attention of many School Boards and Committees, and been made the subject of a good deal of useful legislation. Most school-managers still have something to learn about the principles of school hygiene, and many of them will, no doubt, find in Dr. Newsholme's volume exactly the kind of information they want. He discusses the subject under two heads, "Schools" and "Scholars." Under the first head he presents his ideas on questions connected with the choice of sites for schools, the construction of school buildings, school furniture, lighting of school-rooms, general principles of ventilation, natural ventilation, ventilation and warming, and draining arrangements. In the part relating to "Scholars" he has chapters on mental exercise, excessive mental exercise, age and sex in relation to school work, muscular exercise and recreation, rest and sleep, children's diet, children's dress, baths and bathing, eyesight in relation to school life, communicable diseases in schools, and school accidents. Dr. Newsholme has studied his subject thoroughly, and his conclusions are all the more valuable because they have been to a large extent suggested by his experience as a medical officer of health, and as a medical referee for various schools and training colleges.

LETTERS TO THE EDITOR

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.

[The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.]

Mass, Weight, and Dynamical Units

IF the laws of dynamics were made solely for the use of engineers, as a celebrated engineer declared of rivers that they were intended to feed canals, it might be conceded to Prof. Greenhill that it would not be *necessary* that the more abstract notion of mass should be distinguished from that of weight, and that the fundamental equation of dynamics might conveniently be taken as $P = W\frac{f}{g}$, where W is the weight (or mass) of the body moved expressed in pounds or tons, &c., and P the force producing in it the acceleration f, and reckoned in the same units. But a pound weight as a force is a variable unit, unless it is taken at some particular place (as Greenwich), and then the corresponding value of g must be employed (though the variation of g on the surface of the earth is not so great as often to need to be taken account of by the engineer); and so the astronomer and physicist, as well as the student of abstract dynamics, are right in demanding a less arbitrary measure of force than one founded on the force acting vertically downwards on a body at the earth's surface, as well as an absolute constant belonging to each body (its *mass*) independent of time and place. I conceive, therefore, in spite of Prof. Greenhill's arguments, that, in the interest of clearness of thought, as well as to avoid the practical inconvenience of a variable unit of force, the notions of mass and weight must be kept distinct, and the equation $W = Mg$, as a special case of the general equation $P = Mf$, still insisted on by all teachers of dynamics, at any rate to non-engineering students; while it would be well for engineers also (*me judice*) to have their dynamics cast in the same mould as the rest of the scientific world.

I should not have troubled you with the above very obvious remarks had I not wished to observe, *à propos* of Mr. Geoghegan's suggestion of names for units of velocity and acceleration in NATURE of April 7 (p. 534), that it is highly desirable that a convenient and consistent *notation*, as well as *nomenclature*, should be adopted for the several dynamical units.

With respect to the particular suggestion that *vel* and *cel* (or *velo* and *celo*, as used by Mr. Lock in his forthcoming book, "Dynamics for Beginners") should be employed for the units of speed and acceleration in the foot-second system, I regard it as an almost fatal objection that the accepted C.G.S. system having appropriated the words *dyne* and *erg* for its units of force and work has a prior right to *vel* and *cel* for its units of speed and acceleration; namely, the centimetre per second, and the centimetre per second per second. If so, the units of the foot-second system might be called the *footvel* and the *footcel*.

Names for the dynamical units are, however, I think, of less importance than a convenient and suggestive notation for them. I have endeavoured to devise such a notation (or, rather, to fill up and complete notations which have more or less come into use) in a table, which is now under the consideration of a Committee of the Association for the Improvement of Geometrical Teaching, and which is substantially as follows.

In a perfectly general system, let L, M, T stand respectively for the fundamental units of length, mass, and time, and let V, A, U, Δ, E stand for the units thence derived of speed, quickening (acceleration), momentum or impulse, force, and energy or work respectively: then the statement that the unit of speed is the speed of the unit of length *per* unit of time is

naturally expressed thus, $V = L/T$. On the same principle we should have—

$$A = V/T = L/TT,\ U = MV = ML/T,\ \Delta = MA = ML/TT,$$
$$E = L\Delta = LML/TT.$$

This may be simplified, using the analogy of the fluxional notation, by writing $\dot{L}$ for L/T and $\ddot{L}$ for L/TT. Then $\dot{L}$, $\ddot{L}$ may take the place of V and A, and we have—

$$U = M\dot{L},\ \Delta = M\ddot{L},\ E = L\Delta = LM\ddot{L}.$$

Names for the several units are hardly needed in the general system.

In the C.G.S. system the units of length, mass, and time are respectively the centimetre, gramme, and second, denoted by C, G, S. Then if U_G, Δ_G, E_G denote the units of momentum or impulse, force, and energy or work, we have, on the same principle as before, $\dot{C}$, $\ddot{C}$ to denote the speed of a centimetre per second and the acceleration of a centimetre per second per second respectively, and the equations—

$$U_G = G\dot{C},\ \Delta_G = G\ddot{C},\ E_G = C\Delta_G = CG\ddot{C}.$$

If *names* for all these units are required, we may use these: *cel*, *cel*, *mom*, *dyne*, *erg*; and we may say, a *mom* is a *gramme-cel*, a *dyne* is a *gramme-cel*, and an *erg* a *centimetre-dyne*.

In the F.P.S., or British system, the units of length, mass, and time are respectively the foot, pound, and second, denoted by F, P, S. Then, if U_P, Δ_P, E_P denote the units of momentum or impulse, force, and energy respectively, we have, on the same principles, $\dot{F}$, $\ddot{F}$ to denote the speed of a foot per second and the acceleration of a foot per second per second respectively, and the equations—

$$U_P = P\dot{F},\ \Delta_P = P\ddot{F},\ E_P = F\Delta_P = FP\ddot{F}.$$

I propose as names for these units: *footvel*, *footcel*, *poundem*, *poundal*, *pounderg*. I should have called the unit of force a *pound-dyne* or *poundyn*, but that *poundal* has already obtained general acceptance.

The foregoing are all absolute units. The corresponding (Greenwich) gravitation-units are the *pound-weight* = 32·19 *poundals*, the *foot-pound* = 32·19 *poundergs*, and the *second-pound* (as it has been proposed by Prof. Unwin to name the gravitation-unit of momentum, or time-integral of a pound-weight through one second) = 32·19 *poundems*; so that to convert absolute F.P.S. units into gravitation-units, or *vice versâ*, it is only necessary to divide or multiply by 32·19, since the acceleration due to gravity at Greenwich = 32·19 $\ddot{F}$.

It is, I think, comparatively unimportant whether the *names* above suggested are, all of them, accepted or not; but the *notation* will, I believe, be found a great aid to the beginner in fixing in his mind the dimensions of the different magnitudes, and an effective safeguard against the too common confusion of units of force, impulse, and work. I doubt whether in speaking much would be gained by saying "*footvel*" instead of "foot per second," or "*footcel*" instead of "foot per second per second," while in *writing*, the symbols $\dot{F}$ and $\ddot{F}$ might be always used and read either way.

ROBT. B. HAYWARD

Harrow, April 12

Units of Weight, Mass, and Force

FAR be it from me to interfere between Mr. Alfred Lodge and Prof. Greenhill; but, whilst leaving Mr. Lodge to his fate and Prof. Greenhill, perhaps, as an engineer, I may be permitted to offer a few remarks on the general question. First, then, it appears to me that Prof. Tait's thoroughgoing condemnation of certain phrases of the engineering vernacular, and of the grave errors of certain writers, has been strained in some quarters to mean a general charge against engineers of inability to think or write clearly on the physical laws which lie at the root of their every-day practice. Such an unqualified charge is on the face of it absurd; for otherwise we must confess that the lives' work of Thomson and Tait has been a total failure as regards its influence on the truly practical men of their generation. Can this be so?

Prof. Greenhill's remarks on the abominable semi-numerical equation $W = Mg$, or $\frac{W}{g} = M$, I most heartily welcome [where W is a mass and g a numeric; the moment writers on dynamics, who use the gravitation system, pass from merely proportional equations to their physical interpretation, then must we face with them this most wretched equation]. But perhaps it will be at once a surprise and a gratification to Prof. Greenhill to know that a whole (academic) generation of Scottish University engineering students has been taught to eschew this same equation as an unclean thing, and to adopt the mode of thought clearly set forth in the last two paragraphs of his letter of February 28. Some five or six years ago I was myself so taught by one who is now, alas! no more. The possibility of thus clearing of cant not only the engineering but the purely mathematical mind seems to me, as indeed Prof. Greenhill indicates, to be a direct consequence of the acceptance by Thomson and Tait of the British Imperial pound as the unit of mass or quantity of matter.

Having fixed, then, for good and all, the unit of mass, and taking the British foot and the second as the units of time and length respectively, the unit of force defines itself in virtue of Newton's Second Law. To this unit—the British unit of force—Prof. James Thomson has given, as nearly everyone knows, the name "poundal." Now the most convenient practical unit of force, for physicists as well as engineers, is not the poundal, but the gravitation at the earth's surface of the unit of mass, a quantity which is not absolutely constant, the inconvenience so arising being, however, practically unimportant, or at most involving a reduction to an arbitrary standard. To pass, then, from a force expressed in poundals to a force expressed in units of gravitation of the Imperial pound at the standard place, one simply wants to know how many poundals go to the gravitation of the Imperial pound at that place—in other words, the change ratio. The answer is simple: the numeric g for the standard place; for a force equal to the gravitation of the Imperial pound at the standard place acting upon a mass of one Imperial pound would generate a momentum per second of g (numeric) pounds mass × feet per sec. per sec.; and the poundal a momentum per second of one pound mass × feet per sec. per sec.; and by Newton's Second Law the ratio of the forces is, therefore, the numeric g. What more does the physicist or engineer want to know? How many poundals go to the gravitation of a ton mass at the standard place? Answer, the numeric 2240 g. Could anything be simpler? The difficulty is to find the difficulty, or to assign the *raison d'être* of the so-called gravitation unit of mass.

When the old unnatural gravitation unit of mass is abandoned, and the transition from the natural unit to the gravitation unit of force made by means of the change ratio, the vicious use of the word mass to denote the result of dividing by the numeric g the mass of a body in standard pounds (viciously on the same system called the weight and denoted by W) ceases; and the dire confusion between weight and mass becomes a thing of the past. The emancipation of the term weight from its bondage to mass would appear to have afforded opportunity for its use wherever it might be of service in suggesting or denoting gravitation. For example, there are three units, each called a pound, viz. the Imperial British unit of mass, the gravitation of the same mass at any the same place on the earth's surface, and the pound sterling. Physicists, like Sir Wm. Thomson and Prof. Tait, use terms such as "pound weight," "gramme weight"; similarly we have "pound mass" coming into use; and probably we shall soon hear of "pound money." Prof. Greenhill, with his strong engineering sympathies, objects to the time-honoured "pounds per square inch" being rendered "pounds weight per square inch"; and if I may presume to offer an opinion, the old phrase is already cumbrous enough. Still, if Prof. Tait and Prof. Greenhill ultimately agree that there is anything to be gained in perspicuity, for the sake of the weaker members perhaps it might be well for us to put in practice, on some occasions, the injunction to sacrifice all rather than cause our brother to offend.

Some one might possibly step in to draw attention to the fact that the pages of even our own great high priest of exact applied science are disfigured by $\frac{W}{g}$; but sure I am that were Rankine now with us he would lead the way with Prof. Greenhill in a crusade against the apologists for the obscurity of which W/g is the symbol. Take, for example, Rankine's bold introduction of the dynamical unit of quantity of heat. Take the opinion of

Clausius, than whom none could be a more unprejudiced witness. "At the same time in the theoretical development of the mechanical theory of heat, in which the relation between heat and work often occurs, the method of expressing heat in mechanical units effects such important simplifications that the author has felt himself bound to drop his former objections to the method on the occasion of the present more connected exposition of that theory." ARCHD. C. ELLIOTT

Edinburgh, April 18

Seismometers

I HAVE long ago learnt not to look for any fair recognition of my work in seismometry on the part of Prof. John Milne, and when he accuses me of appropriating without acknowledgment the work of others it is time to decline further controversy with him. The points raised in his last communication (NATURE, April 14, p. 559) are sufficiently answered in mine of December 11 (p. 172). I there quoted part of a letter written by Prof. Chaplin, now of Harvard University, then of Tokio, and Secretary of the Seismological Society of Japan, under whose eyes the events occurred to which Prof. Milne refers. I did not quote the whole of Prof. Chaplin's letter, because it contained sentences I was unwilling to give except under the strongest provocation. After referring to my seismograph in the words already quoted (p. 172), Prof. Chaplin continues:—

"I do not remember that in the discussions on your machine Mr. Gray ever claimed to have invented a similar machine, and I am surprised to know that he makes that claim now. On this and other points it appears to me that Messrs. Gray and Milne have not treated your inventions and investigations with fairness, and that you have just grounds for complaint. I am willing you should make such use of this note as you see fit."

As to the question of priority, this judgment, from a man at once unprejudiced, most competent to form an opinion, and fully informed of the matter in dispute, must (so far as I am concerned) close a discussion of which your readers cannot but be weary. With your permission I shall give, in a later number of NATURE, an example of the excellent work which Prof. Sekiya is now doing with my instruments in Japan.

J. A. EWING

University College, Dundee, April 16

April Meteors

THE Lyrids have, this year, offered a somewhat scanty display, though a few brilliant meteors have been seen shooting from the usual radiant-point.

In 1884 April 19, this shower was very rich, the horary number of its meteors for one observer being about 22, but in the following year, 1885, it exhibited a considerable decline, the hourly rate being only 3. In 1886 I obtained no observations, owing to the bright moonlight and in the present year, on April 20, the horary number was slightly more than 2, so that the numerical character of the recent display has fallen far short of some of its apparitions in preceding years.

On the night of April 17, this year, the shower had not visibly opened, for none of its meteors were recorded in a 2½ hours' watch. On each of the nights of the 18th and 19th the sky was closely observed for 4½ hours, but the Lyrid shower was very feeble, and only furnished 1 meteor per hour. On the 20th, in 3 hours I noted 7 Lyrids, and these were brilliant.

The average radiant-point from the three nights was at 269° + 32°, and there is confirmation that this point advances in R.A. with the time, though not to the marked degree ascribed in NATURE for May 7, 1885, p. 5. But the meteors from this stream have been so scarce at their late recurrence that it has been very difficult to ascertain the exact radiant for each night. Moreover, these Lyrids move with great apparent velocity, flashing out with extreme suddenness and they are gone, together with the faint streaks sometimes accompanying them, before the eye is enabled to catch the directions with satisfactory precision.

On the four nights April 17 to 20 inclusive, I noticed 70 shooting-stars belonging to the minor systems of the Lyrid meteoric epoch, and amongst these the best was that of a radiant of very swift, short meteors at 231° + 17°, a few degrees west of β Serpentis. This stream is not new, for I saw a well-defined shower of Serpentids from the same point during my observations of the Lyrids in 1885, on April 19–20 (NATURE, May 7, 1885, p. 6).

In this and in previous years I have also recorded some meteors ascending in very long flights from a radiant centre close to θ Librae, at 235°−15°. This is the only observation of this shower at the April period, though Lieut.-Colonel Tupman found a pair of radiants near the position assigned in the first week of March 1869–70.

I subjoin a short list of bright meteors seen here while watching the progress of the Lyrids, and I should be glad to hear that any of these had been observed elsewhere.

Date 1887	Hour h. m	Mag.	Apparent Path From	Apparent Path To	Notes	Radiant
			° °	° °		
April 19	13 13	♀	269 + 11	264 + 1	Swift, streak	Lyrid
19	13 46	♀	308 + 61½	56 + 63½	Swift, streak	272° + 13°
20	9 48	1	211 + 7	194 − 4	Very swift	Lyrid
20	10 29½	>1	243 + 14	234 + 5	Swift, streak	Lyrid
20	10 47	1	256 + 53	269 + 62½	Slow, train	269° + 48°
20	12 28	>1	308 + 40	316 + 49½	Very swift	Lyrid

Bristol, April 22 W. F. DENNING

Vertical Decrement of Temperature and Pressure

IN NATURE of March 10 (p. 437), Mr. Maxwell Hall gives an interesting table of the vertical distribution of temperature and pressure in Jamaica, and, apparently in happy ignorance of the dangers of the process known as extrapolation, goes on to apply the results of observations extending to a maximum height of only 7400 feet to the determination of the probable temperature of meteorites in extra-terrestrial space. As he expresses a desire to know whether any similar results have been found in India, and as I have on several occasions during the past ten years discussed the vertical distribution of temperature and pressure in this country, I gladly take this opportunity of referring him to my papers on the meteorology of the North-West Himalaya, and on the temperature of North-Western India, published in the "Indian Meteorological Memoirs," vols. i. and ii. From the latter I extract the following table on the mean decrement of temperature up to a height of 12,000 feet, computed from the observations of twenty-five stations combined in various ways. For each month an interpolation formula of the form

$$T = T_0 + ah + bh^2 + ch^3,$$

was computed, and by its means the decrements from sea-level to 1000 feet, 1000 to 2000 feet, &c., were calculated. Finally, the average decrement for the twelve months was computed, and is here given in an abridged form. The curves for the several months differ very widely from one another, those for the summer giving the most rapid decrement at sea-level, and the decrement increasing with altitude in winter:—

Height Feet	Mean temperature decrement ° F.
0 to 2000	6·16
2000 to 4000	5·87
4000 to 6000	5·61
6000 to 8000	5·37
8000 to 10000	5·16
10000 to 12000	4·98

The mean height of the barometer at sea-level in the region in question, the centre of which lies a little north of Simla, is about 29·8 inches; the mean at 6000 feet is 24·1 inches, and the mean at 12,000 feet about 19·4 inches. With these data, and adopting Mr. Hall's formula

$$\delta T = \lambda.\delta P + \mu.(\delta P)^2,$$

we find λ = 2°·979 and μ = 0°·02. These coefficients do not differ widely from Mr. Hall's values, which are 2°·92 and 0°·08 respectively. At the limit of the atmosphere, where δP = 29°·8, δT would be − 106°·5, which would give, as the mean temperature of external space, about − 30° F., the mean temperature at sea-level being 77° F.

Taking the simplest formula, $\delta T = \lambda.\delta P$, we find λ = 3°·19, which is almost identical with the value quoted by Mr. Hall from an early volume of NATURE, but which, if it held good to the limit of the atmosphere, would make the temperature of external space about − 18° F., since the mean temperature at sea-level is 77° F.

The only conclusion to be drawn from such observations is that the vertical decrement of temperature on mountains varies greatly with locality as well as season, and the results

obtained for one locality cannot be fully applied to another, much less extended to determine the temperature at the superior limit of the atmosphere.

An interesting point of resemblance between Mr. Hall's observations and those made on the Himalaya is that the diurnal range of temperature diminishes to a minimum at about 5000 feet, and then increases with increasing elevation.

Allahabad, March 30 S. A. HILL

Royal Society's *Soirée*

MAY I be permitted, through the columns of NATURE, to ask, on behalf of the Sub-Committee appointed to make arrangements for the forthcoming *soirée* of the Royal Society, that Fellows and others who have apparatus or objects of scientific interest suitable for exhibition on that occasion will communicate at once with the Secretaries or myself. HERBERT RIX,

Royal Society, Burlington House Asst. Sec. R.S.

HOMERIC ASTRONOMY[1]

II.

TURNING to the second great constellation mentioned in both Homeric epics, we again meet traces of remote and unconscious tradition. Yet less remote, probably, than that concerned with the Bear. Certainly less inscrutable. For recent inquiries into the lore and language of ancient Babylon have thrown much light on the relationships of the Orion fable.

There seems no reason to question the validity of Mr. Robert Brown's interpretation of the word by the Accadian *Ur-anu*, "light of heaven" ("Myth of Kirke," p. 146). But a proper name is significant only where it originates. Moreover, it is considered certain that the same brilliant star-group known to Homer no less than to us as Orion, was termed by Chaldeo-Assyrian peoples "Tammuz" (Lenormant, *Origines de l'Histoire*, t. i. p. 247), a synonym of Adonis. Nor is it difficult to divine how the association came to be established. For about 2000 B.C., when the Euphratean constellations assumed their definitive forms, the belt of Orion began to be visible before dawn in the month of June, called "Tammuz," because the death of Adonis was then celebrated. It is even conceivable that the heliacal rising of the asterism may originally have given the signal for that celebration. We can at any rate scarcely doubt that it received the name of "Tammuz" because its annual emergence from the solar beams coincided with the period of mystical mourning for the vernal sun.

Orion, too, has solar connexions. In the Fifth "Odyssey" (121-24), Calypso relates to Hermes how the love for him of Aurora excited the jealousy of the gods, extinguished only when he fell a victim to it, slain by the shafts of Artemis in Ortygia. Obviously, a sun-and-dawn myth slightly modified from the common type. The post-Homeric stories, too, of his relations with Œnopion of Chios, and of his death by the bite of a scorpion [illegible] emblematical of darkness, like the boar's tusk in the [illegible]nis legend), confirm his position as a luminous hero [illegible] Brown, *Archæologia*, vol. xlvii. p. 352; "Great [illegible]k Myth," chap. x. § v.). Altogether, the evidence [illegible] in favour of considering Orion as a variant of [illegible]ported into Greece from the East at an early [illegible] there associated with the identical group of stars [illegible]ommemorated to the Accads of old the fate of [illegible]i (*i.e.* Tammuz), the "Only Son of Heaven."

[illegible]s remarkable that Homer knows nothing of stellar [illegible]nology. He nowhere attempts to account for the [illegible]es of the stars. He has no stories at his fingers' [illegible]s of translations to the sky as a ready means of exit [illegible]m terrestrial difficulties. The Orion of his acquaint[illegible]ce—the beloved of the Dawn, the mighty hunter, sur[illegible]ssing in beauty of person even the divinely-born Aloidæ

[1] Continued from p. 588.

—died and descended to Hades like other mortals, and was there seen by Ulysses, a gigantic shadow "driving the wild beasts together over the mead of asphodel, the very beasts which he himself had slain on the lonely hills, with a strong mace all of bronze in his hand, that is ever unbroken ("Odyssey," xi. 572-75). His stellar connexion is treated as a fact apart. The poet does not appear to feel any need of bringing it into harmony with the Odyssean vision.

The brightest star in the heavens is termed by Homer the "dog of Orion." The name *Seirios* (significant of sparkling), makes its *début* in the verses of Hesiod. To the singer of the "Iliad" the dog-star is a sign of fear, its rising giving presage to "wretched mortals" of the intolerable, feverish blaze of late summer (*opora*). The deadly gleam of its rays hence served the more appropriately to exemplify the lustre of havoc-dealing weapons. Diomed, Hector, Achilles, "all furnish'd, all in arms," are compared in turn, by way of prelude to an "*aristeia*," or culminating epoch of distinction in battle, to the same brilliant but baleful object. Glimmering fitfully across clouds, it not inaptly typifies the evanescent light of the Trojan hero's fortunes, no less than the flashing of his armour, as he moves restlessly to and fro ("Iliad," xi. 62-6). Of Achilles it is said:—

"Him the old man Priam first beheld, as he sped across the plain, blazing as the star that cometh forth at harvest-time, and plain seen his rays shine forth amid the host of stars in the darkness of night, the star whose name men call Orion's Dog. Brightest of all is he, yet for an evil sign is he set, and bringeth much fever upon hapless men. Even so on Achilles' breast the bronze gleamed as he ran" (xxii. 25-32).

In the corresponding passage relating to Diomed (v. 4-7), the *naïve* literalness with which the "baths of Ocean" are thought of is conveyed by the hint that the star shone at rising with increased brilliancy through having newly washed in them.

Abnormal celestial appearances are scarcely noticed in the Homeric poems. There are neither eclipses[1] of sun or moon, nor comets, nor star-showers. The rain of blood, by which Zeus presaged and celebrated the death of Sarpedon ("Iliad," xvi. 459, also xi. 54) might be thought to embody a reminiscence of a crimson aurora, frequently, in early times, chronicled under that form; but the portent indicated is more probably an actual shower of rain tinged red by a microscopic alga. An unmistakable meteor, however, furnishes one of the glowing similes of the "Iliad." By its help the irresistible swiftness and unexpectedness of Athene's descent from Olympus to the Scamandrian plain are illustrated.

"Even as the son of Kronos the crooked counsellor sendeth a star, a portent for mariners or a wide host of men, bright shining, and therefrom are scattered sparks in multitude; even in such guise sped Pallas Athene to earth, and leapt into their midst" ("Iliad," iv. 75-9).

In the Homeric verses the Milky Way—the "path of souls" of prairie-roving Indians, the mediæval "way of pilgrimage"[2]—finds no place. Yet its conspicuousness, as seen across our misty air, gives an imperfect idea of the lustre with which it spans the translucent vault which drew the wondering gaze of the Ionian bard.

The point of most significance about Homer's scanty astronomical notions is that they were of home growth. They are precisely such as would arise among a people in an incipient stage of civilisation, simple, direct, and childlike in their mode of regarding natural phenomena, yet incapable of founding upon them any close or connected reasoning. Of Oriental mysticism there is not a vestige. No occult influences rain from the sky. Not so

[1] Görlitz finds a prediction of a solar eclipse at "Odyssey," xx. 357, but the expression appears quite indefinite and figurative.

[2] To Compostella. The popular German name for the Milky Way is still *Jakobsstrasse*, while the three stars of Orion's belt are designated, in the same connexion, *Jakobsstab*, staff of St. James.

much as a square inch of foundation is laid for the astrological superstructure. It is true that Sirius is a "baleful star"; but it is in the sense of being a harbinger of hot weather. Possibly, or probably, it is regarded as a concomitant cause, no less than as a sign of the August droughts; indeed the *post hoc* and the *propter hoc* were, in those ages, not easily separable; the effect, however, in any case, was purely physical, and so unfit to become the starting-point of a superstition.

The Homeric names of the stars, too, betray common reminiscences rather than foreign intercourse. They are all either native, or naturalised on Greek soil. The transplanted fable of Orion has taken root and flourished there. The cosmopolitan Bear is known by her familiar Greek name. Boötes is a Greek husbandman, variously identified with Arkas, son of Callisto, or with Ikaros, the luckless mandatory of Dionysos. The Pleiades and the Hyades are intelligibly designated in Greek. The former word is usually derived from *plein*, to sail; the heliacal rising of the "tangled" stars in the middle of May having served, from the time of Hesiod, to mark the opening of the season safe for navigation, and their cosmical setting, at the end of October, its close. But this etymology was most likely an after-thought. Long before rules for navigating the Ægean came to be formulated, the "sailing-stars" must have been designated by name amongst the Achaian tribes. Besides, Homer is ignorant of any such association. Now in Arabic the Pleiades are called *Eth Thuraiyâ*, from *thervva*, copious, abundant. The meaning conveyed is that of many gathered into a small space; and it is quite similar to that of the Biblical *kimah*, a near connexion of the Assyrian *kimtu*, family (R. Brown, "Phainomena of Aratus," p. 9; Delitzsch, "The Hebrew Language," p. 69). Analogy, then, almost irresistibly points to the interpretation of Pleiades by the Greek *pleîones*, many, or *pleîos*, full; giving to the term, in either case, the obvious signification of a "cluster."

Of the Hyades, similarly, the "rainy" association seems somewhat far-fetched. They rise and set respectively about four days later than the Pleiades; so that, as prognostics of the seasons, it would be difficult to draw a permanent distinction between the two groups; yet one was traditionally held to bring fair, the other foul weather. There can be little doubt that an etymological confusion lay at the bottom of this inconsistency. "To rain," in Greek is *huein*; but *hus* (cognate with "sow") means a "pig." Moreover, in old Latin, the Hyades were called *Suculæ* ("little pigs"); although the misapprehension which he supposed to be betrayed by the term was rebuked by Cicero (*De Nat. Deorum*, lib. ii. cap. 43). Possibly the misapprehension was the other way. It is quite likely that "Suculæ" preserved the original meaning of "Hyades," and that the pluvious derivation was invented at a later time, when the conception of the seven stars in the head of the Bull as a "litter of pigs" had come to appear incongruous and inelegant. It has, nevertheless, just that character of *naïveté* which stamps it as authentic. Witness the popular names of the sister-group—the widely-diffused "hen and chickens," Sancho Panza's "las siete cabrillas," met and discoursed with during his famous aërial voyage on the back of Clavileño, the Sicilian "seven dovelets,"—all designating the Pleiades. Still more to the purpose is the Anglo-Saxon "boar-throng," which, by a haphazard identification, has been translated as Orion, but which Grimm, on better grounds, suggests may really apply to the Hyades (*Teutonic Mythology*, trans. by J. S. Stallybrass, vol. ii. p. 729). It is scarcely credible that any other constellation can be indicated by a term so manifestly reproducing the "Suculæ" of Latin and Sabine husbandmen.

The Homeric scheme of the heavens, then, (such as it is), was produced at home. No stellar lore had as yet been imported from abroad. An original community of ideas is just traceable in the names of some of the stars; that is all. The epoch of instruction by more learned neighbours was still to come. The Signs of the Zodiac were certainly unknown to Homer, yet their shining array had been marshalled from the banks of the Euphrates at least 2000 years before the commencement of the Christian era. Their introduction into Greece is attributed to Cleostratus of Tenedos, near, or shortly after, the end of the sixth century B.C. By that time, too, acquaintance had been made with the "Phœnician" constellation of the Lesser Bear, and with the wanderings of the planets. Astronomical communications, in fact, began to pour into Hellas from Egypt, Babylonia, and Phœnicia about the seventh century B.C. Now, if there were any reasonable doubt that "blind Melesigenes" lived at a period anterior to this, it would be removed by the consideration of what he lets fall about the heavenly bodies. For, though he might have ignored formal astronomy, he could not have remained unconscious of such striking and popular facts as the identity of Hesperus and Phosphorus, the Sidonian pilots' direction of their course by the "Cynosure," or the mapping-out of the sun's path among the stars by a series of luminous figures of beasts and men.

Thus the hypothesis of a late origin for the "Iliad" and "Odyssey" is negatived by the astronomical ignorance betrayed in them. It has, however, gradations; whence some hints as to the relative age of the two epics may be derived. The differences between them in this respect are, it is true, small, and they both stand approximately on the same astronomical level with the poems of Hesiod. Yet an attentive study of what they have to tell us about the stars affords some grounds for placing the "Iliad" the "Odyssey," and the "Works and Days" in a descending series as to time.

In the first place, the division of the month into three periods of ten days each is unknown in the "Iliad," is barely hinted at in the "Odyssey," but is brought into detailed notice in the Hesiodic calendar. Further, the "turning-points of the sun" are unmentioned in the "Iliad," but serve in the "Odyssey," by their position on the horizon, to indicate direction; while the winter solstice figures as a well-marked epoch in the "Works and Days." Hesiod, moreover, designates the dog-star (not expressly mentioned in the "Odyssey") by a name of which the author of the "Iliad" was certainly ignorant. Besides which an additional constellation (Boötes) to those named in the "Iliad" appears in the "Odyssey" and the "Works and Days"; while the title "Hyperion," applied substantively to the sun in the "Odyssey," is used only adjectivally in the "Iliad." Finally, stellar mythology begins with Hesiod; Homer (whether the Ionian or the Ithacan) takes the names of the stars as he finds them, without seeking to connect them with any sublunary occurrences.

To be sure, differences of place and purpose might account for some of these discrepancies, yet their cumulative effect in fixing relative epochs is considerable; and, even apart from chronology, it is something to look towards the skies with the "most high poet," and retrace, with the aid of our own better knowledge, simple meanings, their glorious aspect held for him.

A. M.

ON ICE AND BRINES[1]

I.

THE composition of the ice produced in saline solutions and more particularly in sea-water, has frequently been the object of investigation and of dispute. It might be thought that to a question of whether ice so formed does or does not contain salt, experiment would at once give a decisive answer. Yet, relying on experiment alone, competent authorities have given contradictory answers.

[1] Paper read before the Royal Society of Edinburgh, by J. Y. Buchanan, on March 27 last.

agree that ice, whether formed artificially in the laboratory by freezing sea-water, or found in nature as one of the various species of sea-water ice, retains, in one form or another, and with great tenacity, the salt existing in solution in the water. The question at issue is whether this salt is to be attributed to the solid matter of the ice or to the liquor mechanically adhering to it, from which it is impossible to free it. Most bodies, and especially those which take a crystalline form, are easily purified and freed from all suspected foreign matter, with a view to analysis, by the simple operation of washing and drying. It is impossible to wash the crystals, formed by freezing a saline solution, with distilled water, because they melt at a temperature below that at which distilled water freezes. The effect of the addition of a small quantity of distilled water to a quantity of saline ice is at first the anomalous one, that what was a wet sludge is transformed into a dry crystalline powder. It is of course impossible to dry the ice by heat, and to do so by more intense freezing would be begging the question. The experimental difficulties therefore account for some of the divergence of opinion on the subject. The mixed character of the substances examined has also much to do with it. As a rule it may be said that those investigators who have confined their observations to the laboratory have concluded that the ice forming when saline solutions of moderate concentration, including sea-water, are frozen, is pure ice, and the salt from which it is impossible to free it entirely belongs to the mother-liquor, while those who have collected and examined sea-water ice in high latitudes have come to the opposite conclusion.

During the Antarctic cruise of the *Challenger* I made a number of observations on the sea-water ice found in those regions, and relying principally on the fact that the melting temperature of the ice was markedly lower than that of fresh-water ice, and that it was impossible by any of the ordinary means familiar to chemists for freeing crystals from adhering mother-liquor to materially reduce its salinity, I came to the conclusion that the ice forming in freezing sea-water is not a mixture of pure ice and brine, but that it contains the salt found in it in the solid state either as a crystalline hydrate or as the anhydrous salt, but most probably as a hydrate. In dealing with this subject, Dr. Otto Pettersson ("Water and Ice," p. 302) quotes my observations, and also rejects the view that "sea-ice is in itself wholly destitute of salts, and only mechanically incloses a certain quantity of unfrozen and concentrated sea-water." He founds his belief on the fact that numerous analyses of specimens of sea-water ice have shown that the constitution of the saline contents of different specimens of ice differs for each specimen, and is always different from that of the saline contents of sea-water. Were the salinity due to inclosed unfrozen and concentrated sea-water, we "ought to find by chemical analysis exactly the same proportion between Cl, MgO, CaO, SO_3, &c., in the ice and in the brine as in the sea-water itself." He adduces numerous examples of analyses of specimens of sea-water ice from the Baltic and from the Arctic Seas to show that this is not the case. Calling the percentage of chlorine in each case 100, he found in various sea-waters the percentage of SO_3 vary from 11·49 to 11·89. In specimens of sea-water ice it varied from 12·8 to 76·6, and in brines separating from the ice and remaining liquid at −30° C. it varied from 1·14 to 1·16.

This argument appears conclusive. In order to explain all the phenomena observed in connexion with sea-water ice he cites Guthrie's investigations, which went to show that, in freezing saline solutions, under a certain concentration, pure ice is formed at a temperature which falls from 0° C., when the amount of salt dissolved is infinitely small, to a certain definite temperature when the solution contains a certain definite percentage of salt. Further abstraction of heat then produces solidification of the solution as a whole, in the form of a crystalline hydrate, of constant freezing- and melting-point. To such hydrates, Guthrie gave the name of cryohydrates. Pettersson quotes the following as being particularly applicable to the case of sea-water:—

The cryohydrate of	Contains per cent. of water	Solidifies at °C.
NaCl ...	76·39 ...	−22
KCl ...	80·00 ...	−11·4
$CaCl_2$ ...	72·00 ...	−37·0
$MgSO_4$ ...	78·14 ...	− 5·0
Na_2SO_4 ...	95·45 ...	− 0·7

And he refers more particularly to the cryohydrate of Na_2SO_4 forming and melting at −0°·7.

Now the bearing of Guthrie's experiments is to show that, while at sufficiently low temperatures, and with suitable concentration, the water will solidify along with one or other of the salts in solution, until this low temperature and high concentration are attained, pure ice must be the result of freezing.

The abnormal phenomena attending the formation and the melting of ice in saline solutions and sea-water, find a natural explanation in an observation which I have frequently quoted, and which Dr. Pettersson mentions in a footnote at p. 318, namely, that "a thermometer immersed in a mixture of snow and sea-water which is constantly stirred indicates −1°·8 C." If this is true, it is clear that my melting-point observations proved nothing. On repeating the experiment I found it confirmed, and took the opportunity this winter of investigating the matter more closely. The paper read before the Royal Society of Edinburgh contains the first portion of the results. It deals with the subject under two heads, namely, (*a*) the temperature at which sea-water and some other saline solutions freeze, and the chemical constitution of the solid and the liquid into which they are split by freezing; and (*b*) the temperature at which pure ice melts in sea-water and in a number of saline solutions of different strengths.

(*a*) The freezing experiments were limited to sea-water and solutions of NaCl comparable with sea-water.

Chloride of Sodium.—Four solutions were used, and they were intended to contain 3, 2·5, 2, and 1·5 per cent. NaCl respectively. Forty grammes of this solution, in a suitable beaker, were immersed in a freezing mixture of such composition as to give a temperature from 2° to 2°·5 C. below the freezing temperature expected. The temperature at which ice began to form (if necessary after adding a minute splinter of ice) was noted, and the freezing was allowed to continue with constant stirring till the temperature had fallen 0°·2 C. A specimen of the mother-liquor was removed, and the chlorine in it determined; the chlorine in the original solution had been determined before. The beaker was then removed from the freezing bath and allowed to melt. The temperature in all cases rose during melting exactly as it had fallen during freezing. In the following table are given the means of the temperature at which ice began to form in the original solution, and that of the liquid when the sample of brine was taken, and the means of the chlorine found in the original solution and in the brine sample

Mean Freezing Temp.	−1°·875 C.	−1°·63	−1°·30	−0°·975
Mean per cent. Cl.	1·87	1·60	1·30	0·98

It will be seen that, in the dilute solutions experimented with, the percentage of chlorine expresses, in terms of the Centigrade scale, the lowering of the freezing-point of the solution.

Sea-Water.—Similar experiments were made with sea-water of different degrees of concentration. In sea-water from the Firth of Clyde containing 1·84 per cent. of

chlorine, ice forms at −1°·9 C. The following results are from means of closely-agreeing results :—

Freezing temperature	−2°·0	−1°·5	−1°·0	−0°·5
Per cent. chlorine	1·94	1·445	0·963	0·475
Difference	0·06	0·055	0·037	0·025

Sea-water resembles a chloride of sodium solution, containing the same percentage of chlorine, and the resemblance is closer the greater the dilution. When the beaker was removed from the freezing-bath, the temperature rose during melting as it had fallen during freezing. In these experiments, which had for their object the determination of the temperature at which the crystals melted, as well as that at which they began to form in the water, it was impossible to remove a sample for analysis large enough to enable the sulphuric acid to be determined in it.

For this purpose a series of observations were made, using quantities of 300 grammes of sea-water. Freezing was continued usually until the temperature had fallen 0°·3 C. below that at which crystals began to form. The mother-liquor was then separated from the crystals by means of a large pipette with fine orifice, before removing the beaker from the freezing bath. The magma of crystals was then brought rapidly on a filter and drained by means of the jet pump. The ice, thus drained, was then melted, and the three fractions were analysed. In the following table (I.) the results of four experiments are given. In the one column (W) will be found the weight of the original water taken and of the fractions into which it was split in freezing ; in the other (R) will be found the ratio of SO_3 to Cl found by analysis, the chlorine being set down as 100 ; thus, in I, the percentage of chlorine found in the crystals, melting at the lowest temperature, was 1·497, and that of the SO_3, 0·174 ; the ratio (R) is therefore 11·62.

TABLE I.—*Freezing sea-water—Analyses of fractions.*

No. of Experiment.	I.		II.		III.		IV.	
Nature of Water...	Forth 100 %		Mother-liquor		Clyde 100 %		Clyde 50 %	
	W.	R.	W.	R.	W.	R.	W.	R.
Original water	300	11·83	90	11·67	300	11·58	300	11·21
Mother-liquor	170·6	11·67	—	11·83	102	11·57	78	11·67
Drainings			—	—	94	11·56	109	—
Crystals	106	11·62	23	11·22	97	11·67	106	11·44
,, ...	22·5	11·11	—	—	—	—	—	—

It will be seen that the ratios (R) found for mother-liquor, drainings, and ice agree with one another quite as closely as those found in samples of pure sea-water from different localities. It is to be remembered that in these experiments the water was frozen *gently*, that is, the rate of abstraction of heat was low, the temperature of the freezing bath being regulated so as to be about 2° C. below the freezing temperature of the solution. Much of the error and uncertainty about the freezing of saline solutions arises from the violence of the methods employed. Judging then by the constancy of the relation of the percentage of Cl to SO_3 we see that in sea-water, frozen at moderate temperatures, the composition of the saline contents of the original water, the mother-liquor and the ice is identical ; and we are justified in concluding that it is probable that the saltness of the ice is due to unfrozen and concentrated sea-water adhering to it. Ice forming in even very weak saline solutions closely resembles snow (which is ice forming in air), and has the same remarkable power of retaining mechanically several times its weight of water or brine.

A strict account was kept of the heat removed from the sea-water while the freezing was going on. In Table II. will be found the number of heat-units (gramme ° C.) removed during the freezing in the case of Nos. III. and IV. ; and this number, divided by 79·25, gives the weight of pure ice, which could have been formed at 0° C. by the removal of heat.

TABLE II.—*Calculation of ice formed.*

		III.	IV.
Weight of original water (grammes)	W	300	300
Per cent. Cl in ditto	c	1·836	0·923
Per cent. Cl in mother-liquor	K	2·212	1·153
Weight of mother-liquor $W\frac{c}{K}=$	L	249·0	239·3
Weight of ice $W-L=$	I	51·0	60·7
Mean freezing temperature (° C).....	...	−2·05	−1·85
Heat abstracted (grammes ° C)	...	4230	5193
Equivalent ice formed (grammes)	...	53·4	65·5

Sea-water, like other saline solutions, is easily cooled several degrees below its freezing-point before crystals begin to form. While cooling down to and below what was known to be its freezing-point, simultaneous observations of the temperature of the sea-water and the freezing bath were made from half-minute to half-minute. From these observations, the rate of abstraction of heat for different differences of temperature of sea-water and bath was found. At a given moment a minute splinter of ice (weighing much less than a drop of water) was introduced. Crystals immediately began to form, and the temperature rose in from ten to fifteen seconds to the freezing-point. During the freezing the temperatures of bath and sea-water were observed at regular intervals. The heat removed is thus made up of that eliminated during the few seconds when freezing began and the temperature rose to the freezing-point, which is found by multiplying the rise of temperature by the weight of liquid, and that removed during the subsequent cooling, which is deduced from the duration of the operation and the rate of loss of heat observed before freezing commenced. The specific heat of the solution is taken as unity. In the table are further given the weight of the sea-water used, the percentage of chlorine in the original water and in the mother-liquor, the weight of the mother-liquor on the assumption that it contains all the salt of the original water, and, by difference, the weight of the ice formed. The agreement between the two quantities of ice formed as calculated by the different methods is as close as could be expected.

It has thus been shown that the composition of the saline contents of the ice formed as above described is the same as that of the original water, and this of itself is almost conclusive that the salt is contained in adhering brine and not as a solid constituent of the ice. Assuming that this is so the amount of ice formed as deduced from the composition of the mother-liquor agrees well with the amount deduced from the thermal exchange taking place during the freezing.

It has, moreover, been proved by Guthrie, Rüdorff, and others, that, in solutions of the salts occurring in sea-water, ice does separate out at first, and continues to separate out until the concentration has become many times greater than that of sea-water. Assuming that in sea-water all the chlorine is united to sodium, 87 per cent. of the water would have to be removed as ice before a cryohydrate would form, and if it contained nothing but sulphate of soda in the proportion corresponding to the sulphuric acid formed in it, over 90 per cent. of the water would have to go as ice, before the cryohydrate would be formed.

In my experiments, about 15 per cent. of the weight of the water was frozen out as ice, causing a lowering of freezing-point by 0°·3 C. In nature it is probable that the ice forming at the actual freezing surface does so at an almost uniform temperature, the local concentration pro-

duced by the formation of a crystal of ice being immediately eliminated by the mass of water below. In the interstices of the crystals there will be retained a weight of slightly concentrated sea-water at least as great as that of the ice crystals. These retain the brine in a meshwork of cells, and, as the thickness of the ice covering increases, and the freezing surface becomes more remote, the ice and the brine become more and more exposed to the atmospheric rigours of the Arctic winter. The brine will continue to deposit ice until its concentration is such that, for example, the cryohydrate of NaCl is ready to separate out. It probably will separate out until it comes in conflict with, for instance, the chloride of calcium or the chloride of magnesium, which will retain some of the water, without solidifying, even at the lowest temperatures. At the winter quarters of the *Vega* brine was observed oozing out of sea-water ice and liquid at a temperature of -30° C. It was very rich in calcium and especially magnesium chlorides. In fact, *it is probably quite impossible by any cold occurring in nature to solidify sea-water.*

The residual and unfreezable brine which remains in considerable quantity liquid when sea-water is frozen, must also remain in greater or less quantity when fresh water is frozen. All natural waters, including rain-water, contain some foreign and usually saline ingredients. If we take chloride of sodium as the type of such ingredients, and suppose a water to contain a quantity of this salt equivalent to one part by weight of chlorine in a million parts of water, then we should have a solution containing 0·0001 per cent. of chlorine, and it would begin to freeze and to deposit pure ice at a temperature of $-0^{\circ}{\cdot}0001$ C.; and it would continue to do so until, say, 999,000 parts of water had been deposited as ice. There would then remain 1000 parts of residual water, which would retain the salt, and would contain, therefore, 0·1 per cent. of chlorine, and would not freeze until the temperature had fallen to $-0^{\circ}{\cdot}1$ C. This water would then deposit ice at temperatures becoming progressively lower, until, when 900 more parts of ice had been deposited, we should have 100 parts residual water, or brine as it might now be called, containing 1 per cent. of chlorine, and remaining liquid at temperatures above $-1^{\circ}{\cdot}0$ C. When 90 more parts of ice had been deposited, we should have 10 parts of concentrated brine containing 10 per cent. of chlorine and remaining liquid at -10° C. In the case imagined, we assume the saline contents to consist of NaCl only, and with further concentration the cryohydrate would no doubt separate out and the mass become really solid. On reversing the operations, that is, warming the ice just formed, we should, when the temperature had risen to -10° C., have 999,990 parts ice and 10 brine containing 10 per cent. chlorine. Now, owing to the remarkable fact (which is dealt with at length in the second part of the paper) that pure ice, in contact with a saline solution, melts at a temperature which depends on the nature and the amount of the salt in the solution, and is identical with the temperature at which ice separates from a solution of the same composition on cooling, the brine liquefies more and more ice at progressively rising temperatures, until, as before, when the temperature of the mass has risen to $-0^{\circ}{\cdot}1$ C., it consists of 999,000 parts of ice and 1000 parts of liquid water, containing 1 part of chlorine. The remainder of the ice will melt at a temperature gradually rising from $-0^{\circ}{\cdot}1$ C. to 0° C.

The consideration of this example furnishes an easy explanation of the anomalous behaviour of ice, formed from anything but the very purest distilled water, in the neighbourhood of its melting-point. This subject has been studied with great care and thoroughness by Pettersson. The apparent expansion of all but the very purest ice, when cooled below 0° C., is ascribed by him in part to solid saline contents of the ice which exercise a disturbing and unexplained influence on its physical properties. Viewed in the light of the fact that the presence of even the smallest quantity of saline matter in solution prevents the formation of ice at 0° C. and promotes its liquefaction at temperatures below 0° C., we see that this apparent expansion of the ice on cooling is probably due to the fact that we are dealing not with homogeneous solid ice but with a mixture of ice and saline solution. As the temperature falls this solution deposits more and more ice and its volume increases. But the increase of volume is due to the formation of ice out of water and not to the expansion of a crystalline solid already formed.

In Table III. are given the volumes occupied by the ice (with inclosed brine) formed by freezing 100,000 c.c. (at 0° C.) of a water containing chloride of sodium equivalent to 7 grammes chlorine in 1,000,000 cubic centimetres (at 0° C.).

TABLE III.—*Water containing 7 parts Cl in 1,000,000.*

Temp. °C.	Water frozen. c.c.	Ice formed. c.c.	Brine remaining. c.c.	Ice and Brine. c.c.	Pettersson III. Vol. of ice at T. c.c.	Diff.
T	V_1	v_1	V_2	v_2	P	$P - v_2$
$-0{\cdot}07$	99000	107979	1000	108979	108980	1
$-0{\cdot}10$	99300	108306	700	109006	109007	1
$-0{\cdot}15$	99533	108561	467	109028	109038	10
$-0{\cdot}20$	99650	108687	350	109037	109048	11
$-0{\cdot}40$	99825	108879	175	109054	109057	3

The volume of the ice formed on freezing this water is compared with that observed by Pettersson in freezing a sample of the distilled water in ordinary use in the laboratory.

It will be seen that the volumes observed by Pettersson agree very closely with those calculated for a water containing 7 parts of chlorine in a million.

The irregularities in the melting-points of bodies like acetic acid, to which Pettersson refers, are without doubt due to a perfectly similar cause.

Also the very low latent heat observed by Pettersson for sea-water is to be explained by the fact that the salt retains a considerable proportion of the water in the liquid state even at temperatures many degrees below the freezing-point of distilled water.

The *plasticity* of ice and the motion of glaciers receive a simple and natural explanation when we see, as in Table III., that, if the water from which this ice is produced contains no more than 7 parts of chlorine per million, it will, in the process of thawing, when the temperature has risen to $-0^{\circ}{\cdot}07$ C., consist to the extent of 1 per cent of its mass of liquid brine or water. The water considered in Table III. is certainly not less free from foreign ingredients than rain or snow. It follows, therefore, that a glacier, in a climate where the temperature is for the greater part of the year above 0° C., must have a tendency to *flow*, owing to the power of saline solutions to deposit ice and to dissolve it at temperatures below 0° C.

(*To be continued.*)

NOTES

THE Endowed Schools Committee, of which Sir Lyon Playfair is Chairman, after sitting for a year and a half, have agreed to their Report. This is not yet issued, but it is known that the Committee have reported in favour of endowed schools being in future largely used for the promotion of scientific and technical education. The Report also recommends that local authorities should be authorised to employ local rates for founding or contributing to laboratories and workshops in such schools in order to promote practical scientific education.

LAST week an important Conference was held at Oxford for the consideration of questions connected with the University Extension Scheme. The meetings were attended by many members of the University, local delegates, and others interested in

this method of University development. There can be no doubt whatever as to the good work done by University Extension lecturers. Unfortunately, however, it is hard to obtain the funds which are necessary for the complete success of the experiment. One speaker urged that "the University should lead the way by the creation of a Jubilee Fund, and so stimulate local efforts." To this Prof. Rogers replied that the University was "positively poor." Prof. Rogers added that the result of an appeal to London Companies "had not been favourable," but that the Charity Commissioners might perhaps be willing to do something for the movement.

THE American Exhibition to be opened in the Earl's Court neighbourhood on May 9 will contain much that ought to be of scientific interest. The large encampment of American Indians will be found to contain a great variety of types, and ought to prove attractive to ethnologists. The machinery department will contain many illustrations of the successful applications of science, especially in the section directed to machines for the production and application of electricity. Under mining and metallurgy there will be a large collection of minerals, ores, and stones, besides specimens of metallurgical products. In the department of education and science will be found illustrations of the varied educational appliances and apparatus used in the United States, exhibits from the many institutions and organisations which exist in the States, and a very varied collection of scientific and philosophical instruments.

A NEW scientific journal—*Centralblatt für Physiologie*—has made its appearance this month in Germany. It is edited by Dr. S. Exner, of Vienna, and Dr. J. Gad, of Berlin, who have the advantage of the co-operation of the Berlin Physiological Society. The journal will be issued once a fortnight.

A MONUMENT to Galileo has been erected in Rome, on the Via Pincio, fronting the old Medici Palace, now occupied by the French Embassy, where he was kept a prisoner, in 1637, during his prosecution by the Inquisition. The monument consists of a column with a pedestal, on which is the following inscription in the Italian language:—"Erected in memory of Galileo Galilei, who was kept a prisoner in this Palace, for having seen that the earth moves round the sun."

DR. R. MÜLLER publishes, in the April number of *Mittheilungen aus dem Gebiete des Seewesens*, the results of an investigation as to whether or not the popular idea of equinoctial gales, the existence of which was contested some time ago as regards this country by Mr. Scott (NATURE, vol. xxx. p. 353), holds good for the Adriatic Sea. For this purpose the hourly records of the anemometer at Pola, from 1876-86, were used. During this period strong winds or gales were registered on 607 days, 63 per cent. of which occurred in the winter season (October to March). The months with least wind were naturally June and July; then a tolerably regular increase in the number of days with stormy winds took place till the end of January. A considerable decrease occurred in February, while March had the greatest number of stormy days. The result arrived at is that, for the Adriatic, no important influence can be attributed to the equinoctial seasons, especially during the autumnal equinox. Dr. Müller also quotes a similar investigation made by the *Deutsche Seewarte*, for the years 1878-83, for the German coasts, with nearly similar results; the percentage of storms for the winter season being 80 per cent., and for the summer season only 20 per cent. The greatest number of storms occurred in November and December, March having 14 per cent., and September 3 per cent. only.

AT a recent meeting of the Italian Meteorological Society, reported in its *Bollettino mensuale* for February last, the Committee enumerated the meteorological stations lately established by it abroad, viz. one in Tripoli, two in the Argentine Republic, three in Uruguay, one in Colombia (South America), and one in Mexico, and notified their intention of shortly establishing others on the Patagonian coasts of the Pacific, and in some of the islands near Cape Horn. Among other matters discussed was the proposed suppression of the *Bollettino decadico*—which has reached its fourteenth yearly volume, and which contains the observations made at ordinary stations, and at stations in the Alps and Apennines, for decades—as the increasing work of the Society renders its publication difficult. The monthly means of these observations appear in the *Bollettino mensuale*, but the last published are for March 1886.

ON the night of April 12, at about 11.30, a brilliant meteor was seen in Værdalen, in Norway. It appeared in the east, and went in a southerly direction. At first the colour was a pure white, but during the progress of the meteor it changed into green and yellow. The lustre of the body was very bright, and its greatest apparent size was about that of an ordinary plate. On the meteor disappearing from view behind a mountain ridge, a sudden brilliancy seemed to indicate that it had burst into fragments, but no detonation was heard. It left a faint trail of smoke behind, about a few yards in length, which remained for a few seconds in the sky, then disappeared.

ON April 13 a shock of earthquake was felt at Lisbon, and in Malta and Sicily. Considerable alarm was caused in Jersey at a few minutes past 3 o'clock on the morning of April 21 by a slight shock of earthquake, the direction of which was from south-west to north-west. There was so loud a noise that at first some persons fancied guns were being fired. About the same time a smart shock of earthquake was experienced in Guernsey. A decided tremor of the earth, lasting about three seconds, and accompanied by a rumbling noise, was felt in all parts of the island.

THE death is announced of Dr. Nathaniel Lieberkühn, Professor of Anatomy at the University of Marburg, on April 14, at the age of sixty-five; and of Herr J. B. Obernetter, well known by his researches in photographic chemistry, on April 13, at the age of forty-seven.

A NEW GUINEA Exhibition will shortly be opened at Bremen.

MESSRS. R. FRIEDLÄNDER AND SON, of Berlin, send us the first quarterly list for 1887 of their new publications. It includes many valuable works in natural history and the exact sciences.

THE scheme for the formation of a North Sea Fisheries Institute is still under the consideration of the National Fish-Culture Association and of various local authorities, by whom efforts are being made to secure the necessary funds. It is proposed to form a Fish-Culture Station at Cleethorpes, and schools at Grimsby, and to carry out scientific observations wherever the conditions seem to be most favourable. Particular attention is to be given to the culture of the oyster and cod. A meeting has lately been held in London to advance the undertaking, and another is to take place shortly at Grimsby for the same purpose.

THE list of elements whose atomic weights have been determined with great accuracy has just received two valuable additions, for although one of them, silicon, is by no means rare in its occurrence in nature, and the other, gold, is neither among the most recently discovered of metals nor rare from the chemist's point of view, yet past determinations of the atomic weights of these important elements have resulted in leaving the subject enshrouded with considerable ambiguity. Prof. Thorpe and Mr. J. W. Young, who have recently determined the atomic weight of silicon, used for this purpose the tetrabromide $SiBr_4$,

and, instead of the small quantities of material used by other experimenters, prepared upwards of half a kilogramme of this substance by passing bromine vapour over a heated mixture of pure silicon dioxide and charcoal. The product was rectified in an atmosphere of nitrogen, and portions for analysis were collected in bulbs without exposure to air; these bulbs were then broken in bottles containing pure water, and in each case the resulting turbid liquid was very slowly evaporated to complete dryness, the relation of the weight of silicon dioxide obtained to that of the tetrabromide used forming the basis of the calculations. The result of this long and difficult series of analyses fixes the atomic weight of silicon as 28·332. The instability of the salts of gold has long been a stumbling-block in the way of obtaining accurate determinations of its atomic weight, but Prof. Thorpe and Mr. A. P. Laurie have overcome this difficulty by utilising the double bromide of gold and potassium, which they prepared by digesting together pure gold, bromine, potassium bromide, and water, the salt being afterwards subjected to several recrystallisations. An unknown quantity of the pure salt was then carefully ignited, and the mixture thus obtained, of potassium bromide and gold, weighed; after removal of the potassium bromide by washing, the weight of residual gold obtained in each analysis furnished data from which one set of values averaging 196·876 was obtained. The bromine in the potassium bromide as determined by titration with silver nitrate gave a second averaging 196·837, and the weight of silver bromide formed yielded a third series of numbers, averaging 196·842. Taking Stas's value for oxygen at 15·96 the atomic weight of gold is fixed by these analyses at 196·85; but if, along with Mendelejeff, we consider oxygen 16, then gold becomes 197·28, and it is interesting to note that Mendelejeff considered the old value, 196·2, to be too low, there being no place in the periodic system for an element of atomic weight having the properties of gold. Hence the result of the present determination has been to place gold in its former position in the periodic classification. Prof. Krüss has just published (*Ber. Deut. Chem. Ges.* No. 2, 1887) the results of a determination of the atomic weight of gold recently made by him, according to which the probable value is 196·64. The method employed, however, was slightly different from the above, the weighed quantity of the double bromide itself being the basis of a portion of the analyses.

In a paper on Electric Locomotion, read before the Society of Arts on the 20th inst., Mr. Reckenzaun pointed out that in the United States and on the European continent there are dozens of electric railways at work to the satisfaction of everybody, while there are few opportunities of testing their advantages in England. England is "the home of the dynamo-machine, the country where the electromotor has found its highest development." We have been outstripped in this matter chiefly because an Act of Parliament must be obtained before electric cars can be run, and every company has to apply for it separately.

THE other day M. Émile Rivière discovered a prehistoric station in the wood of Chaville, to the right of the Versailles road, in a part where there are comparatively few trees. Some flint implements and weapons were found, and a fragment of coarse pottery without ornament.

AT the February meeting of the Pekin Oriental Society, Mr. Edkins read a paper on animal worship amongst the Chinese. He referred at considerable length to the worship paid to the fox, weasel, hedgehog, and snake, to which at Tientsin is added the rat. The first four are called the immortals. These deified animals seem to usurp the entire attention of the people, even to the exclusion of the Buddhist and Taoist gods. Dr. Edkins quoted from the Chinese to prove that animal worship was known in ancient times, while Dr. Dudgeon pointed out that it was a mistake to suppose that animal worship was confined to the four animals mentioned. The horse, cow, dog, insects, dragon, lion, &c., are worshipped. In the fifth month the centipede, lizard, scorpion, frog, and snake—the five poisonous animals, as they are called—are also objects of worship. Dr. Martin disputed Dr. Edkin's theory that animal worship was unknown in ancient times because it was not mentioned by Confucius; he (Dr. Martin) believed that it existed to a much greater extent in ancient than in modern times. From the observations of other speakers it is clear that animal worship occupies a very large place in Chinese superstitious observances.

THERE was an interesting Geographical Exhibition in connexion with the meeting of the Deutsche Geographentag at Carlsruhe on the 13th inst. An historical department showed the development of cartography, all the exhibits being from Baden and Würtemberg. Water-colour sketches by the well-known African traveller Paul Reichard, and some fine oil sketches by the painter Hellgrave, who was sent to East Africa by the Artists' Club at Berlin, were exhibited. In the plant department were shown cotton plants found growing wild in Togoland, wild coffee and sugar-cane from Cameroons, and tobacco and various seeds from the gardens of the German East African Society.

AN interesting case of "colour-hearing" was recently reported to a meeting of the Société de Psychologie Physiologique. In this case, colour hearing was an hereditary peculiarity, transmitted from father to daughter.

THE third volume of the "Grande Encyclopédie" has just been published. It is expected that thirty volumes will probably be required to complete this great work. Each volume consists of 1200 quarto pages in two columns, printed in small type.

EVERYONE who takes an interest in zoology is probably acquainted with the "Zoological Record," which consists of an annual volume containing a summary of the work done in the various branches of zoology. It was begun in 1865, and for the first six years was published by Mr. Van Voorst. For the last sixteen years it has been carried on by an Association of zoologists called the "Zoological Record" Association, who have received assistance in the shape of grants from the Government Fund of the Royal Society, the British Association, and the Zoological Society of London. The "Zoological Record" Association, having been lately unsuccessful in obtaining the continuance of some of these grants, and being unwilling to carry on the publication of the "Record" any longer, have agreed, upon certain conditions, to transfer their whole stock to the Zoological Society of London, who, for the future, have determined to carry on this most useful publication. The "Zoological Record" will, therefore, beginning with the volume for the present year (which will contain the record of the zoological literature of 1886), be published by the Zoological Society of London, under the management of a Committee of the Council of that Society, and will be edited by Mr. F. E. Beddard, the Society's Prosector. The "Record" will be published for the Society by Messrs. Gurney and Jackson at the former price of 30*s.* per volume. But all members of the Society will have the privilege of receiving it, including the cost of delivery, at a subscription price of 20*s.* per annum. This subscription will be due on July 1 in every year, and the privilege of subscription will be forfeited unless the amount be paid before December 1 following. The Zoological Society, having purchased the entire stock of the "Zoological Record," are now able to supply complete sets of the first twenty-two volumes at the price of 5*l.* 10*s.*, that is 5*s.* per volume. Volumes of any single year can likewise be supplied at 10*s.* per volume. Learned Societies and Institutions and members of the former "Zoological Record" Association

will be permitted to subscribe to the "Record" on the same conditions as are accorded to members of the Zoological Society.

It is intended to form a class, including beginners and advanced students, this summer, in the same way as last year, for the study of geology near London, to be conducted on Saturday afternoons, by Prof. H. G. Seeley, F.R.S., King's College. Applications for tickets should be made at once to the Hon. Secretary, W. W. R. May, 16 Bethune Road, Manor Road, Stoke Newington, N.

The additions to the Zoological Society's Gardens during the past week include two Rhesus Monkeys (*Macacus rhesus* ♂ ♀) from India, presented by Mr. W. F. Lock; a Common Fox (*Canis vulpes* ♂) British, presented by Mr. Isaac Bell, Jun.; a Bosch-bok (*Tragelaphus sylvaticus* ♂) from South Africa, presented by Capt. Travers; a Vulpine Phalanger (*Phalangista vulpina* ♂) from Australia, presented; two Turkey Vultures (*Cathartes aura*) from the Falkland Islands, presented by Mr. James H. Moore; a Common Viper (*Vipera berus*), British, presented by Mr. S. E. Gunn; a Chinese Lark (*Melanocorypha mongolica*) from China; two Common Rheas (*Rhea americana* ♂ ♀) from the Argentine Republic, received in exchange; a Burrhel Wild Sheep (*Ovis burrhel*); two White-backed Pigeons (*Columba leuconota*) from the Himalayas; a Hodgson's Partridge (*Perdix hodgsonia*) from Bootan, purchased; four Long-fronted Gerbilles (*Gerbillus longifrons*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

Barnard's First and Second Comets 1887.—Comet *c* 1887, discovered by Mr. Barnard on January 23, has now attained a high declination, and, though faint, may possibly be observed within the next few days. Dr. H. Kreutz gives the following ephemeris for it for Berlin midnight, derived from Dr. H. Oppenheim's elements:—

1887	R.A.	Decl.	log Δ	log *r*
	h. m. s.	° ′		
April 27 ...	1 12 46 ...	65 40·4 ...	0·4742 ...	0·3989
29 ...	1 21 49 ...	65 52·7		
May 1 ...	1 30 47 ...	66 3·8 ...	0·4827 ...	0·4057
3 ...	1 39 38 ...	66 13·7		
5 ...	1 48 22 ...	66 22·5 ...	0·4910 ..	0·4125

Correction of ephemeris for April 15, in R.A. + 3m. 46s.; in Decl. *nil*.

The second comet discovered by Mr. Barnard, viz. Comet *d* 1887, discovered February 16, is scarcely likely to be seen further. Its present brightness is but one-seventh of that which it had on March 11, and having almost exactly the same R.A. as the sun it scarcely frees itself from the twilight. An ephemeris for its course throughout the month of April, based on Dr. Palisa's elements, was given by Dr. Kreutz in the *Astronomische Nachrichten*, No. 2777, and in the *Observatory* for April; but the probability of its being observed after the April full moon had passed away, except with very powerful instruments, was very slight.

Probable Re-discovery of Hesperia.—Dr. R. Luther detected a minor planet on April 11 which it appears probable is no other than the lost Hesperia, No. 69, as the magnitude and motion resembled those of the missing asteroid. Dr. Luther had previously looked for the planet in vain in 1882, 1885, and in March of the present year.

The Ellipticity of Uranus.—Prof. W. Valentiner, of the Karlsruhe Observatory, writing in the *Astronomische Nachrichten*, No. 2781, states that Herr von Rebeur, observing Uranus with the 6-inch refractor of the Observatory on the evening of April 3, noticed that the disk appeared distinctly elliptical. On the following evening Prof. Valentiner himself observed the planet, and found that the direction as estimated of the major axis of the disk, the ellipticity of which was unmistakable, agreed closely with that of the assumed equatorial diameter as read off from the position-circle of the micrometer. Prof. Valentiner brings the subject forward now in the hope that those astronomers who have the command of powerful telescopes may be induced to give some attention to it.

The Washington Observatory.—It appears from *Science*, vol. ix. No. 218, that the statement (reported in last week's Nature, p. 595) that the sum of 400,000 dollars had been appropriated by Congress for the erection of a new Naval Observatory near Washington is erroneous. The amount actually available is but 100,000 dollars, with the understanding that the entire cost of the work shall not exceed 400,000 dollars.

The Paris Conference.—The same number of *Science* states that Ensign Winterhalter, of the United States Naval Observatory, had sailed for Paris, to represent the Observatory at the Photographic Conference. It is understood that Dr. Peters, of Clinton, and Mr. Rutherfurd, of New York, will also attend the Conference.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1887 MAY 1-7

(For the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on May 1

Sun rises, 4h. 34m.; souths, 11h. 57m. 0·2s.; sets, 19h. 20m.; decl. on meridian, 15° 4′ N.: Sidereal Time at Sunset, 9h. 58m.

Moon (Full on May 7) rises, 11h. 27m.; souths, 18h. 59m.; sets, 2h. 19m.*; decl. on meridian, 14° 0′ N.

Planet	Rises	Souths	Sets	Decl. on meridian
	h. m.	h. m.	h. m.	° ′
Mercury ...	4 6 ...	10 30 ...	16 54 ...	3 59 N.
Venus	5 58 ...	14 21 ...	22 44 ...	24 16 N.
Mars	4 32 ...	11 51 ...	19 10 ...	14 24 N.
Jupiter... ...	18 1 ...	23 14 ...	4 27* ...	9 59 S.
Saturn... ...	8 30 ...	16 38 ...	0 46* ...	22 21 S.

* Indicates that the setting is that of the following morning.

Occultations of Stars by the Moon (visible at Greenwich)

May	Star	Mag.	Disap.	Reap.	Corresponding angles from vertex to inverting
			h. m.	h. m.	
1 ...	*o*′ Cancri	6 ...	0 25 ...	0 53 ...	
5 ...	γ Virginis... ...	2½ ...	0 25 ...	1 8 ...	
5 ...	B.A.C. 4277 ...	6 ...	1 40 ...	1 46 ...	
5 ...	*l*² Virginis ...	5 ...	21 30 near approach		

May	h.	
1 ...	15 ...	Venus at least distance from the Sun
6 ...	8 ...	Jupiter in conjunction with and 3° of the Moon.

Saturn, May 1.—Outer major axis of outer ring = outer minor axis of outer ring = 16″·4; southern surface

Variable Stars

Star	R.A.	Decl.			h.
	h. m.	° ′			
U Cephei	0 52·3 ...	81 16 N. ...	May	4,	3 40
S Aurigæ	5 19·7 ...	34 3 N. ...	,,	3,	
R Canis Minoris...	7 2·5 ...	10 12 N. ...	,,	6,	
R Camelopardalis .	14 26·2 ...	84 21 N. ...	,,	4,	
δ Libræ	14 54·9 ...	8 4 S. ...	,,	4,	20 11
U Coronæ	15 13·6 ...	32 4 N. ...	,,	7,	22 7
S Herculis	16 46·8 ...	15 8 N. ...	,,	3,	
R Ophiuchi	17 1·3 ...	15 57 S. ...	,,	2,	
U Ophiuchi... ...	17 10·8 ...	1 20 N. ...	,,	4,	2 37
			and at intervals of		20 8
W Sagittarii ...	17 57·8 ...	29 35 S. ...	May	2,	22 0
			,,	6,	2 0
T Herculis	18 4·8 ...	31 0 N. ...	,,	7,	
U Sagittarii... ...	18 25·2 ...	19 12 S. ...	,,	2,	2
			,,	5,	1
β Lyræ...	18 45·9 ...	33 14 N. ...	,,	2,	22
			,,	6,	4
R Aquilæ	19 0·9 ...	8 4 N. ...	,,	2,	

M signifies maximum; *m* minimum; *m*, secondary minimum

Meteor-Showers

	R.A.	Decl.
Near υ Herculis	236	47° N.
η Ophiuchi	254	21 S.
ζ Draconis	262	64 N.
α Aquilæ	298	5 N.

GEOGRAPHICAL NOTES

WE are glad to know that General R. Strachey, R.E., F.R.S., has agreed to accept the presidency of the Royal Geographical Society, in succession to Lord Aberdare. The Society's honours for the present year will be conferred as follows:—The Founder's Medal to Lieut.-Colonel T. H. Holdich, R.E., for the eminent services he has rendered to geography in Afghanistan; the Patron's Medal to the Rev. George Grenfell, for the extensive explorations he has carried out during his thirteen years' residence in Africa, partly in the Cameroons country and more recently in the Congo region; the Murchison Grant to Mr. George Bourne, second in command and sole survivor of the Landsborough Expedition, which crossed the continent of Australia in 1861; the Back Premium to Sarat Chandra Das, for his researches in Tibet; the Gill Memorial to Mr. J. F. Needham, for his explorations in the Lohit Valley of the Brahmaputra. The following have been made Honorary Corresponding Members:—H.R.H. Krom Mun Damrong Rajah Nubharp, Director-General of Surveys and Minister of Public Instruction, Siam; Dr. Alfred Kirchhoff, Professor of Geography at Hallé University, and President of the Hallé Geographical Society; and Dr. E. Naumann, late Director of the Geographical and Topographical Survey of Japan.

THE paper read at the Royal Geographical Society on Monday was by General J. T. Walker, F.R.S., on the Lu River of Tibet, the Lu-Kiang, or Lu-tse-Kiang of the Chinese. This river is generally held to be the source of the Salwin, but General Walker adduced many reasons for maintaining that it is more probably that of the Irrawadi. In the course of an able paper, the result of much research, General Walker gave a most useful summary of exploration in this highly interesting hydrographical region; more particularly insisting on the value of the work of the late Abbé Krick, who ascended the Lohit in 1852, but of whom little is known in this country. General Walker made out a strong case for his position, but the leading conclusion of his valuable paper is that further exploration in this remarkable region is urgently demanded. Probably no region of the earth would yield more valuable results to scientific geography.

ACCORDING to the latest news, Mr. Stanley is well up to time in his ascent of the Congo with the Emin Pasha Expedition. He is at present on his march across country from Matadi, at the lower end of the Livingstone Falls, to Leopoldville, on Stanley Pool. It is hoped that when he reaches the Pool he will find sufficient vessels in readiness to convey his large following up the river without delay. So far the Expedition has been exceedingly fortunate.

THE statement that Baron Nordenskjöld will undertake an Antarctic expedition at the expense of the King of Sweden and Mr. Oscar Dickson is, to say the least, premature. We are informed by Mr. Dickson that Baron Nordenskjöld is "willing" to undertake such an expedition, but that if he does so neither the King of Sweden nor Mr. Dickson will find the money. No doubt Baron Nordenskjöld would be an excellent leader for such an expedition, and as Committees have been formed both in this country and in Australia to promote Antarctic exploration, would it not be wise in them to unite their forces, and place themselves in communication with the Baron? Those who are competent to give an opinion on the subject maintain that an Antarctic expedition is much less risky than one to the other Pole. There would be no difficulty in a party wintering on some part of the Antarctic continent; a vessel could cruise round the verge of the ice during the winter and watch a favourable opening, of which immediate notice could be given to the exploring party, while a third vessel could leave New Zealand at a suitable time with additional supplies. No doubt the subject will again be brought up at the next meeting of the British Association, when it is hoped a strong and active Committee will be appointed. Baron Nordenskjöld will be among the distinguished foreigners invited to the meeting, and we hope he will accept the invitation.

THE Germans continue to show great activity in the exploration of their portion of New Guinea. Freiherr von Schleinitz has recently accomplished a running survey of Huon Gulf, and besides establishing the direction of the coast-line and the positions of reefs, has laid down eight hitherto unknown harbours and discovered nine new rivers. Some of them, especially the Markham River, would form excellent routes for the exploration of the interior; the broad valley of the latter extends for miles between high ranges of mountains. The south coast of Huon Gulf consists exclusively of primitive and metamorphic rocks, with older sedimentary rocks and volcanic formations. At a later date a further survey was made of the coast from Astrolabe Bay to the mouth of the Empress Augusta River, and led to the discovery of a series of bays, harbours, islands, and rivers.

M. GRIMAILO, in company with his brother, an engineer, and six Cossacks, has set out for a further exploration of the Pamir.

DR. LABONNE left Cherbourg a few days ago for a further exploration of the geysers and glaciers of Iceland.

PRELIMINARY NOTE ON THE FOSSIL REMAINS OF A CHELONIAN REPTILE, CERATOCHELYS STHENURUS, *FROM LORD HOWE'S ISLAND, AUSTRALIA*[1]

THE interesting remains of which I propose to give a brief notice in the present communication are contained in a friable sandstone (apparently formed of concreted blown sand), and they have a very recent appearance. The age of the deposit in which they are found is unknown, but it is probably Quaternary. The specimens have been for some years in the palæontological collection of the British Museum, and, for the most part, they have not yet been submitted to careful examination. But I learn that the greater number of them were long since rightly determined to be Chelonian by Mr. Davis, and set aside as such.

Several of the most important of these numerous and, in general, very fragmentary bones were originally found imbedded close together in the same block of sandstone. They consist of a great part of a pelvis, a caudal vertebra, and an imperfect skull. Of the pelvis, a right ischium and a pubis are imbedded in the rock, while an imperfect right ilium, which fits well on to the ischium, is separate; all these bones are unmistakably Chelonian. The caudal vertebra has remarkable peculiarities. It resembles an ordinary Chelonian caudal vertebra from the anterior half of the tail, in its general characters; but it is strongly opisthocœlous, the centrum having a deep cup behind and a correspondingly curved articular head in front. From the posterior part of the ventral face two stout processes diverge, and present terminal rounded facets for the rami of the large chevron bone which must have articulated with them. As a general rule, the caudal vertebræ of Chelonia are procœlous—but *Chelydra* and *Gyposchelys* (perhaps also *Staurotypus* and *Platysternum*) form well-known exceptions,[2] in so far as the vertebræ behin the third and fourth are strongly opisthocœlous. In fact, the vertebra in question closely resembles the sixth or seventh of *Chelydra* or of *Gyposchelys* (see Figs. 1 and 2). In the first, however, the transverse processes are very much stronger, and the pentagonal platform into which the upper surface of the neural arch expands, in place of a neural spine, is as long as the vertebra, instead of being only about half as long. The stout pre-zygapophysis of the right side is broken off, leaving only the base visible in the fossil.

[1] Paper read at the Royal Society, by Prof. Thomas H. Huxley, F.R.S., on March 31.

[2] The opisthocœlous character of most of the caudal vertebræ of *Chelydra* was first pointed out by Von Meyer in his description of the Œningen *Chelydra*. Baur ("Osteologische Notizen," *Zool. Anzeiger*, No. 238, 1886) has gone fully into the question, and has pointed out the exceptional nature of their structure among the Chelonia. Since the above paragraph was written, Dr. Günther has kindly enabled me to examine a spirit specimen and a skeleton of *Platysternum*. The caudal vertebræ resemble those of *Chelydra*, except that the last nine are procœlous, while that between these and the more anterior opisthocœlous vertebræ is nearly flat at the ends. In this, as in other respects, *Platysternum* presents characters intermediate between *Chelydra* and the ordinary *Emydæ*. Prof. Cope ("Vertebrata of the Tertiary Formations of the West," 1883, p. 111) ascribes opisthocœlous caudal vertebræ to the *Baenidæ*, but no figures or descriptions of such vertebræ are given. Of the opisthocœlous Chelonian vertebræ figured in Plate XXIV. of the "Report of Extinct Vertebrata obtained in New Mexico" (1887), it is expressly stated that their "correct reference cannot now be made" (p. 43).

Two other caudal vertebræ, having the same structural features, occur among the detached remains, and belong, like the first, to the second fourth of the tail. Another tolerably complete vertebra, with a considerably longer centrum, corresponds very closely with a caudal vertebra of *Gypochelys* from the third fourth of the tail. In this, as in one of the foregoing vertebræ, the chevron bones are anchylosed with the centrum. I conceive, then, that there can be no doubt that the pelvic bones and these caudal vertebræ belonged to a Chelydroid Chelonian, of about the size of the largest "snapping turtles" which are met with in North America at the present day.

Primâ facie, the skull found in the same block might also be expected to be that of a Chelydroid; and, in fact, it is so. I do not base this interpretation on the Chelonian character of the upper jaw, as there are various extinct Saurian reptiles which closely approximate to Chelonia in this part of their structure. The diagnostic characters lie in the back part of the skull; and especially in the auditory region, which is altogether Chelonian. Not only so, but when this fragmentary skull is compared with that of *Chelydra*, the correspondence between the two is singularly exact (Figs. 3 and 4). In two respects, however, the fossil differs from *Chelydra* and *Gypochelys*.

(1) The roof over the temporal fossa formed by the parietal, post-frontal, and other bones, which leaves the auditory region uncovered in the recent genera,[1] extends back, beyond the occiput, in the fossil, and sends down a broad vertical rim from its margin.

(2) The upper surface of the cranial shield is, at most, rugo e

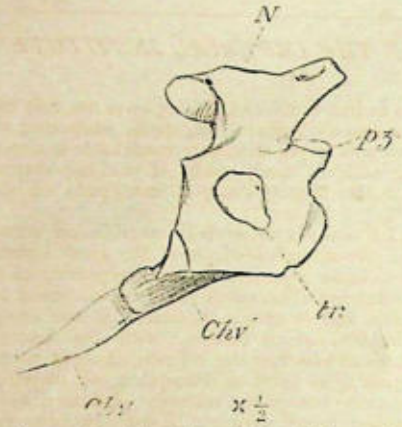


Fig. 1.—Caudal vertebra of *Ceratochelys*. *N*, platform on the neural arch; *pz*, pre zygapophysis mutilated; *tr*, broken transverse process; *Chv'*, processes for the chevron bone; *Chv*, chevron bone.



Fig. 3.

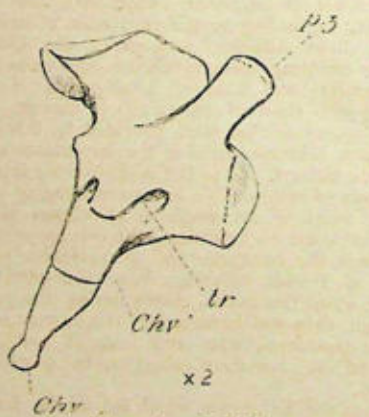


Fig. 2.—Caudal vertebra of *Chelydra*. Letters as in Fig. 1.

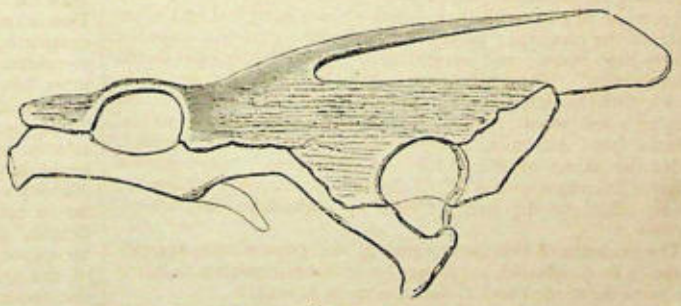


Fig. 4.

Figs. 3, 4.—Skulls of *Ceratochelys* (Fig. 3) and *Chelydra* (Fig. 4); the latter of the natural size, the former much reduced. The portion of the skull of *Chelydra* which corresponds with the fossil is shaded.

in the recent *Chelydridæ*; in the fossil, three strong conical processes, like horn-cores, of which the middle is the longest, are developed from its posterior and lateral region.[1]

This skull is described and figured in the Philosophical Transactions for 1886 (Plate 30, Fig. 1) by Sir R. Owen, under the generic or sub-generic name of *Meiolania*, and is said to belong to a Saurian reptile closely allied to the "*Megalania prisca*" described in earlier communications. But the skull is assuredly that of the Chelydroid Chelonian to which the pelvis and caudal vertebra belong. What *Megalania prisca* may be I do not pretend to say; but the remains which I have described can have nothing to do with any Saurian reptiles; and I propose to confer on the genus of Chelonia to which they belong the name of *Ceratochelys*.

The singular osseous caudal sheaths described by Sir R. Owen, in the same memoir, also appertain to *Ceratochelys*. They formed part of the series of remains sent to the British Museum along with the foregoing, in which none but Chelonian bones have yet been discovered; and the remains of vertebræ left in these sheaths are similar to the caudal vertebræ of the terminal fourth of the tail in the *Chelydridæ*. The snapping turtles are noted for the length and strength of the tail and for the strong, laterally-compressed, acuminated "scales" which form a crest along the median dorsal line, while others, less strongly keeled, lie at the sides of the tail. In many Chelonia, the extremity of

[1] It is possible that these may be dermal bones coherent with the proper cranial shield.

[1] The "roof" extends much further back in *Platysternum*.

the tail is enveloped in a continuous sheath. These and other scale-like structures in the Chelonia are usually spoken of as if they were entirely epidermal. But, a day or two ago, Dr. Günther informed me that in the Australian tortoise, *Manouria*, the great imbricated scales of the limbs contain bony scutes; and that similar scutes are to be found in *Testudo graeca*. This, of course, suggested the examination of the caudal scales of *Chelydra* and *Gypochelys*; and, having been enabled by Dr. Günther's kindness to examine the caudal scales of a good-sized specimen of the latter, I have found that those of the crest contain bony scutes.[1] The bony scute corresponds very closely in form with the whole "scale," but the recurved apex of the latter is formed only by epidermal substance (Figs. 5 and 6).

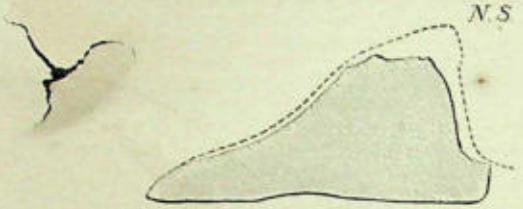


FIG. 5.



FIG. 6.

FIGS. 5, 6.—Sectional views of a scute of the tail-armour of *Ceratochelys* (Fig. 5), and of one of the crest plates of *Gypochelys*, both of the natural size.

The living *Chelydra*, therefore, has a caudal armature which, in principle, is similar to that of *Ceratochelys*, but the osseous elements are relatively atrophied. There is exactly the same relation between the armour of species of living *Crocodiles* and *Alligators*, on the one hand, and those of *Jacare* and *Caiman* and the extinct *Teleosauria*, on the other. In the former, the epidermal scales remain well developed on the ventral side of the body, while the corresponding osseous scutes, fully developed in *Jacare*, *Caiman*, and *Teleosauria*, have vanished.

Among the detached fragments to which I have referred, there are remains of ribs, with their costal plates; marginal and other plates of the carapace; parts of the plastron; part of a scapula; sundry limb bones; and several of the cranial processes called "horn-cores." They all agree, so far as they can be compared, with the determination already arrived at; which, to sum it up in a few words, is that the remains of crania and caudal sheaths from Australia, hitherto referred to Saurian reptiles, under the names of *Megalania* and *Meiolania*, appertain to a hitherto unknown species of Chelonian, *Ceratochelys sthenurus*, closely allied to the living *Chelydra*, *Gypochelys*, and *Platysternum*.

The evidence of this fact offered in the present note appears to me to be conclusive, but it may be desirable hereafter to figure the parts mentioned and to describe them at length.

The interest which attaches to the discovery of this singular Chelonian arises partly from the fact that the group of Chelonia to which it belongs is wholly unrepresented in the fauna of Australia, as at present known. *Platysternum* is usually said to be found in China. Dr. Günther, however, informs me that Upper Burmah is its proper habitat; otherwise, North America, west of the Rocky Mountains, is the nearest region in which the *Chelydridæ* are to be found. But *Chelydridæ*, and, indeed, species of the genus *Chelydra*, occur in Upper Miocene (Œningen) and in Eocene formations in Europe. Moreover, *Platychelys* of the Upper Jurassic series of Bavaria and Switzerland, heralded by Rütimeyer as an early form of the group.

Lord Howe's Island is about 200 miles from the nearest Australian mainland, and something like 400 miles, as the crow flies, from the Darling Downs, in which the caudal armour, which has been ascribed to *Megalania*, was found. The discovery of *Ceratochelys*, therefore, has an interesting bearing on the question of the former extension of Australia to the eastward, on the one hand; and of the possible derivation of such forms as *Ceratochelys* from Asia, on the other hand. An elevation of the sea-bottom of 6000 feet would place Norfolk Island and Lord Howe's Island on a peninsula extending from the region of the present Barrier Reef to New Zealand; and the flora and fauna of those islands are known to have special affinities with those of New Zealand, and none with those of Australia.

Speculations respecting the origin of the Chelonian carapace are suggested by the discovery of osseous scutes in the vertebral region of the tail, and their coalescence in *Ceratochelys* to form a sort of caudal carapace, ridged in a manner resembling that of *Chelydra* and *Platychelys*. But the consideration of these points would take me beyond the limits of the present note.

[1] The fact is noted by Rütimeyer (Lang and Rütimeyer, "Die Fossilen Schildkröten von Solothurn," *Denkschriften der Allg. Schweiz. Gesellschaft*, vol. xxii.). The armature of the tail in *Platysternum* is for the most part arranged in zones, of four plates in each zone; but I have not yet been able to find any bone in them.

THE WORK OF THE IMPERIAL INSTITUTE[1]

I.

THE Colonial and Indian Exhibition, which owes not only its conception, but also its brilliantly successful realisation to your Royal Highness, will be pre-eminently remarkable in times to come, for having achieved many results of vital importance and highest benefit to Her Majesty's subjects in all parts of her vast realms.

The collection of all that is commercially valuable and scientifically interesting of the natural products of the great Indian Empire and of the Colonies in one Exhibition, embracing as it also did very comprehensive illustrations of the development of commerce, of the arts, and of certain industries, in the many countries beyond the seas which combine with the United Kingdom to constitute our vast Empire, afforded those at home an opportunity, surpassing all previous conception, of studying and comparing the natural history and resources of those distant lands, of which, attached though we might be individually to one or more of them by ties of friendship or of interest, the knowledge of many of us was of a very vague or partial character.

To the Colonists who visited us last year, the Exhibition has been of inestimable value, in affording them a most favourable and appropriate opportunity of becoming acquainted or renewing their old friendship with the mother country, and of examining the progress there made in industrial, educational, and commercial development; in leading to the cultivation of intimacy between Colonists from different sections of the Queen's Dominions; and in affording them invaluable opportunities of comparing the resources and state of development of their respective countries with those of other parts of Europe. No more convincing illustrations than were provided by this great Exhibition could have been conceived of the importance to the home country, to each Colony, and to India, of fostering intimate relationship and unity of action. No more encouraging proof could have been afforded of the desire of all classes of Her Majesty's subjects at home to cultivate a knowledge of those far-off countries which the enterprise and perseverance of the British, and men of British offspring, have converted into prosperous and important dominions, chiefly during the period of the Queen's reign, than was furnished by the interest which the thousands upon thousands, who came from all parts, displayed in the study of the instructive collections in the galleries at South Kensington.

It was the success of the Exhibition which led to the definite formulation of the suggestion first made by your Royal Highness in a letter addressed by you in the autumn of 1884 to the Agents-General of the Colonial Governments, that a permanent representation of the resources of the Colonies and India, and of their continually progressing development, might, with great benefit to the Empire at large, be established in this country. That the realisation of this idea upon a sufficiently comprehensive basis might constitute a worthy memorial of the accomplishment of fifty years of a wise and prosperous reign; a memorial not personal in its character excepting so far as it constituted an emblem of the love and loyalty of Her Majesty's subjects, but tending, as she would most desire, to serve the interests of the entire Empire; this had only to be pointed out by your Royal Highness to be heartily concurred in by the official representatives of the Colonies and India, who

[1] Lecture (abridged) delivered at the Royal Institution, on Friday, April 22, by Sir Frederick Abel, C.B., F.R.S.; H.R.H. the Prince of Wales, K.G., F.R.S., Vice-Patron, in the Chair.

were so intimately identified with the triumphs of the recent Exhibition.

The Committee to whom you, Sir, intrusted the elaboration of a scheme for carrying this conception into effect, became persuaded by a careful consideration of the subject that such an Institution as your Royal Highness desired to see spring into life, to be a memorial really worthy of the Jubilee of Her Majesty's reign, and to fulfil the great purposes which you had in view, must not be confined in its objects to particular portions of Her Majesty's Dominions, but must be made thoroughly representative of the interests and of the unity of the whole Empire.

The outline of the scheme for the establishment of an Imperial Institute for the United Kingdom, the Colonies, and India, which met with the cordial approval of your Royal Highness, was necessarily concise in dealing with the very wide extent of ground which the operations of the Institute are intended to cover; but those who have carefully considered it, and rightly interpreted its proposals, have not failed to realise that it aims at very much more than the creation and maintenance of collections illustrative of the natural resources of our Colonies and of India, and of the development and present condition of the chief industries of different parts of the Empire.

One of the primary objects of the Institute will certainly be the establishment of thoroughly well selected, carefully arranged, and efficiently maintained representations of the natural products which constitute the treasures, and are emblematic of the important positions in the Empire, of those great colonial possessions which, during the fifty years of Her Majesty's reign, have, in many instances, experienced a marvellous development in extent, in commercial, social, and even in political importance.[1] The recent Exhibition not only afforded conclusive demonstration of the great interest and value to the United Kingdom which must attach to such collections if properly organised; it also served, by such illustrations as the magnificent collections of valuable woods, from nearly every colony, many quite unknown in England, and the great variety of valuable economic products from India, of the existence of which we at home had little idea, to convince us that our knowledge of the great countries which constitute the chief portion of the Empire is very limited and imperfect, and that their resources are in many directions still in the infancy of development. Our Colonial brethren cannot, on their part, fail to be greatly benefited by being thoroughly represented in a well-selected and carefully organised assemblage of illustrations of the sources of prosperity which constitute the sinews of their commerce, and upon a continued exploration and cultivation of which must depend the maintenance of their influence upon industrial and social progress. Neither can they fail to reap substantial advantages by pursuing a friendly rivalry with each other in demonstrating the advances made from time to time in the development of the resources of the respective portions of the Empire in which their lot is cast.

The hearty co-operation and important material support to which the great Colonies, through their representatives in London, pledged themselves when the scheme for the proposed Imperial Institute was in the first instance limited to this branch of the great work which it is now contemplated to accomplish, afforded conclusive evidence of their earnest desire to be in all respects thoroughly represented in the mother country, and to take their places permanently in our midst as fellow-labourers in the advancement of the prosperity of the Empire. In furtherance of this important end, a notable feature of that building which, in its character, will, it is hoped, be worthy of the momentous epoch which it is to commemorate, will be the attractions and conveniences presented by it, as a place of resort and a *rendezvous* for Colonists visiting England, and, it is also anticipated, for the important Societies which represent the Colonies and Asiatic possessions in this country, and the facilities which it will afford for reference to literature concerning the Colonies and India, for conferences on matters of common interest and value to the Colonists and those at home, for the interchange of information between the British manufacturer and those in the Colonies who are directly interested in meeting his requirements, and generally for the cultivation of intimate relations and good fellowship between ourselves and our brethren from all parts of the Empire.

The Institute will, however, not only operate actively under its own roof in promoting the cultivation of a better knowledge of the geography, natural history, and resources of our Colonies, and for the advancement of the interests of the Colonists in this country; it is also contemplated that representative collections of the natural products of the Colonies and India, carefully identified with the more elaborate collections of the head establishment, shall be distributed to provincial centres, and that the provinces shall be kept thoroughly conversant with the current information from the Colonies and India, bearing upon the interests of the commercial man, the manufacturer, and the intending emigrant.

Although the formation and maintenance up to date of collections illustrative of the development and present condition of the important industries of the Empire also forms, as I have stated, a part of the programme of the Institute, the scope of its activity in relation to industry will be of a much more comprehensive character; indeed, it is to be hoped that the work which it will achieve in furtherance of the development and progress of industries and their future maintenance in the United Kingdom at least upon a footing of equality with their conditions in the great Continental States, will be most prominent in securing to the Imperial Institute the exalted position which it should occupy as the National Jubilee Memorial of Her Majesty's reign.

There is no need for me to recall to the minds of an audience in the Royal Institution the great strides which have been made during the last fifty years in the applications of science to the purposes of daily life, to the advancement of commerce, and to the development of the arts and manufactures. Nor is it necessary to dwell upon the fact that this country is the birth-place of the majority of the great scientific and practical achievements which have revolutionised means of intercommunication, and have in other ways transformed the conditions under which manufactures, the arts, and commerce are pursued. These very achievements, of which we as a nation are so justly proud, have led, however, by many of their results, to our becoming reduced to an equality of position with other prominent nations in regard to important advantages we so long derived from the possession in this country of great material resources easy of access and application, and from the consequent pre-eminence in certain branches of the trade and industry which we so long enjoyed.

In 1852, Sir Lyon Playfair was impelled by the teaching of the preceding year's Great Exhibition to point out that "the raw material, formerly our capital advantage, was gradually being equalised in price and made available to all by the improvements in locomotion," and "that industry must in future be supported, not by a competition of local advantages, but by a competition of intellect." If this was already felt to be the state of the case six-and-thirty years ago, how much more must we be convinced of the full truth of this at the present day, by the conditions under which the British merchant and the manufacturer have to compete with their rivals on the Continent and in the United States.

It is still within the recollection of many that almost the whole world was in very great measure dependent upon Great Britain for its supplies of ordinary cast iron. Even as lately as 1871, the United States of America received from Great Britain nearly one-fifth of its total produce of pig iron; but from 1875 all importation of British iron ceased for over three years, and it was only in consequence of requirements in the States exceeding the capabilities of production, that some small demands arose in 1879, which were for some time maintained.

Within three years, however, the make of iron in the United States increased by 70 per cent., and although, since 1882, the actual make has not increased, the *capacity of production* has risen enormously, it being at present estimated at nearly 300 per cent. greater than it was in 1879. Looking nearer home, we find that the iron of France, Belgium, and Germany not only competes with ours in the open market, but that Belgian and German iron is actually imported into this country to a modest extent.

From time to time the ground which we have lost through the development of the resources of other countries has been more than retrieved temporarily by improvements effected through a more thorough comprehension and consequent better application of the scientific principles underlying processes of manufacture, but the ultimate effect of advances of importance has not unfrequently been to improve the position, in relation to the manufactures concerned, of other nations less favourably circumstanced than Great Britain.

The history of the development of steel manufacture during the last twenty-five years affords a most instructive illustration of the

[1] Statistical statements illustrating the development of the colonies during the Queen's reign are appended.

fluctuations which may ensue in the value of our natural resources, and the consequent condition of one or other of our important industries, arising out of continued advances made in the application of science to the perfection or transformation of manufacturing processes, and of the stimulating effects of such fluctuations upon the exertions of those who are able to bring scientific knowledge to bear upon the solution of problems in industrial operations which entirely baffle the ordinary manufacturer. Within that period the inventions of Bessemer and of Siemens have led to the replacement of iron by steel in some of its most extensive applications. This important change in our national industry was, ere long, productive of a serious crisis therein, and for the reason that the pig iron produced from a large proportion of those ores which, from their abundance and the cheapness of their treatment, have been greatly instrumental in placing Great Britain in her high position as an iron-producing nation, could not be applied to the production of marketable steel by means of the Bessemer converter. Hence the application of this rapid steel-making process had to be chiefly restricted to particular kinds of ores, free from the impurity, phosphorus, which it was powerless to eliminate; the supplies of such ores being limited to a few districts in this country. These had to be largely supplemented by importations from other countries; nevertheless the cheapness of production and superiority in point of strength, durability, and lightness of the steel rails thus sent into the market from the Bessemer converter combined to maintain a supremacy of them over iron rails, &c., manufactured by the old puddling process from the staple ores of the country.

The advantages presented by steel over the wrought iron of the puddling furnace for constructive purposes speedily became evident, and the effect of the rapid displacement of malleable iron by steel produced from ores of a particular class has been that at least 85 to 90 per cent. of the iron ores of Great Britain could no longer be applied to the production of material for rails, for ships, and for other important structures. Great has been the apprehension among the owners of those ores that the demand for iron which they can furnish could not revive, but the scientific metallurgist has successfully grappled, from more than one direction, with the great problem of restoring their commercial importance; and a simple alteration of the method of carrying out the Bessemer process has within the last few years led to really triumphant results, with the employment of those ores which before could only be dealt with by the searching operation of the old puddling furnace. A new era has thus been established in steel manufacture, there being now but very few restrictions to the application of the quick processes to iron produced from all varieties of ores. Indeed, the treatment is actually being applied profitably to the recovery of iron from the rich slag forming the refuse-product of the puddling furnace in the production of malleable iron, which before had been condemned to limited usefulness as a material for road-making. Yet another most interesting and valuable result has been achieved by this simple application of scientific knowledge. The slag or refuse-product of the so-called *basic treatment* of iron contains, in the form of phosphates of lime and magnesia, the whole of the phosphorus which it is the main function of that treatment to separate from the metal; it was soon found that the phosphoric acid was there presented in a condition as readily susceptible of assimilation by plants as it is in the valuable artificial manure known as superphosphate; this refuse-slag, simply ground up, constitutes therefore a valuable manure which already commands a ready sale at very profitable prices.

The origination of this latest advance in the development of steel manufacture dates back only nine years, and already the year's product of the basic process amounts to over 1,300,000 tons of steel. But although it is to Englishmen that the owner of iron property and the steel-maker are again indebted for these important results, and to English manufacturers that the first practical demonstration of the success of this process is due, its application has been far more rapidly elaborated upon the Continent than here; in Germany the importance of the subject was at once realised, and it is there that considerably the largest proportion of steel is produced by the basic treatment; it is in Germany also that the value of the slag for agricultural purposes has been developed, the first steps in its utilisation here being but just now taken, in Staffordshire.

I have already referred to the remarkable strides which have been made in the extension of iron manufacture in the United States; the development there of steel production has been no less marvellous, and the causes of this are evident; the resources of the country in ore and fuel are gigantic, and the systematic technical training of the people has made its influence felt upon the development of this as of every other branch of industry which our friendly rivals pursue. But it is not only in the United States that the development in the production of iron and steel has greatly increased of late years; thus, in Germany the increase in the production of pig iron alone, during the last twenty-one years, has been 237 per cent., while with us it has been 75 per cent.

Although, however, the increase in actual production of iron and steel in Great Britain has not kept pace with that of some other countries, it is satisfactory to know that our *productive power* has very greatly increased in late years, and there is probably no one branch of our industries in which we have maintained our position so satisfactorily in regard to quality of product as that of iron and steel manufacture, even though, every now and then, we have indications that in the struggle with other nations for superiority of product and for pre-eminence in continuity of progress, we have to look to our laurels.

There are, however, other important branches of industry, for a time essentially our own, the present condition of which, in this country, we cannot contemplate with equal satisfaction. Several instructive illustrations might be quoted, but I will content myself with a brief examination of one of the most interesting.

In illustrating the advances which were being made, thirty-five years ago, as demonstrated by the Exhibition of 1851, Playfair referred to the great development of the value of the evil-smelling coal-tar, which was then made to furnish the solvent liquids benzene and naphtha, and the antiseptic creosote, the residual material being utilised for pavements and for artificial fuel. The chemist little dreamt then that between 1851 and the year of the next great Exhibition, 1862, coal-tar would have become a mine of wealth equally to science, the manufactures, and to the arts, in which fresh workings have ever since continued to be opened up, and still present themselves for exploration. Hofmann, in his valuable report on the chemical products and processes elucidated by that Exhibition, dwells with the enthusiasm of the ardent worker in science upon the brilliant products obtained from coal-tar which had resulted from the labours of the scientific chemist, and had already acquired an almost national importance, although this great industry was then still in its infancy. From the year 1856, when the first colouring-matter, known as *mauve*, was discovered and manufactured by one of Hofmann's most promising young pupils, Mr. Perkin, down to the present time, the production of new coal-tar colours, or of new processes for preparing the known colours in greater purity, has progressed uninterruptedly, this industry having long since become one of the most important, and also one of the most remarkable, as illustrating by each stage of its development the direct application of scientific research to the attainment of momentous practical results.

The difficulties to be overcome before mauve could be produced upon a manufacturing scale were very great, and were only solved by a steady pursuit of scientific research, side by side with practical experiments suggested by its results. Aniline—the parent of the first coal-tar colour, a liquid organic alkali—a most fertile source of interesting and important discoveries in organic chemistry, was produced with difficulty by various methods in very small quantities, so as to be almost a chemical curiosity at the time of the discovery of mauve. Among the substances from which it had been prepared was the volatile liquid known as *benzene*, first discovered in the laboratory of this Institution in 1825 by Faraday, in the liquid products condensed from oil gas, but afterwards obtained by Mansfield, in the College of Chemistry, from coal-tar naphtha. The conversion of benzene into aniline was accomplished as a manufacturing process after many difficulties by Perkin; and within a year after the discovery of mauve by him, it was in the hands of the silk dyer. Perkin's success led other chemists at once to pursue researches in the same direction, especially in France, where the next important coal-tar colour, *magenta* or fuchsine, was obtained, by M. Verguin, the successful manufacture of which in a pure state was, however, first accomplished by English chemists. In 1861 beautiful violet and blue colours were produced, again by French chemists, but were manufactured shortly afterwards in a pure state in England.

The six years succeeding those which formed the first period (1854-62) of existence of this industry were fruitful, not only of many beautiful new dyes, first produced in England, but also

of important progress made here, as well as on the Continent, in the development of the manufacture, and of our knowledge of the constitution, of the parent colours.

In the next period of six years (1868-74) another great stride was made in the coal-tar colour industry, due to important scientific researches carried out by two German chemists, Graebe and Liebermann, which led them, in the first place, to obtain an insight into the true nature of the colouring-matter of one of the most important staple dye-stuffs, namely the madder-root. They found that this colouring-matter which chemists call *alizarine* was related to *anthracene*, one of the most important solid hydrocarbons formed in the distillation of coal, a discovery which was speedily followed by the artificial formation of the madder-dye, alizarine, from that constituent of coal-tar. At first, this achievement of Graebe and Liebermann was simply of high scientific interest; but Perkin, and Graebe, and Liebermann, were not long in discovering methods by which the conversion of anthracene into the madder-dye could be accomplished on a large scale, and the manufacture of alizarine was soon most actively pursued in this country, with very momentous results, as regards the market value of the madder root. The latter has long been most extensively cultivated in Holland, South Germany, France, Italy, Turkey, and India, the consumption of madder in Great Britain having attained to an annual value of as much as 1,000,000*l.* sterling. Playfair pointed out in 1852 that important improvements had lately been attained in the extraction of the red colour or alizarine from the madder-root, but those results, most valuable at the time of the first Great Exhibition, became insignificant when once the dye was artificially manufactured from anthracene; the price paid for madder in 1869 was from 5*d.* to 8*d.* per pound, but now the equivalent in artificial madder-dye, or alizarine, of one pound of the root, can be obtained for one-halfpenny.

With the discovery of artificial alizarine the truly scientific era of the coal-tar industry may be said to have commenced, most of the commercially valuable dye-products, obtained since that time, being the result of truly theoretical research by the logical pursuit of definite well-understood reactions. The wealth of discovery in this direction made during the last thirteen years is a most tempting subject to pursue; but I must content myself with mentioning that one of the results was the production of very permanent and brilliant scarlet and red dyes, the manufacture of which has greatly reduced the market value of cochineal; that the careful study of the original coal-tar colours led to their production in a state of great purity by new and beautifully simple scientific methods; and that even the well-known vegetable colouring-matter, *indigo*, one of the staple products of India, now ranks among the colours synthetically obtained by the systematic pursuit of scientific research, from compounds which trace their origin to coal-tar.

The rapid development of the industry has also not failed to exercise a very important beneficial influence upon other chemical manufactures; thus, the distillation of tar, which was a comparatively very crude process, when, at the period of the first Exhibition, benzene, naphtha, dead-oil, and pitch were the only products furnished by it, has become a really scientific operation, involving the employment of comparatively complicated but beautiful distilling apparatus for the separation of the numerous products which serve as raw materials for the many distinct families of dyes. Very strong sulphuric acid became an essential chemical agent to the alizarine manufacturer, and, as a consequence, the so-called anhydrous sulphuric acid, the remarkable crystalline body which was for many years prepared only in small quantities from green vitriol, is now made at a low price upon a very large scale by a beautifully simple process worked out in England. The alkali- and kindred chemical trades have been very greatly benefited by the large consumption of caustic soda, of chlorate of potash, and other materials used in the dye manufactures, and the application of constructive talent, combined with chemical knowledge, to the production of efficient apparatus for carrying out on a stupendous scale the scientific operations developed in the investigator's laboratory, has greatly contributed to the creation of a distinct profession, that of the chemical engineer.

One of the most beneficial results of the rapid development of the coal-tar colour industry has been its influence upon the ancient art of dyeing, which made but very slow advance until the provision of the host of brilliant, readily-applicable colours completely revolutionised both it and the art of calico-printing.

I venture to think that it will be interesting at this point to quote some words of prophecy included in Prof. Hofmann's important "Report on the Chemical Section of the Exhibition of 1862," and to inquire to what extent they have been verified. In commenting upon one of the features of greatest novelty in that world's show, the exhibition of the first dye-products derived from coal-tar, he says:—

"If coal be destined sooner or later to supersede, as the primary source of colour, all the costly dye woods hitherto consumed in the ornamentation of textile fabrics; if this singular chemical revolution, so far from being at all remote, is at this moment in the very act and process of gradual accomplishment; are we not on the eve of profound modifications in the commercial relations between the great colour-consuming and colour-producing regions of the globe? There is fair reason to believe it probable that, before the period of another decennial Exhibition shall arrive, England will have learnt to depend, for the materials of the colours she so largely employs, mainly, if not wholly, on her own fossil stores. Indeed, to the chemical mind it cannot be doubtful that in the coal beneath her feet lie waiting to be drawn forth, even as the statue lies waiting in the quarry, the fossil equivalents of the long series of costly dye-materials for which she has hitherto remained the tributary of foreign climes. Instead of disbursing her annual millions for these substances, England will, beyond question, at no distant day become herself the greatest colour-producing country in the world; nay, by the strangest of revolutions, she may ere long send her coal-derived blues to indigo-growing India, her tar-distilled crimson to cochineal-producing Mexico, and her fossil substitutes for quercitron and safflower to China, Japan, and the other countries whence these articles are now derived."

So far as concerns the displacement of madder, cochineal, quercitron, safflower, and other natural dye-materials from their positions of command in the markets of England and the world, Hofmann's predictions have been amply fulfilled, and it appeared in the earlier days of the coal-tar colour industry as though he would be an equally true prophet in regard to England becoming herself the greatest colour-producing country in the world. But, although Germany did little in the very early days of this industry, beyond producing a few of the known colours in a somewhat impure condition, many years did not elapse ere she not only was our equal in regard to quality of the dyes produced, but, moreover, had outstripped us in the quantities manufactured and in the additions made to the varieties of valuable dyes sent into the market. So far back as 1878 the value of the make of colours in England was less than one-fourth that of Germany, and even Switzerland, which, in competing with other countries industrially, is at great natural disadvantages, was not far behind us, ranking equal to France as producers. The superior position of Germany in reference to this industry may be in a measure ascribable to some defects in the operation of our Patent Laws and to questions of wages and conditions of labour; but the chief cause is to be found in the thorough realisation, by the German manufacturer, of his dependence for success and continual progress upon the active prosecution of scientific research, in the high training received by the chemists attached to the manufactories, and in the intimate association, in every direction, of systematic scientific investigation with technical work.

The young chemists whom the German manufacturer attracts to his works rank much higher than ours in the general scientific training which is essential to the successful cultivation of the habit of theoretical and experimental research, and in the consequent power of pursuing original investigations of a high order. Moreover, the research laboratory constitutes an integral part of the German factory, and the results of the work carried on by and under the eminent professors at the universities and technical colleges are closely followed and studied in their possible bearings upon the further development of the industry.

The importance attached to high and well-organised technical education in Germany is demonstrated not only by the munificent way in which the scientific branches of the universities and the technical colleges are established and maintained, but also by the continuity which exists between the different grades of education; a continuity, the lack of which in England was recently indicated by Prof. Huxley with great force.

The important part taken by the German universities in the training of young men for technical pursuits has often been dwelt upon as constituting a striking feature of contrast to our university systems. The national appreciation of the opportunities there

presented for scientific training is demonstrated by the large number of students which are always working in the university laboratories, while the expenditure of 30,000*l.* upon the physical laboratory, and 35,000*l.* upon the chemical department, of the New University of Strasburg, serves to illustrate the unsparing hand with which the resources of the country are devoted to the provision of those educational facilities which are the very life-spring of the industrial progress whence those resources are derived.

In France, higher education had been allowed to sink to a low ebb after the provincial universities had been destroyed in the great Revolution, and the University of Paris had been constituted by the first Napoleon the sole seat of high education in the country. Before the late war, matters educational were in a condition very detrimental to the position of the country among nations. There was no lack of educational establishments, but the systems and sequence of instruction lacked organisation, but since the war, France has made great efforts to replace her educational resources upon a proper footing. The provincial colleges have been re-established at a cost of 3,280,000*l.*, and the organisation of industrial education has now been greatly developed, though still not on a footing of equality with that of Germany. Every large manufacturing centre has its educational establishment where technical instruction is provided, with special reference to local requirements; and, in order to render these colleges accessible to the best talent of France, more than 500 scholarships have been founded, at an annual cost of 30,000*l.* The Ecole Centrale des Arts et Manufactures, of Paris, still maintains the reputation as the great technical university of the country which it earned many years ago, and receives students from the provincial colleges, where they have passed through the essential training preliminary to the high technical education which that great institution provides.

Switzerland has often been quoted as a remarkable illustration of the benefits secured to a nation by the thoroughly organised education of its people. Far removed from the ocean, girt by mountains, poor in the mineral resources of industry, she yet has taken one of the highest positions among essentially industrial nations, and has gained victories over countries rich in the possession of the greatest natural advantages. Importing cotton from the United States, she has sent it back in manufactured forms, so as to undersell the products of the American mills. The trade of watch-making, once most important in this metropolis, passed almost entirely to Switzerland years ago; the old-established ribbon trade of Coventry has had practically to succumb before the skilled competition of Switzerland; and although she has no coal of her own, Switzerland is at least as successful as France in her appropriation of the coal-tar colour industry and her rivalry in rate of production with England, the place of its birth and development. Comparative cheapness of labour will not go very far to account for these great successes; they undoubtedly spring mainly from the thoroughly organised combination of scientific with practical education of which the entire people enjoys the inestimable benefit.

Holland furnishes another brilliant example of the success with which a nation brings the power of systematic technical education to bear in securing and maintaining industrial victories in the face of most formidable disadvantages, while the United States of America, so rich in natural resources, have long since realised the immensity of additional advantages to be gained over European nations in the war of industry by a wide diffusion and thorough organisation of technical education. So long as forty years ago the States already possessed several excellent educational institutions established upon the basis of the Continental polytechnic schools, but it was not until about fifteen years later that the country became thoroughly impressed with the great advances achieved by Germany in technical education, and that the subject was made a thoroughly national one. It is now just upon a quarter of a century ago since Congress ordained that each State should provide at least one college, having for its leading objects the diffusion of scientific instruction in its relations to the industry of the country, and decreed that public lands should be granted to the States and Territories providing such colleges. The combined effect of this State action, and of great private munificence, was a remarkably rapid development of scientific and technical education throughout the country; besides some fifty colleges, with eight or nine thousand students, which sprang out of the Land Grant Act for Industrial Education, there are now in the States about 400 other universities and colleges, in a large proportion of which efficient instruction in applied science is provided. To the useful work accomplished within a few years by these and many other highly important educational institutions, which have placed the acquisition of scientific knowledge within the reach of the very humblest, the enormous strides made by the United States in the development of home industries must unquestionably be in the main ascribed.

(*To be continued.*)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

OXFORD.—There are only a few alterations and additions to the usual scientific lecture-list to report, as most of the courses are in continuation of those given last term. Prof. Sylvester is to lecture on the theory of numbers; in the Chemical Department, Mr. Wyndham Dunstan lectures on organic chemistry in relation to medicine and physiology; Prof. Prestwich is to have his usual summer geological excursions; Dr. Tylor continues his exposition of the development of arts, as illustrated in the Pitt-Rivers Museum.

The Sibthorpian Professorship of Rural Economy has been filled up by the re-election of Dr. Gilbert. The Radcliffe Travelling Fellowship has been awarded to Mr. W. Overend, B.A., of Balliol. The statutes of the University Commissioners, which limited the competition for most college scholarships to candidates under nineteen, seem to be having an unfortunate, though not unexpected, effect, as several colleges have lately found it impossible to award scientific scholarships, owing to the want of sufficiently qualified candidates.

There is a good deal of strong feeling in the University with regard to the approaching appointment of a Reader in Geography, and the action of the Delegates of the University Fund in transferring a Readership from History to Geography, just after the offer of the Royal Geographical Society for a similar purpose had been refused, is the subject of much unfavourable comment. There is no thought of opposition to the study of geography, even of scientific geography, but history lecturers not unnaturally complain that the only University appointment open to them should be abolished to make a post for a lecturer in another subject.

CAMBRIDGE.—Among the seven courses on chemistry being delivered this term are lectures on gas analysis and on aromatic bodies, by Dr. S. Ruhemann. Prof. Dewar and Dr. Ruhemann also superintend laboratory practice specially directed to research.

The course given by Mr. Lyon, the Superintendent of the Mechanical Workshops, this term is on machine construction.

Mr. Langley is giving a special course on the central nervous system, with demonstrations and practical work.

Prof. Macalister's lectures this term are on the history of human anatomy. It is to be hoped that he will publish them.

Mr. M. A. Fenton is lecturing on elementary comparative osteology: Dr. Gadow on the morphology of Mammalia, recent and extinct, and on the palæontology of the Vertebrata.

Dr. Vines has a course of advanced embryology of plants, and Mr. F. Darwin is giving advanced demonstrations in the physiology of plants.

In geology, Prof. Hughes is taking the geology of the neighbourhood of Cambridge, by lectures and field excursions; Mr. Marr, foreign stratigraphy; and Mr. Roberts, the Trilobites.

Prof. Roy has classes for general pathology, morbid anatomy, and practical morbid histology, bacteriology, &c.

The lectures mentioned above are only a selection of the more interesting courses. The lists from which the above are selected announce about seventy-five courses of lectures and practical work.

Candidates for the John Lucas Walker Studentship, the holder of which must devote himself or herself to original research in pathology, should send their applications to Prof. Roy, Trinity College, Cambridge, not later than May 31 next. The Studentship is of the annual value of 250*l.*, and is tenable under certain conditions for three years.

SCIENTIFIC SERIALS

The American Journal of Science, April.—Contributions to meteorology, twenty-second paper, by Elias Loomis. In this communication the author treats of areas of high pressure, their

magnitude and direction of movement, and their relation to areas of low pressure. The latter subject is illustrated with a plate giving the isobars for December 15, 1882, in the northern hemisphere, and it is shown generally that the movement of areas of high pressure depends upon very different causes from that of areas of low pressure, which seem to be endowed with a power of locomotion residing within themselves. Areas of high pressure exhibit no such power, their movement seeming to depend entirely on external forces.—The faults of South-West Virginia, by John J. Stevenson. Here is given a summary of the information communicated by the author in several memoirs read before the American Philosophical Society (1880-84) on a reconnaissance made by him of the faulted region in Virginia from the Tennessee line to nearly twenty miles beyond New River, a total distance of 150 miles.—On Taconic rocks and stratigraphy, with a geological map of the Taconic regions, part 2, by James D. Dana. The general facts are here detailed which bear on the geographical distribution of the limestone and other rocks. A description is given of Williamstown, regarded as the birthplace of the Taconic system, and it is shown generally that the great quartzite formation, forming the foundation of the Palæozoic of the region, derived its material from Archæan formations of the vicinity and not from the fabled "Atlantis" as some geologists have supposed.—Irish esker drift, by G. H. Kinahan. It is pointed out that, in common with some other observers, Prof. Carvill Lewis confounds true esker drift and ridges of esker-like drift. His statement in the December number of the *American Journal of Science* that the Irish eskers appear to be adjuncts of the melting of the ice-sheets is shown to be impossible.—Physical characteristics of the northern and north-western lakes, by L. Y. Schermerhorn. The results are given of the lately completed surveys made by the United States of all the great lakes draining through the St. Lawrence to the Atlantic. The total water-area is 95,275, and the total area of the lacustrine basin over 270,000, square miles. The length of shore-line with connecting rivers is about 5400 miles, the extreme depth of Superior 1008 feet, or over 406 below sea-level, the mean annual rainfall of the whole basin 31 inches, the volume of water in the lakes about 6000 cubic miles, and the discharge of Ontario at St. Lawrence River 300,000 cubic feet per second.—Mineralogical notes from the laboratory of Hamilton College, by Albert H. Chester. Specimens are described and analysed of fuchsite, pink celestite, zinkenite, brochantite, pectolite, crystals of barite, scorodite, and bismuthite.—The topography and geology of the Cross Timbers and surrounding regions in Northern Texas, by Robert T. Hill. This wooded zone penetrating in two belts from Indian territory through the surrounding prairie southwards to 32° N. lat., is explained by the detritus of arenaceous strata which occupy well-defined horizons in the geological series, and which have been exposed by the denudation of the overlying strata.—American Jurassic mammals, by Prof. O. C. Marsh. In this paper are described the remains of several hundred individuals which have come to light since the appearance of the author's previous papers on the subject. Although fragmentary, the remains are usually well preserved, comprising the lower jaws, teeth *in situ*, various portions of the skull, vertebræ, and other parts of the skeleton. Placental as well as marsupial mammals occur in the oldest formations, whence the inference that the former do not derive from the latter evolutionally, as is supposed, but that both of these orders descend in independent lines from a common ancestor.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, March 24.—"On the Magnetisation of Iron in Strong Fields." By Prof. J. A. Ewing, University College, Dundee, and William Low.

The behaviour of iron and steel when subjected to very strong magnetising forces is a matter of considerable practical and very great theoretical interest, especially from its bearing on the molecular theory of magnetisation, which assigns an upper limit to the intensity of magnetism that a piece of iron can acquire, and even suggests that the metal may become diamagnetic under the influence of a sufficiently great force. All experiments hitherto made, by magnetising iron in the field of an electric solenoid, have shown that the intensity of magnetism, $\mathfrak{J}$, as well as the induction, $\mathfrak{B}$, is increasing with the highest values actually given to the magnetising force, $\mathfrak{H}$. It is scarcely practicable, however, to produce by the direct action of a magnetising solenoid, a field whose force exceeds a few hundreds of C.G.S. units.

In the space between the pole-pieces of a strong electro-magnet we have a field of force of much greater intensity than it is practicable to produce by the direct action of the electric current. This field is not well adapted for experiments whose object is to determine with precision the relation of magnetisation to magnetising force, on account of the distortion which it undergoes when the piece of iron to be magnetised is introduced into it. It is, however, well suited for experiments whose object is to determine how much magnetism the metal can be forced to take up.

In the authors' experiments, bobbins of Lowmoor and Swedish wrought-iron and cast-iron were magnetised by placing them between the pole-pieces of a large electro-magnet. The bobbin consisted of a short narrow central neck with conical ends. The magnetic induction in the neck was measured ballistically by means of an induction coil, consisting of a single layer of fine wire, wound on the neck; and the magnetic field in the air-space immediately contiguous to the neck was also measured by means of a second induction coil wound over the first, and of slightly greater diameter. This enabled the non-ferrous space under the inner induction coil to be corrected for, and also gave an approximation to the value of $\mathfrak{H}$, the magnetic force acting on the metal. The magnetic force varied up to about 11,000 C.G.S. units, and the highest induction observed (in a sample of Lowmoor wrought-iron) was 32,880 C.G.S. units. In some instances the magnetic induction was observed by withdrawing the bobbin; in others the bobbin was turned round suddenly so that its magnetism was reversed. The following results refer to Lowmoor wrought-iron and to cast-iron.

Lowmoor wrought-iron

Field round iron neck per sq. cm.	Magnetic induction in the metal	Current in field magnets, amperes	$\mathfrak{B}$ − outside field / 4π	$\mathfrak{B}$ / outside field
3,630	24,700	1·98	1680	6·80
6,680	27,610	4·04	1670	4·13
7,800	28,870	5·81	1680	3·70
8,810	29,350	7·60	1630	3·33
9,500	30,200	11·0	1650	3·18
9,780	30,680	13·5	1660	3·14
10,360	30,830	16·2	1630	2·98
10,840	31,370	21·6	1630	2·89
11,180	31,560	26·8	1620	2·82

Cast-iron

Field round iron neck per sq. cm.	Magnetic induction in the metal	Current in field magnets, amperes	$\mathfrak{B}$ − outside field / 4π	$\mathfrak{B}$ / outside field
3,900	19,660	1·97	1250	5·04
6,400	21,930	3·75	1240	3·42
7,710	22,830	5·38	1200	2·96
8,080	23,520	7·08	1230	2·91
9,210	24,580	13·15	1220	2·67
9,700	24,900	16·9	1210	2·57
10,610	25,600	22·6	1190	2·46

The magnetic force within the metal ($\mathfrak{H}$) differs from the field in the surrounding space by an amount which cannot be estimated without a knowledge of the distribution of free magnetism on the pole-pieces and conical faces of the bobbin. It appears probable that, with the dimensions of the various parts used in these experiments, the magnetic force within the metal is less, but not very greatly less, than the outside and closely neighbouring field. In the absence of any exact knowledge of $\mathfrak{H}$, it is interesting to examine the relation of $\mathfrak{B}$ to the outside field. Thus, ($\mathfrak{B}$ − outside field)/4π gives a quantity which is probably not much less than the intensity of magnetism, $\mathfrak{J}$. The values of this quantity and also of the ratio $\mathfrak{B}$/outside field for Lowmoor wrought-iron and cast-iron are stated in the tables above.

Curves are given showing the relation of $\mathfrak{B}$ to $\mathfrak{B}$/outside field for Lowmoor iron and for cast-iron, in the manner introduced by Rowland for showing the relation of $\mathfrak{B}$ to μ (the permeability). The curves have the same kind of inflection that a curve of μ and $\mathfrak{B}$ begins to have when the magnetising force is raised sufficiently high. The range through which the permeability of iron may vary is well shown by comparing the values

reached here (probably in the extreme case less than 3) with the value 20,000, which was found by one of the authors in the case of a soft wire exposed to a very small magnetising force and kept at the same time in a state of mechanical vibration.

The experiments give no support to the suggestion that there is a maximum of the induction, $\mathfrak{B}$. The value of $\mathfrak{B}$ capable of being reached by the method here employed depends mainly on the scale of the experiments. Larger field magnets with pole-pieces tapering to a narrow neck should yield values of $\mathfrak{B}$ greatly in excess even of those that were observed.

Linnean Society, April 7.—Mr. William Carruthers, F.R.S., President, in the chair.—Mr. Hunter J. Barron, Mr. Jas. H. Dugdale, and Mr. Edwd. B. Poulton were elected Fellows of the Society.—Fresh specimens were exhibited of a pure white variety of primrose, which had been gathered, growing wild, near Lannritz, France, by Mr. W. D. Godolphin Osborne.—A large series of instantaneous photographs of storks nesting, &c., were exhibited for Mr. E. Bidwell. These had been taken in Germany, and were specially interesting as showing the peculiar attitudes assumed in flight, &c.—Some malformed trout in an early stage of development were shown and commented on by Dr. F. Day.—A paper was read by Prof. Huxley on "The Gentians; Notes and Queries." Taking the flower as a basis, he divides the Gentianeæ into two great series, each of which is characterised by a peculiar disposition of the nectarial organs, and a gradation of forms of the corolla from the deeply cleft rotate or stellate condition, through the campanulate to the extreme infundibulate kind. In one series termed (I.) Perimelitæ, the nectarial cells are aggregated in a single or two patches; in the other series (II.) Mesomelitæ, the distinguishing characters are a zone of secreting cells encircling the ovary, or absence of such, with presence of a honey-secreting surface which may exist in the central parts of the flower. He assumes, on morphological grounds, a hypothetical ancestral flower or Ur-Gentian = Haplanthe. As a starting-point, this would lead, on the one hand, to the series of Perimelitæ, with four subsidiary types; and on the other to the Mesomelitæ, also with four subsidiary types of floral structure. The Perimelitæ comprise the groups:—1. Actinanthe, 2. Keratanthe, 3. Lophanthe, and 4. Stephananthe; the Mesomelitæ comprise:—1. Asteranthe, 2. Limnanthe, 3. Lissanthe, and 4. Ptychanthe. The one series appears to bear a certain progressive relation in its evolution to the leading morphological modifications of the opposite series. In treating of the geographical distribution of the gentians, Prof. Huxley adopts the lines previously followed by him on animal distribution. Under (I.) Arctogea he includes Europe, Africa, Asia, and North America as far as Mexico; South Africa, Madagascar, Hindostan, and Indo-China forming a sub-province = South Arctogea; the remainder = North Arctogea. (II.) Austro-Columbia comprises South America, isthmus and islands as far north as Mexico. (III.) Australia is another province; and (IV.) New Zealand with adjoining islands. Species of the Gentianeæ are found in all these provinces, the head-quarters being North Arctogea and Austro-Columbia. The Ptychanthe are predominant in North Arctogea; the Lissanthe in South Arctogea; and Actinanthe, Lophanthe, and Lissanthe in Austro-Columbia. In Australia and New Zealand there is a paucity of species. He considers that the present distribution of the Gentianeæ is not to be accounted for by migration from any given centre, whence diffusion to their present localities. Borrowing analogy from zoological distribution, he likens the gentians to the tapirs, at present only represented in South America and the Indo-Malayan region. Yet the Tapiridæ in the Middle Tertiary epoch were distributed everywhere in the intermediate areas. Though fossil remains of gentians are not yet known, Prof. Huxley nevertheless suggests that in Pliocene and Miocene times their distribution may have been substantially similar to what is now extant. He further throws out the hint that, could the age of the first appearance of dipterous, hymenopterous, and lepidopterous insects provided with long haustra be indicated, we should then be in a position to guess approximately when specialisation of the types of the gentians and their ultimate distribution occurred.

Geological Society, April 6.—Prof. J. W. Judd, F.R.S., President, in the chair.—The following communications were read:—On the rocks of the Malvern Hills, part 2, by Mr. Frank Rutley. The details of the microscopic examination of the rocks constituted the principal part of the present paper. The author concluded that the rocks of the Malvern Hills represent part of an old district consisting of plutonic and, possibly, of volcanic rocks associated with tuffs, sedimentary rocks composed mainly or wholly of eruptive materials, and grits and sandstones; that the structural planes in these rocks (sometimes certainly, at others possibly) indicate planes of stratification, and that the foliation, in many cases if not in all, denotes lamination due to deposition either in water or on land surfaces, probably more or less accentuated or altered by the movements which produced the upheavals, subsidences, and flexures prevalent in the range.—On the alleged conversion of crystalline schists into igneous rocks in County Galway, by Dr. C. Callaway.—A preliminary inquiry into the genesis of the crystalline schists of the Malvern Hills, by Dr. C. Callaway. The author's researches amongst the crystalline rocks of Connaught had suggested certain lines of investigation which had subsequently been followed out in the Malvern district. He had satisfied himself that many of the Malvern schists had been formed out of igneous rocks; but at present he limited himself to certain varieties. The materials from which these schists were produced were diorite (several varieties), granite, and felsite. The metamorphism had been brought about by lateral pressure. Evidence of this was seen in the intense contortion of granite-veins and in the effects of crushing as observed under the microscope. The products of the metamorphism were divided into two groups:—(1) Simple schists, or those formed from one kind of rock. (2) Injection schists, formed by the intrusion of veins, which had acquired parallelism by pressure. Veins of diorite in diorite produced *duplex diorite-gneiss*, and veins of granite in diorite originated *granite diorite-gneiss*. It was further noted that (1) generally the particular varieties of schist occurred in the vicinity of the igneous masses to which they were most nearly related in mineral composition; (2) the mineral banding of the rocks in the field was more like vein-structure than stratification. The author accepted the received view of the age of the schists. The parallel structure was clearly antecedent to the Cambrian epoch, and the occurrence of similar rocks as fragments in the Uriconian conglomerate of Shropshire seemed to indicate that the Malvernian schists were older Archæan. The reading of this paper was followed by a discussion in which the President, Mr. Teall, Dr. Hicks, Colonel McMahon, Dr. Callaway, and Mr. Rutley took part.

Entomological Society, April 6.—Dr. David Sharp, President, in the chair.—Mr. Francis Galton, F.R.S., Mr. J. H. Leech, B.A., F.L.S., and Mr. G. S. Parkinson, were elected Fellows.—Mr. S. Stevens exhibited specimens of *Arctia mendica*, collected in the county of Cork. The peculiarity of the Cork form of the species is that the majority of the males are as white as the female of the English form, and the typical black or English form appears to be unknown in Cork.—Mr. McLachlan exhibited a zinc box used by anglers for the purpose of keeping living flies in, which he thought might be adapted to practical use in the field by entomologists.—Mr. G. T. Porritt exhibited specimens of *Hybernia progemmaria*, from Huddersfield. All the females and a large proportion of the males were of the dark variety *fuscata*, which formerly was almost unknown in Yorkshire, but which now seemed likely to replace the original type. Mr. Jenner-Weir and Lord Walsingham both remarked that the number of melanic forms appeared to be on the increase in the north, and suggested explanations of the probable causes of such increase.—Mr. Gervase F. Mathew, R.N., exhibited several new species of Rhopalocera taken by him in the Solomon Islands during the visits to those islands of H.M.S. *Espiègle* in 1882 and 1883. Amongst them were species of *Euploea*, *Myealesis*, *Messarus*, *Rhinopalpa*, *Cyrestis*, *Diadema*, *Parthenos*, *Pieris*, *Papilio*, &c.—Mr. E. B. Poulton exhibited a large and hairy lepidopterous larva brought from Celebes by Dr. Hickson, and made remarks on the urticating properties of the hairs of the species, which were said by the natives to produce symptoms similar to those of erysipelas if the larva was handled. Lord Walsingham, Mr. McLachlan, Dr. F. A. Dixey, Mr. Jenner-Weir, Dr. Sharp, Mr. Slater, and Mr. Poulton, took part in a discussion as to whether urtication was due to the mechanical action of the hairs in the skin, or to the presence of formic acid, or some other irritant poison, in glands at the base of the hairs. There appeared to be no doubt that in some species the irritation caused by handling them was merely due to the mechanical action of the hairs.—Mr. P. Crowley exhibited a collection of Lepidoptera recently received from West Africa, including several new or undescribed species of *Mylothris*, *Diadema*, *Harma*, *Rhomalea*-

soma, &c.—Mr. H. Goss announced the capture by Mr. G. D. Tait, at Oporto, of a specimen of *Anaxia flexippus*, and remarked that, although some twenty specimens had been caught in the South of England, only two specimens had been previously recorded from the continent of Europe.—Lord Walsingham read a paper entitled "A Revision of the Genera *Acrolophus* (Poey) and *Anaphora* (Clem.)"; and exhibited about twenty new species of these and allied genera. Mr. Stainton made some remarks on the genera, and said he was glad Lord Walsingham was working at them and their allies.—Mr. Poulton read "Notes in 1886 on Lepidopterous Larvæ." In the discussion which ensued, Lord Walsingham referred at some length to instances of protective resemblance in larvæ, and alluded to the existence in certain species, especially of the genus *Melitæa*, of prothoracic glands.—Dr. F. A. Dixey remarked on the extraordinary powers of contraction which appeared to be possessed by the retractor muscle of the flagellum in *D. vinula*, and inquired whether any corresponding peculiarities of minute structure had been observed in it. The discussion was continued by Mr. G. F. Mathew, Mr. W. White, Dr. Sharp, Mr. Porritt, and others.

PARIS

Academy of Sciences, April 18.—M. Janssen, President, in the chair.—On an absolute unity of time; electric standards of time and chronoscopes of their variations, by M. Lippmann. It is shown that from the study of certain electric phenomena an absolute invariable unity of time may be obtained. The electric apparatus here described yields more accurate results than the best constructed astronomical clock. It has the further advantage of indicating, recording, and, where needed, automatically correcting, its variations of velocity.—Solar observations made at Rome during the first quarter of the year 1887, by M. Tacchini. The period of minimum activity for the spots and faculæ, as recorded in November 1886, has continued throughout the first three months of 1887. The protuberances also continued to decline during the same period.—On antipyrine, an antidote against pain, by M. Germain Sée. Antipyrine, with the formula $C_{11}A_{12}N_2O$, discovered by Knorr in 1884, is shown to be not only a good febrifuge, but also a most efficacious remedy for gout, rheumatism, and similar affections.—On the earthquake of February 23, by M. J. L. Soret. Certain derangements of the telephonic apparatus in the central office at Cannes seem to show that the violent shock which occurred at 5.50 a.m. was accompanied by strong electric discharges.—On a special circumstance connected with the production of the bicarbonate of soda, by M. Paul de Mondésir. An experiment here described shows that the carbonate of soda, combined with a single equivalent of water, scarcely absorbs carbonic acid at the ordinary temperature at all. But when it is mixed with a slight portion of dry bicarbonate the reaction on the contrary begins at once, and with an energy in direct proportion to the quantity of the bicarbonate and the thoroughness of the mixture.—Method of determining the relative value of the four unities of chemical action of the atom of carbon, by M. Louis Henry. At the base of the doctrines of organic chemistry as now understood lie the two principles of the quadrivalence of the atom of carbon, and the identity in value of its four unities of chemical action. The former is an accepted fact proved by experiment, while the latter is far from possessing the same degree of objective certainty. The author here proposes a method by means of which its truth may be rigorously determined.—Artificial reproduction of rose-red spinel (balas ruby), by M. Stanislas Meunier. The author, who has been for several years incidentally occupied with the synthesis of spinel, has lately again attacked the problem in a way quite different from his first method. He now crystallises the aluminate of magnesia, tinted a rose colour by traces of chromium, the result being a stone absolutely identical with the balas ruby of nature. The experiment here described has already been varied in several ways, yielding a series of products, such as the aluminates of zinc, iron, &c., besides secondary compounds, whose study is still in progress.—On the functions of the semicircular ducts, by M. J. Steiner. From experiments made on Crustaceans at the Zoological Station at Naples, the author shows that these organs exercise little or no influence on the locomotion of the lower animals, as supposed by Delage, Viguer, and others.—On a station of the Stone Age discovered at Chaville, by M. E. Emile Rivière. This station of Chaville lies on the skirt of the wood of like name on the right side of the road between Paris and Versailles. Here the author has just discovered a large number of flint implements of the Neolithic epoch, scrapers, knives, arrow-heads, and the like. All lay on or near the surface, and were of a more or less deep gray colour, some showing clear traces of the action of fire. They closely resemble the objects found by the author at the Neolithic station of Trou-au-Loup, Clamart, in 1884-85. Amongst them was a small fragment of black, siliceous pottery without any ornamentation, and also perfectly analogous to the pottery of the Neolithic beds in the same neighbourhood.—The members of the International Conference on Celestial Photography were present at the sitting, and were welcomed by the President in an appropriate address dwelling especially on the importance for astronomy of the photographic labours of MM. Henry, of Paris.

BOOKS, PAMPHLETS, and SERIALS RECEIVED

Hyderabad, Kashmir, Sikkim, and Nepal: Sir R. Temple and Capt. R. C. Temple (Allen).—Geology of England and Wales, 2nd edition: H. Woodward (Philip).—An Elementary Treatise on the Mathematical Theory of Perfectly Elastic Solids: W. J. Ibbetson (Macmillan).—Dynamics for Beginners: Rev. J. B. Lock (Macmillan).—Catalogue of Lizards, 2nd edition, vol. iii.: G. A. Boulenger (British Museum).—Mineral Resources of the United States, 1885 (Washington).—Photography of Bacteria: E. M. Crookshank (Lewis).—Chemistry for Beginners: R. L. Taylor (Low).—Woodland Tales: J. Stinde (Unwin).—Geological and Natural History Survey of Minnesota, 13th and 14th Annual Reports: W. H. Winchell (St. Paul).—Longmans' New Geographical Readers, Standard VII. (Longmans).—The Prevention of Consumption: C. Candler (K. Paul).—Pictographs of the North American Indians: G. Mallery (Washington).—Der Bau des Menschen: Dr. R. Wiedersheim (Williams and Norgate).—Thomas Young: Prof. Tyndall.—Oberpliocän-Flora aus den Baugruben des Klärbeckens bei Niederrad und der Schleuse bei Höchst A. M.: Drs. Geyler and Kinkelin (Frankfort).—The Eruption of Krakatão: E. D. Archibald.—City Government of St. Louis: M. S. Snow (Baltimore).—Notes to Accompany a Geological Map of Northern Canada: G. M. Dawson (Montreal).—Etude Numérique des Concours de Compensation de Chronomètres: G. Cellérier (Genève).—Journal of the Royal Statistical Society, March (Stanford).—Zeitschrift für Wissenschaftliche Zoologie, xlv. Band, 2 Heft (Leipzig).—Bulletin de l'Académie Royale des Sciences de Belgique, No. 3 (Bruxelles).

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THURSDAY, MAY 12, 1887.

THE AINOS.

The Language, Mythology, and Geographical Nomenclature of Japan viewed in the Light of Aino Studies. By Basil Hall Chamberlain. Including an Ainu Grammar by John Batchelor, and a Catalogue of Books relating to Yezo and the Ainos. (Memoirs of the Literature College, Imperial University of Japan, No. 1, 1887. Published by the Imperial University, Tokio.)

THE Ainos have long been a puzzle to the philologist and ethnologist. Their place amongst the races of the world, living or extinct, has been, and remains, unsettled; and their relations to the present inhabitants of the Japanese archipelago, though the subject of frequent discussion in recent years in Japan, form an unsolved problem. Like fragments of races still existing in various other lands, the Ainos refuse to fit into any ethnological scheme, and are waifs and strays in science much as they are in the world around them. The main cause of this, no doubt, is that so little has really been known about this curious race. A certain amount of knowledge has been repeated by one writer after another, but that invaluable instrument of investigation, the Aino language, has stood outside the pale of philology. The writer of this very important and interesting monograph does not attempt to answer the questions arising out of the presence of the Ainos in Yezo, the Kuriles, and Southern Saghalien; his object is, "by comparing the language and mythology of the Ainos with the language and mythology of the early Japanese, to ascertain what sort of relationship, if any, exists between the two races, and to shed light on the obscure problem of the nature of the population of the Japanese archipelago during late prehistoric times." His equipment for this interesting task is a profound knowledge of the Japanese language and mythology—"which, in the absence of a thorough practical knowledge of Aino itself, is the first condition of the successful investigation of any subject connected with the Island of Yezo"—and travel and investigation, especially in regard to their myths, amongst the Ainos themselves. He has also associated with him in the work the Rev. John Batchelor, of the Church Missionary Society, who has published in the present monograph a grammar of the Aino language, and whose "five years' intercourse with the Ainos in their own homes, and close study of the language as it falls from the lips of the people, enable him to speak with an authority belonging to no other investigator." The result of this co-operation is the work before us, and perhaps the best method of reviewing it is to explain the method followed by Prof. Chamberlain in his investigation, and the results at which he has arrived.

First, then, he compares the Aino language with the Japanese. The close and intimate resemblance between the two is only superficial, and vanishes as soon as they are carefully compared. "The paradox of two races so strongly contrasted speaking related languages has no foundation in fact." Then follows a list of fifteen salient points of difference between the Japanese and Aino linguistic systems. Some of these, the writer says, may not be appreciated at their true value by scholars accustomed exclusively or chiefly to the study of the Aryan family of languages, whose looser structure allows of such wide divergences between the various members of the family. "But the Altaist, knowing the iron rule which forces all the Tartar tongues into the same grammatical mould, however widely their vocabularies may be separated, will hold the opinion of fundamental want of connexion between Japanese and Aino, until very strong arguments shall have been brought forward on the other side," and he proceeds to point out that on thirteen of the fifteen points of difference there is absolute identity between Japanese and Corean. As for the points of similarity between Japanese and Aino—such as the same construction of the sentence, and nearly the same phonetic system—Prof. Chamberlain suggests the long contact between the two peoples; but the borrowing, if borrowing there be, must have been on the side of the Ainos. On the whole, he is inclined to accept the theory of Von Schrenck, in his work on Amur Land, that Aino is to be regarded as a language altogether isolated at the present day, and "when it is remembered that the Aino race is isolated from all other living races by its hairiness and by the extraordinary flattening of the tibia and humerus, it is not strange to find the language isolated too." He treats with ridicule the suggestion that the Aino may be an Aryan tongue.

Next he comes "to that of which language is the vehicle—to the religion, the traditions, the fairy-tales of the two nations. Do the Ainos account for the origin of all things after the manner of their Japanese neighbours? Do Aino mothers and Japanese mothers lull their little ones to sleep with the same stories?" Japanese mythology is almost all to be found in the *Kojiki*, a work of the early part of the eighth century of our era, a literal translation of which, by Prof. Chamberlain himself, was noticed in NATURE a few years ago. With regard to the Aino myths, as there are no Aino books of any sort, these have to be obtained orally, by a tedious process of listening to successive story-tellers, for the brain of the Aino soon tires. The writer gives the results side by side: on one side the Japanese account of the Creation, of their origin, of the origin of civilisation, of the aborigines, of heaven and hell, the sun and moon; and then the Aino myths on similar subjects. In addition, a large number of stories of both peoples, relating to such subjects as Rip Van Winkle, the Isle of Women, a visit to the underworld, various beast-myths, stories about monsters, the causes of the peculiarities of natural objects, &c., are related—sometimes side by side for purposes of comparison; sometimes only the Aino version is given, the corresponding Japanese tale being readily accessible elsewhere. It will be seen from this bare outline of the contents of this section that a new world of folk-lore is here opened to the study of inquirers into this branch of research. The general conclusion at which Prof. Chamberlain arrives after this comparison of the two mythologies is that there is even less connexion between them than between the two languages. The stories could scarcely be more divergent in general complexion. The Japanese stories "are myths pure and simple, airy phantoms of the imagination," and have no moral tendency whatever. Japanese commentators on their own myths, struck with

the absence of morality in them, account for it by saying that their countrymen needed no moral teaching, because they were perfect already, and not depraved like the Chinese and foreign nations generally. The tales of the Ainos, on the other hand, generally point a moral or account for some natural fact. Birds and beasts are the characters; those of the Japanese are generally men, or gods who are the counterparts of men.

The third line of investigation adopted by Mr. Chamberlain is that of place-names in Yezo and in Japan. His first process was to make a catalogue of the names of the principal places in Yezo, with their Japanese corruptions, and the Chinese characters used by the Japanese in writing them. From this he compiles a kind of key, composed of Aino words contained in the names of places in the previous list, and common Aino designations for features of the landscape, such as are likely to occur in the names of places, their meanings, and the Japanese pronunciation. This he applies to the place-names of Japan proper in order to test whether they are of Aino origin. By this ingenious, elaborate, and toilsome method, Prof. Chamberlain examines numbers of Japanese geographical names in various parts of the country, with an amazing profusion of learning. We can do no more here than give the broad results, which are sufficiently clear and striking. He can say with certainty that names, as to the Aino origin of which there can scarcely be a question, may be traced right through the main island of Japan into the two great southern islands. They are fairly abundant even in the extreme southern province. The inference to be drawn from this is that the Ainos were the true predecessors of the Japanese all over the archipelago. "The dawn of history shows them to us living far to the south and west of their present haunts; and ever since then, century by century, we see them retreating eastwards and northwards, as steadily as the American Indian has retreated westwards under the pressure of the colonists from Europe."

It will be observed that Prof. Chamberlain comes to this conclusion, after a comparison of the languages, mythologies, and place-names of the Japanese and the Ainos; it is likewise the conclusion at which Prof Milne arrived a few years ago along a different line of investigation. The latter gentleman compared the kitchen-middens, stone implements, and other prehistoric remains found in numerous parts of Japan with those of undoubted Aino origin—some of the middens being even now in course of construction in Yezo. Prof. Milne's papers on the subject will be found in the Proceedings of the Anthropological Society for 1881, and of the Asiatic Society of Japan (vol. viii. Part 1, and vol. x. Part 2). Hence it may be taken as established sufficiently for all practical purposes that the pre-Japanese inhabitants of the Japanese islands were the Ainos. Beyond this conclusion we are not taken either by Prof. Milne or by Prof. Chamberlain, and with it we must be content until scholars have carried out that series of linguistic comparisons which is "the surest key for unlocking the mysteries of racial affinity and race migrations in this portion of Asia," of which Prof. Chamberlain's work is the beginning.

The last word is very far indeed from being yet said about the Ainos. Meanwhile their numbers are growing smaller decade by decade, their industries are passing into Japanese hands; the animals which were their principal sustenance are rapidly becoming extinct; the survivors of this people almost all speak Japanese as well as their own tongue, and are losing their special characteristics. Hence they "must without delay be subjected to all the necessary scientific tests: their language must be analysed, their folk-lore registered; for soon there will be nothing left." Prof. Chamberlain does not share the regrets of those who mourn over the *Japonisation* and approaching extinction of the Ainos. They have had abundant opportunities of improvement, but they have not profited by them. "The son of the greatest living Aino chief is glad to black the boots of an American family in Sapporo. This is now their latest investigator concludes his interesting and instructive monograph:—"The Aino race is now no more than a 'curio' to the philologist and to the ethnologist. It has no future, because it has no root in the past. The impression left on the mind after a sojourn among the Ainos is that of a profound melancholy. The existence of this race has been as aimless, as fruitless, as is the perpetual dashing of the breakers on the shore of Horobetsu. It leaves behind it nothing save a few names." The whither of the race is unhappily only too certain; its whence still remains a question to perplex the ethnologist, and, if present indications are to be trusted, it will continue an unsolved problem for many years to come. Prof. Chamberlain's monograph carries us just one step back in the life-history of the race; behind that, all is still darkness and doubt.

THE ZOOLOGICAL RESULTS OF THE "CHALLENGER" EXPEDITION.

Report on the Scientific Results of the Voyage of H.M.S. "Challenger" during the Years 1873-76 *under the Command of Capt. G. S. Nares, R.N., F.R.S., and of the late Capt. F. T. Thomson, R.N.* Prepared under the Superintendence of the late Sir C. Wyville Thomson, F.R.S., &c., and now of John Murray, one of the Naturalists of the Expedition. Zoology—Vol. XVII. (Published by Order of Her Majesty's Government, 1886.)

VOLUME XVII. of the Zoological Reports of the voyage of the *Challenger* contains three memoirs. The first is the second and concluding Part of the Report on the Isopoda collected during the Expedition, by Mr. Frank Evers Beddard, of which the first Part was published in 1884, and dealt exclusively with the family of the Serolidæ. The collection of Isopoda made during the voyage was very rich in new species and genera, more particularly in the deep-water forms, of which no less than thirty-eight are described as new. Among the shallow-water species the greater number of novelties were dredged off Kerguelen and the adjacent islands, adding no less than fifteen new species to the previously short list known. In other parts of the world, with the exception of Australia, dredging in shallow water did not yield any considerable number of species of the group. Many of the species described as new were previously briefly diagnosed by the author, in the Proceedings of the Zoological Society of London. Passing from the description of the species of this exceedingly interesting group of Crustacea

to the summary of their distribution, we find that, while the 300-fathoms line marks approximately the boundary between what may be called the deep-sea and the shallow-water species, yet there is no trace of any zone of depth that has not its Isopod fauna. From 345 fathoms down to 2740 fathoms, species were dredged continuously; there was nowhere a break of more than 100 fathoms. In passing from the lesser to the greater depths, there is evidently a decreasing number of species that are common to these depths and to shallow water; but it is impossible to draw an absolute line of division which would separate an abyssal from a shallow-water fauna. Of the seven species found at a depth of 2000 fathoms and upwards, two range into lesser depths, another (perhaps two) into shallow water, leaving only three distinctly abyssal forms.

One of the most important results of these investigations has been to show that ocean regions cannot be marked out with anything like the same definiteness as can the terrestrial areas. Among the Isopods the same genus, and even the same species, is often to be found in the most widely separated areas: thus, *Eurycope fragilis*, found in the North Pacific, near Japan, ranges as far south as lat. 60° S., close to the Antarctic ice-barrier and to the neighbourhood of the Crozets. It would also seem that the deep-sea Isopods are distributed very unevenly over the floor of the ocean. In long stretches of ocean—occurring, for instance, along the whole of the Central and Southern Atlantic, and the Central and Western Pacific—no species were found; but in drawing conclusions from such negative evidence, the imperfection of the record must be borne in mind. Among the Isopods thirty-four of the deep-sea species were found to be totally blind, and three others, unfortunately only represented by fragments, may in all probability be added to the list. In four more the eyes were evidently degenerate. On the other hand, in eighteen species, there were well-developed eyes. It must not be forgotten that certain shallow-water species are blind. Possibly, the author thinks, the explanation of these anomalies is to be sought for in the length of time that has elapsed since the migration of the different species into the abyssal regions of the ocean. This excellent Report is illustrated by twenty-five plates.

The second memoir in this volume is a Report on the Brachyura, by Mr. Edward J. Miers. We learn from the very modest preface to this really important contribution to the natural history of the brachyurous Crustacea that the groups richest in new genera and species were the Oxyrhyncha (Maioidea) and the Oxystomata (Leucosioidea), and to these belong most of the new forms collected at depths exceeding 100 fathoms. No brachyurous crab was found at a depth exceeding 2000 fathoms and but very few at depths exceeding 500 fathoms. The localities furnishing the greatest proportion of new or interesting forms were the stations at, among; or near the islands of the Malaysian archipelago, and at the Fijis. An atlas of twenty-nine plates accompanies the Report.

The third Report is by the late Mr. George Busk, F.R.S., and is on the Polyzoa, being Part 2, treating of the Cyclostomata, the Ctenostomata, and the Pedicellinea. With this memoir we propose to deal in a separate article.

THE ELEMENTS OF ECONOMICS.

The Elements of Economics. By Henry Dunning Macleod, M.A. Two Vols. (London: Longmans, 1886.)

WE should have been disposed to speak more kindly of this work upon a much troubled subject—a subject, nevertheless, affecting the happiness of the whole of human society—if we had not read in the letter of dedication that the author claimed to offer to his Right Reverend patron "a new inductive science; a new body of phenomena brought under the dominion of mathematics; a new order of variable quantities brought under the theory of variable quantities in general: the great science of analytical economics." Since recently it was an accepted theory among its students that at present there is no "science" of political economy, we were prepared to find a new revolution-working theory of the whole subject, and were surprised to find that the title sufficiently expressed the general contents of the book. The writer goes to the very elements of the science, building up from the beginning in the clearest of language, and illustrating by means of the derivation of words and of many legal phrases and customs, both ancient and modern, English and foreign, "the great science of economics." Mr. Macleod fiercely assails the opinions of Ricardo and other writers, but much of the error he attacks is only apparent. In economic language, there is no such thing, perhaps, as intrinsic value; nor does cost in all cases fix value, as every proprietor of superseded machinery, or of goods gone out of fashion, knows too well; yet it is misleading to teach that the fixing of value by cost may not be accepted as a fair working rule. In the ordinary state of any trade, 95 per cent., say, of the price will be fixed by the cost, and 5 per cent. by the state of the market; and if some such proportions as these are exceeded, increased or decreased production will soon restore them.

Mr. Macleod urges the claims of perpetual copyright, but we cannot see his distinction between property in that and in a patent. If patents are inconvenient for those whom they restrain, copyright is also inconvenient to men wanting cheap literature. An excellent argument to show how much (market) "value" arises from demand is drawn from this commodity: "Writers of the most learned works do not earn the wages of a day-labourer, whereas the writers of trashy and ephemeral novels may earn a fortune."

The practical remarks upon supply and demand and the folly of subsidising a trade so as to increase the supply where it is already too great for the demand (Vol. II. p. 213), and those upon the errors of the Socialists (p. 215), are good; and the old balance-of-trade error is fully exposed. But we do not see the mistake in the quotation from Mill (p. 76): a banker's credit would be small if he had not capital; and surely it is worse than a paradox to say that the policies of an Insurance Company are its capital; as well might the name be given to the money owing for raw material by a manufacturer!

In an attack upon writers of well-known ability, such as we have here, a critic should be careful of his own expressions. On p. 181, Vol. I., in lines 8 and 9 from the bottom, there is a reversal of the important words "debtor" and "creditor," which, though corrected in the next paragraph, adds to the puzzledom of

the whole passage. Again, on p. 200, even after carefully considering the meaning of "purchaser," "consumer," the author arrives at the conclusion that "the consumer is simply the purchaser or customer," whereas the consumer is the purchaser who does not intend to sell again. If an architect builds a palace (to take Mr. Macleod's first example) to carry out some grand idea of his own which he feels sure will attract him a royal customer for it, but lack of funds compels him to sell it unfinished to a commercial company who have a similar faith in his design, they are not consumers, because they intend to sell it again. But if a monarch retired from business buys it of them for his residence, he is the consumer, because, although the palace may stand for centuries, he does not intend to sell it again. To take a much more familiar case, going on under our own eyes: a builder erects a row of villas as a speculation of his own; as long as he has them on his hands they are stock in the market, but as one purchaser is found who elects to inhabit one, and another to inhabit another, those houses are, as far as economics is concerned, "consumed," and the builder is encouraged to produce more.

Far more careful printing is required in such a book. On p. 309, Vol. II., line 1 is quite unintelligible through the misplacing of two commas. On p. 156, no doubt the "division of labour" should be the "division of employment" with combination of labour. For the sake of clearness (we suppose) qualifications have been sacrificed in many places, with, we feel sure, mischievous effect to any student inquiring into the "elements" of so intricate a science.

OUR BOOK SHELF.

Outlines of Lectures on Physiology. By T. Wesley Mills. (Montreal: Drysdale and Co., 1886.)

THIS little work of scarcely 200 pages gives at a glance very precise information as to the kind of instruction provided in the Physiological Department of the McGill University.

The teaching appears to be both scientific and practical in its character, and of a standard certainly equal to that of the teaching in many of our English schools. Prof. Mills most properly insists on the importance of comparative physiology and biology, the only keys to many of the most complicated problems in human physiology itself. It is, however, unfortunate that he is obliged to incorporate so much elementary biology in his lectures, suggesting, as it does, that this important subject is, in Canada as well as in England, often relegated to the teachers of physiology, who should be in a position to begin with students already acquainted with the fundamental facts of this science. Pathology, or the application of physiology to disease, is hardly touched upon in this book. It is a most unfortunate omission, unless both pathology and therapeutics are taught in other departments of the University far more systematically than with us. From the fact that it is so sketchy it is difficult to understand how Dr. Mills' work can be of any value to the general reader who is not at the same time interested in the progress of medical education, or to the ordinary student of physiology. Under "Saliva" (page 86), which may be taken as an example, we find the following headings without any explanatory text. "Mixed saliva found in the mouth. Secretion of *serous* and mucous glands compared. Morphological elements of saliva. Chemical constitution," &c. The work professes, however, to be only an outline, and such it is.

Chemistry for Beginners. By R. L. Taylor. (London: Sampson Low and Co., 1887.)

THIS little book is valuable as being the outcome of practical experience in the teaching of the first principles of chemistry, and, from its small size and simple statement, is likely to be much used in the sphere for which it is intended. It appears eminently suited for the use of pupils in our higher grade Board schools, where the author has gained most of his experience, and may with advantage be used as an elementary class-book, especially as it contains a graduated series of original problems. We are glad to notice the introduction of an undoubtedly beneficial method of representing chemical reactions, which, especially in more complex cases, expresses what really happens in a very clear light. An example extracted from Mr. Taylor's book is as follows:—

$$\begin{array}{r|l} K & NO_3 \\ SO_4H & H. \end{array}$$

Of course, the equation written in the ordinary form is given, as is proper, side by side with the above.

Although it is unfortunate that the illustrations are of so primitive a character, the book is very readable and likely to interest beginners, and the author may be congratulated upon the absence of all appearance of cram, which has such a paralyzing influence upon the thinking powers of those from amongst whom our future chemists are to be derived. A. E. T.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Thought without Words.

THE recent work of Prof. Max Müller contains theories on the descent of man which are entirely based on the assertion that not even the most rudimentary processes of true thought can be carried on without words. From this he argues that as man is the only truly speaking animal the constitution of his mind is separated from that of brutes by a wide gulf, which no process of evolution that advanced by small steps could possibly stride over. Now, if a single instance can be substantiated of a man thinking without words, all this anthropological theory, which includes the more ambitious part of his work, will necessarily collapse.

I maintain that such instances exist, and the first that I shall mention, and which I will describe at length, is my own. Let me say that I am accustomed to introspection, and have practised it seriously, and that what I state now is not random talk but the result of frequent observation. It happens that I take pleasure in mechanical contrivances; the simpler of these are thought out by me absolutely without the use of any mental words. Suppose something does not fit; I examine it, go to my tools, pick out the right ones, and set to work and repair the defect, often without a single word crossing my mind. I can easily go through such a process in imagination, and inhibit any mental word from presenting itself. It is well known at billiards that some persons play much more "with their heads" than others. I am but an indifferent player; still, when I do play, I think out the best stroke as well as I can, but not in words. I hold the cue with nascent and anticipatory gesture, and follow the probable course of the ball from cushion to cushion with my eye before I make the stroke, but I say nothing whatever to myself. At chess, which I also play indifferently, I usually caculate my moves, but not more than one or two stages ahead, by eye alone.

Formerly I practiced fencing, in which, as in billiards, the "head" counts for much. Though I do not fence now, I can mentally place myself in a fencing position, and then I am intent and mentally mute. I do not see how I could have used mental

words, because they take me as long to form as it does to speak or to hear them, and much longer than it takes to read them by eye (which I never do in imagination). There is no time in fencing for such a process. Again, I have many recollections of scrambles in wild places, one of which is still vivid, of crossing a broad torrent from stone to stone, over some of which the angry-looking water was washing. I was intellectually wearied when I got to the other side, from the constant care and intentness with which it had been necessary to exercise the judgment. During the crossing, I am sure, for similar reasons to those already given, that I was mentally mute. It may be objected that no true thought is exercised in the act of picking one's way, as a goat could do that, and much better than a man. I grant this as regards the goat, but deny the inference, because picking the way under difficult conditions does, I am convinced, greatly strain the attention and judgment. In simple algebra, I never use mental words. Latterly, for example, I had some common arithmetic series to sum, and worked them out, not by the use of the formula, but by the process through which the formula is calculated, and that without the necessity of any mental word. Let us suppose the question was, how many strokes were struck by a clock in twelve hours (not counting the half-hours), then I should have written 1, 2 . . . ; and below it, 12, 11, . . . ; then 2 . . . . 13×12, then $13 \times 6 = 78$. Addition, as De Morgan somewhere insisted, is far more swiftly done by the eye alone: the tendency to use mental words should be withstood. In simple geometry I always work with actual or mental lines; in fact, I fail to arrive at the full conviction that a problem is fairly taken in by me, unless I have contrived somehow to disembarrass it of words.

Prof. Max Müller says that no one can think of a dog without mentally using the word dog, or its equivalent in some other language, and he offers this as a crucial test of the truth of his theory. It utterly fails with me. On thinking of a dog, the name at once disappears, and I find myself mentally in that same expectant attitude in which I should be if I were told that a dog was in an obscure part of the room or just coming round the corner. I have no clear visual image of a dog, but the sense of an ill-defined spot that might shape itself into any specified form of dog, and that might jump, fawn, snarl, bark, or do anything else that a dog might do, but nothing else. I address myself in preparation for any act of the sort, just as when standing before an antagonist in fencing I am ready to meet any thrust or feint, but exclude from my anticipation every movement that falls without the province of fair fencing.

He gives another test of a more advanced mental process, namely, that of thinking of the phrase "cogito ergo sum" without words. I addressed myself to the task at a time when I was not in a mood for introspection, and was bungling over it when I insensibly lapsed into thinking, not for the first time, whether the statement was true. After a little, I surprised myself hard at thought in my usual way—that is, without a word passing through my mind. I was alternately placing myself mentally in the attitude of thinking, and then in that of being, and of watching how much was common to the two processes.

It is a serious drawback to me in writing, and still more in explaining myself, that I do not so easily think in words as otherwise. It often happens that after being hard at work, and having arrived at results that are perfectly clear and satisfactory to myself, when I try to express them in language I feel that I must begin by putting myself upon quite another intellectual plane. I have to translate my thoughts into a language that does not run very evenly with them. I therefore waste a vast deal of time in seeking for appropriate words and phrases, and am conscious, when required to speak on a sudden, of being often very obscure through mere verbal maladroitness, and not through want of clearness of perception. This is one of the small annoyances of my life. I may add that often while engaged in thinking out something I catch an accompaniment of nonsense words, just as the notes of a song might accompany thought. Also, that *after* I have made a mental step, the appropriate word frequently follows as an echo; as a rule, it does not accompany it.

Lastly, I frequently employ nonsense words as temporary symbols, as the logical x and y of ordinary thought, which is a practice that, as may well be conceived, does not conduce to clearness of exposition. So much for my own experiences, which I hold to be fatal to that claim of an invariable dependence between thoughts and words which Prof. Max Müller postulates as the ground of his anthropological theories.

As regards the habits of others, at the time when I was inquiring into the statistics of mental imagery, I obtained some answers to the following effect: "I depend so much upon mental pictures that I think if I were to lose the power of seeing them I should not be able to think at all." There is an admirable little book published last year or the year before by Binet, "Sur le Raisonnement," which is clear and solid, and deserves careful reading two or three times over. It contains pathological cases in which the very contingency of losing the power of seeing mental pictures just alluded to has taken place. The book shows the important part played by visual and motile as well as audile imaginations in the act of reasoning. This and much recent literature on the subject seems wholly unknown to Prof. Max Müller, who has fallen into the common error of writers not long since, but which I hoped had now become obsolete, of believing that the minds of everyone else are like one's own. His aptitudes and linguistic pursuits are likely to render him peculiarly dependent on words, and the other literary philosophers whom he quotes in partial confirmation of his extreme views are likely for the same cause, but in a less degree, to have been similarly dependent. Before a just knowledge can be attained concerning any faculty of the human race we must inquire into its distribution among all sorts and conditions of men, and on a large scale, and not among those persons alone who belong to a highly specialized literary class.

I have inquired myself so far as opportunities admitted, and arrived at a result that contradicts the fundamental proposition in the book before us, having ascertained, to my own satisfaction at least, that in a relatively small number of persons true thought is habitually carried on without the use of mental or spoken words.

FRANCIS GALTON.

Tabasheer mentioned in Older Botanical Works.

IN recent issues of NATURE (pp. 396 and 488) Mr. Thiselton Dyer and Mr. Judd have made two interesting contributions to the knowledge of "tabasheer," and Mr. Tokutaro Ito, and others, have supplied remarkable additional notes (pp. 462, 437, &c.). But no one has told us what is to be found about so interesting a substance in the older botanical works. In numerous botanical works of the præ-Linnean period, "tabaxir," as it was called by all authors of that time, is mentioned, and some of them give us very good information about it.

The first who wrote on tabasheer seems to have been Al-Hussain Abu-Ali Ebn Sina, or Avicenna, as he is generally called by Eastern literary men, a celebrated physician and minister of the Persian Empire, who lived from 980 till 1037, and whose works, written in Arabic, obtained as early as the twelfth century a very great reputation. Avicenna introduced the Persian word tabaxir, طبهاشير, into the Arabian language; it signifies "condensed milk-sap," or as Ray (Raius) translates it (1688) in his "Historia Plantarum," *lac lapidescens*. Avicenna was not well instructed about the origin of tabasheer, for in lib. ii. cap. 609, he says that it is got "ex radicibus arundinum crematis," and by these words he created an erroneous opinion, which lasted several centuries. For Gerardus of Cremona, who in the twelfth century translated the work of Avicenna into Latin, was induced by this suggestion to identify the Indian tabasheer with the *σποδός* of the Greeks or the Arabian "tutia," because this remedy was also got by burning the roots of a certain plant, which was probably a Lawsonia.[1]

This error was corrected by Garcia de Orta, the physician of a viceroy of India, who wrote a book "De Plantis et Aromatibus," in Portuguese, which was translated into Latin by De l'Ecluse (Clu-ius) in his "Exoticarum Libri Decem," and whose information is the best I have found in writers of that time. He says:—"Vocatur autem ab indigenis 'Sacar Mambu,' quasi dicas Saccharum de Mambu, quoniam Indi arundines, sive ramos arboris illud proferentes Mambu vocant. Attamen nunc etiam *Tabaxir* vocare coeperunt, quoniam eo nomine petitur ab Arabibus, Persis, et Turcis, qui id mercimonii causa ex India in suas regiones exportant. Magno emitur hoc medicamentum pro proventus eius ratione. *Eius tamen commune pretium in Arabia est, ut pari argenti pondere ematur.* Arbor in qua gignitur interdum magna est et instar Populi procera: Inter singula internodia liquor quidam dulcis generatur, crassus veluti

[1] Afterwards, the signification of the word "spodium," or "spodos," must have totally changed, for Matthiolius and others make it a mixture of metals, probably containing zinc.

amylum congestum et simili candore, interdum multus, nonnunquam vero perpaucus. Sed non omnes arundines sive rami eum humorem continent, at ii dumtaxat quos Bisnager, Batecala et pars Provinciae Malavar profert. Hic autem liquor concretus interdum nigricans et cinereus invenitur, sed non ideo improbatur. Nam aut ob nimiam humiditatem, aut quod diutius ligno inclusus permanserit, hunc sibi colorem conciliat: non autem ob arborum incendium, veluti nonnulli putarunt. Siquidem in multis ramis, quos non contigit ignis, niger etiam invenitur."

Garcia also gives information as to the medical virtues of tabasheer, which were esteemed to be very important at that time: "Ceterum ex Medicorum tum Indorum, tum Arabum, Persarum, et Turcorum testimonio Tabaxir internis et externis convenit ardoribus, tum etiam biliosis febribus et dysenteriis: praesertim autem in biliosis fluxionibus utuntur; nostri vero trochiscos ex eo conficiant addito semine Oxalidis."

Almost all prae-Linnean writers who mentioned tabasheer for the most part only reproduced what they found in Garcia's book. Joh. Bauhinus even identifies the name of tabasheer with the plant itself, which he calls in his "Historia Plantarum," i. 2, p. 222, "Tabaxir sive Mambu arbor, Tabaxir folio oleae." Rumphius in his "Herbarium Amboinense," of the year 1763, relates that he had never found any trace of tabasheer in the bamboos growing in the Molucca Islands, except on one occasion:—"Juniores arundines plerumque in inferioribus suis nodis semi-repletae utcunque sunt lympida aqua potabili, quae hisce in terris sensim evanescit, in aliis vero regionibus exsiccatur in substantiam albam et calceam, quae Tabaxir vocatur. Illud tantum addere debeo, mihi in Hituae ora moranti semel adductum fuisse per pueros meos substantiam albam, siccamque instar farinae amyli, quae in illa ora ab illis fuerat detecta, quantum recordor, in Bulu seru (*Beesha humilis*, Kunth, *Bambusa Fax*, Poir.) fistulis, dura autem erat, sicca, ac penitus insipida omnibusque Aethiopibus, quibus ostendebam, ignota, ipsiusque albido sensim in cinereum degenerabat colorem."

Further information on tabasheer is given by Piso, a well-instructed Dutch physician, in the year 1658, but I am inclined to think that he is wrong in identifying "Achar," a sweet dish celebrated in India as well as in Europe at that time, with the tabaxir of the Eastern peoples. But let us hear what he says:—"Novissimi autem stolones, qui maxime succulenti sunt et saprosi magni fiunt in Indiis, apud Advenas aeque ac Indigenas, quod bases sunt celebris istius compositionis 'Achar' dictae, quae in Europam invecta in deliciis habetur palutum doctis, et a me quoque non semel cum voluptate gustata est. At vero ubi hae Arundines procerae et annosae factae fuerint, liquores contenti substantia, color, sapor, et efficacia mutantur, atque paullatim protruditur foras et iuxta internodium vi Solis coagulatur ac instar pumicis albi indurescit, mox nativae suavitatis expers facta, peculiarem saporem cum parva adstrictione, eboris usti aemulum acquirit, vocaturque apud indigenas 'Sacar Mambu'—Tabaxir Garciae et Acostae—qui quo levior, albicantior ac glabrior eo praestantior: quo magis inaequalis atque cinerei coloris evadit, deterior habetur."

Though it is very probable that under certain circumstances almost all species of the genus Bambusa and its allies are able to produce tabasheer, but few are specially mentioned as capable of producing this interesting substance. All the species that I have found noted in the literature of earlier and modern times are the following: (1) *Bambusa arundinacea*, Retz, or the common bamboo; (2) *Bambusa spinosa*, Roxb., which is called by Burmann, 1737, in his "Thesaurus Zeylanicus," "Arundo indica arborea maxima cortice spinosa Tabaxir fundens"; (3) *Beesha humilis*, Kunth, which is Rumph's bamboo mentioned above; (4) *Beesha Rheedii*, Kunth, and (5) *Guadua angustifolia*, Kunth, the species from which Humboldt's specimen of tabasheer was taken.

ERNST HUTH.

Frankfurt, Oder, April 17.

A Brilliant Meteor.

I SAW here this evening a splendid meteor; time, by London and North-Western Railway, 8.19. Its apparent point of origin was nearly south, and altitude 45° from the zenith; its path from east to west; finishing about west-south-west, some 30° from the horizon; duration at least four seconds. It increased in brilliancy until near extinction, when it quickly faded in a dull red glow, like that of the residuum from the fire-ball of a rocket. The head, of an apparent brilliancy three times that of a star of the first magnitude, had precisely the appearance of the incandescent spot of the oxy-hydrogen light, and the tail, very long, exhibited a red glow. Some neighbouring trees and the chimney of a house enabled me with a pocket compass to get the altitude and bearings approximately.

ARTHUR NICOLS.

Watford, May 8.

THE following particulars relating to a very fine meteor may be of service in fixing its course if it was seen elsewhere:—

(1) Position of observation: the open space in front of St. Anne's, Soho.

(2) Size: three or four times > Venus.

(3) Colour: decidedly green.

(4) Path: it was first seen somewhere near γ Geminorum, and in two or three seconds disappeared slowly behind the houses in the direction of Aldebaran.

(5) Time of disappearance: 20h. 22m. 19s. May 8.

The time can be relied upon, as my watch was compared on Saturday and again this morning with G.M.T.

Saturn was just visible, and Venus, therefore, must have been very bright, yet she seemed quite dull and yellow by the side of the splendid fireball.

MAURES HORNER.

28 Upper Montagu Street, W., May 9.

P.S.—γ Geminorum was of course invisible, and Aldebaran behind the houses.

ON Sunday, the 8th inst., at 8.23 p.m., a very brilliant meteor was seen here by a party of four persons, of whom I was one. When I first saw it, it was almost in the zenith, and appeared considerably larger and more luminous than Venus (which had been visible for some time), though of much the same colour. It crossed the sky in a north-westerly direction, and became invisible about 17° above the horizon. As it travelled, a brilliant trail of red light appeared behind it, which increased in length and brightness as it descended, being fully three times longer than the head, when it attained its greatest length.

The meteor was one of striking brilliance, and must have been specially so, as the sky which it crossed was still bright with the yellow glow of sunset.

ISABEL FRY.

5 The Grove, Highgate, May 10.

Residual Affinity.

I WAS greatly interested in Prof. Armstrong's recent articles on "Residual Affinity," as it is a subject I brought before the Royal Society of Edinburgh fully nine years ago, as one of the main causes of solution, molecular compounds, &c. I was, however, somewhat disappointed with the conclusions he came to, and was tempted to exclaim in Scriptural language, "Ye did run well; what did hinder you that you are again entangled in the yoke of *bond*age?" Prof. Armstrong comes to the conclusion that HCl and NH_3 combine owing to the residual affinity of Cl for N. Now how can this be? If we regard it from a thermal point of view, we find that, in the combination of HCl with NH_3, 41,900 units of heat are given out, while the combinations H with Cl and N with H_3 give out 22,000 and 11,890 units respectively; that is, the residual affinity of N for Cl, as measured by heat, exceeds by about one-third the sum of the affinities of H for Cl and H_3 for N; and yet, under ordinary circumstances, Cl has very little affinity for N. Is it not more rational to conclude that the residual affinity is not confined to the negative elements, but extends to both, and that the combination of HCl and NH_3 is due mainly to the residual affinity of Cl and N for H? It is easy to understand that this residual affinity is so lowered in intensity that neither Cl nor N can retain unassisted more than one and three atoms; but when the energy of the H is reduced by combination with another body, each of them can then act upon it. That residual affinity exists in both positive and negative elements seems to me evident from the fact that the heats of solution of salts in water vary directly as the affinity of the metal for the O of the water and also directly as the affinity of the negative element for the H, as I have pointed out in my letter on "Laws of Solution," in NATURE, vol. xxxiv. p. 263. It seems strange to me that chemists will search out for occult causes of phenomena which can much more easily be explained by what is already known of

the actions of one element on another rather than abandon the assumption that chemical affinity acts in definite units.

Portobello, April 28. WM. DURHAM.

[Without discussing the general question, I may point out that unfortunately we are at present unable to base any argument on the thermal behaviour of elements, as the fundamental values are entirely unknown: we do not know, for example, what amount of heat would be given out on combination of H and Cl; the value deduced for H_2,Cl_2 by Thomsen being the algebraic sum of several values, some of which are negative, some positive.—H. E. ARMSTRONG.]

The Spherical Integrator.

I FIND that my name has been alluded to in a letter by Prof. Hele Shaw, in your last number (vol. xxxv. p. 581).

I shall be glad if you will kindly permit me to state that the idea of reducing the moment of inertia of the sphere in a spherical integrator, by making it hollow, occurred to me while abroad in Algeria. An account of the modified form is given in the *Phil. Mag.*, August 1886, p. 147. I now find, from a letter from Prof. Shaw, of this month, that exactly the same method of dealing with the difficulty had occurred to him. At the end of Prof. Shaw's letter in your last issue the following words are used: "Now in the 'sine' form, of which this integrator is an example, this pin should move in the arc of a circle, and it would be interesting to know if approximately correct results have been obtained with what is in some respects a more convenient device." From this it would appear that the principle of the instrument is not correct. This morning I received a post-card from Prof. Shaw in which he writes that he had misunderstood the diagrammatic outline in the *Phil. Mag.* His words are: "You are quite right as you use it; I was thinking of a contrivance in which the sphere and frame move together." With respect to M. Ventosa's letter on the subject, in your paper of a month ago, (p. 513) in which he speaks very favourably of the method of using a hollow sphere, although M. Ventosa used a spherical integrator in a certain form of anemometer at an early date, yet I think that all who have seen and read Prof. Shaw's work will admit that he has expanded the use of the spherical integrator and its mathematical importance in a way which is both masterly and original. FREDK. SMITH.

28 Norham Gardens, Oxford, April 25.

THE HENRY DRAPER MEMORIAL.[1]

DR. HENRY DRAPER, in 1872, was the first to photograph the lines of a stellar spectrum. His investigation, pursued for many years with great skill and ingenuity, was most unfortunately interrupted in 1882 by his death. The recent advances in dry-plate photography have vastly increased our powers of dealing with this subject. Early in 1886, accordingly, Mrs. Draper made a liberal provision for carrying on this investigation at the Harvard College Observatory, as a memorial to her husband. The results attained are described below, and show that an opportunity is open for a very important and extensive investigation in this branch of astronomical physics. Mrs. Draper has accordingly decided greatly to extend the original plan of work, and to have it conducted on a scale suited to its importance. The attempt will be made to include all portions of the subject, so that the final results shall form a complete discussion of the constitution and conditions of the stars, as revealed by their spectra, so far as present scientific methods permit. It is hoped that a greater advance will thus be made than if the subject was divided among several institutions, or than if a broader range of astronomical study was attempted. It is expected that a station to be established in the southern hemisphere will permit the work to be extended so that a similar method of study may be applied to stars in all parts of the sky. The investigations already undertaken, and described below more in detail, include a catalogue of the spectra of all stars north of −24° of the sixth magnitude and brighter, a more extensive catalogue of spectra of stars brighter than the eighth magnitude, and a detailed study of the spectra of the bright stars. This last will include a classification of the spectra, a determination of the wave-lengths of the lines, a comparison with terrestrial spectra, and an application of the results to the measurement of the approach and recession of the stars. A special photographic investigation will also be undertaken of the spectra of the banded stars, and of the ends of the spectra of the bright stars. The instruments employed are an 8-inch Voigtländer photographic lens re-ground by Alvan Clark and Sons, and Dr. Draper's 11-inch photographic lens, for which Mrs. Draper has provided a new mounting and observatory. The 15-inch refractor belonging to the Harvard College Observatory has also been employed in various experiments with a slit spectroscope, and is again being used as described below. Mrs. Draper has decided to send to Cambridge a 28-inch reflector and its mounting, and a 15-inch mirror, which is one of the most perfect reflectors constructed by Dr. Draper, and with which his photograph of the moon was taken. The first two instruments mentioned above have been kept at work during the first part of every clear night for several months. It is now intended that at least three telescopes shall be used during the whole night, until the work is interrupted by daylight.

The spectra have been produced by placing in front of the telescope a large prism, thus returning to the method originally employed by Fraunhofer in the first study of stellar spectra. Four 15° prisms have been constructed, the three largest having clear apertures of nearly 11 inches, and the fourth being somewhat smaller. The entire weight of these prisms exceeds a hundred pounds, and they fill a brass cubical box a foot on each side. The spectrum of a star formed by this apparatus is extremely narrow when the telescope is driven by clockwork in the usual way. A motion is accordingly given to the telescope slightly differing from that of the earth by means of a secondary clock controlling it electrically. The spectrum is thus spread into a band, having a width proportional to the time of exposure and to the rate of the controlling clock.

This band is generally not uniformly dense. It exhibits lines perpendicular to the refracting edge of the prism, such as are produced in the field of an ordinary spectroscope by particles of dust upon the slit. In the present case, these lines may be due to variations in the transparency of the air during the time of exposure, or to instrumental causes, such as irregular running of the driving clock, or slight changes in the motion of the telescope, resulting from the manner in which its polar axis is supported. These instrumental defects may be too small to be detected in ordinary micrometric or photographic observations, and still sufficient to affect the photographs just described.

A method of enlargement has been tried which gives very satisfactory results, and removes the lines above mentioned as defects in the negatives. A cylindrical lens is placed close to the enlarging lens, with its axis parallel to the length of the spectrum. In the apparatus actually employed, the length of the spectrum, and with it the dispersion, is increased five times, while the breadth is made in all cases about 4 inches. The advantage of this arrangement is, that it greatly reduces the difficulty arising from the feeble light of the star. Until very lately, the spectra in the original negatives were made very narrow, since otherwise the intensity of the starlight would have been insufficient to produce the proper decomposition of the silver particles. The enlargement being made by daylight, the vast amount of energy then available is controlled by the original negative, the action

[1] "First Annual Report of the Photographic Study of Stellar Spectra." Conducted at the Harvard College Observatory." Edward C. Pickering, Director. With Plate. (Cambridge: John Wilson and Son, University Press, 1887.)

of which may be compared to that of a telegraphic relay. The copies therefore represent many hundred times the original energy received from the stars. If care is not taken, the dust and irregularities of the film will give trouble, each foreign particle appearing as a fine spectral line.

Other methods of enlargement have been considered, and some of them tried, with the object of removing the irregularities of the original spectra without introducing new defects. For instance, the sensitive plate may be moved during the enlargement in the direction of the spectral lines; a slit parallel to the lines may be used as the source of light, and the original negative separated by a small interval from the plate used for the copy; or two cylindrical lenses may be used, with their axes perpendicular to each other. In some of these ways the lines due to dust might either be avoided or so much reduced in length as not to resemble the true lines of the spectrum.

The 15-inch refractor is now being used with a modification of the apparatus employed by Dr. Draper in his first experiments,—a slit spectroscope from which the slit has been removed. A concave lens has been substituted for the collimator and slit, and, besides other advantages, a great saving in length is secured by this change. It is proposed to apply this method to the 28-inch reflector thus utilising its great power of gathering light. . . . .

The results to be derived from the large number of photographs already obtained can only be stated after a long series of measurements and a careful reduction and discussion of them. An inspection of the plates, however, shows some points of interest. A photograph of *a* Cygni, taken November 26, 1886, shows that the H line is double, its two components having a difference in wave-length of about one ten-millionth of a millimetre. A photograph of *o* Ceti shows that the lines G and *h* are bright, as are also four of the ultra-violet lines characteristic of spectra of the first type. The H and K lines in this spectrum are dark, showing that they probably do not belong to that series of lines. The star near χ^1 Orionis, discovered by Gore in December 1885, gives a similar spectrum, which affords additional evidence that it is a variable of the same class as *o* Ceti. Spectra of Sirius show a large number of faint lines besides the well-known broad lines.

The dispersion employed in any normal map of the spectrum may be expressed by its scale, that is, by the ratio of the wave-length as represented to the actual wave-length. It will be more convenient to divide these ratios by one million, to avoid the large numbers otherwise involved. If one-millionth of a millimetre is taken as the unit of wave-length, the length of this unit on the map in millimetres will give the same measure of the dispersion as that just described. When the map is not normal, the dispersion of course varies in different parts. It increases rapidly towards the violet end when the spectrum is formed by a prism. Accordingly, in this case the dispersion given will be that of the point whose wave-length is 400. This point lies near the middle of the photographic spectrum when a prism is used, and is not far from the H line. The dispersion may accordingly be found with sufficient accuracy by measuring the interval between the H and K lines, and dividing the result in millimetres by 3·4, since the difference in their wave-lengths equals this quantity. The following examples serve to illustrate the dispersion expressed in this way: Angström, Cornu, 10; Draper, photograph of normal solar spectrum, 3·1 and 5·2; Rowland, 23, 33, and 46; Draper, stellar spectra, 0·16; Huggins, 0·1. Fig. 1, 0·06; Fig. 2, 0·10; Fig. 3, 0·63; Fig. 4, 1·3; Figs. 5 and 6, 6·5.

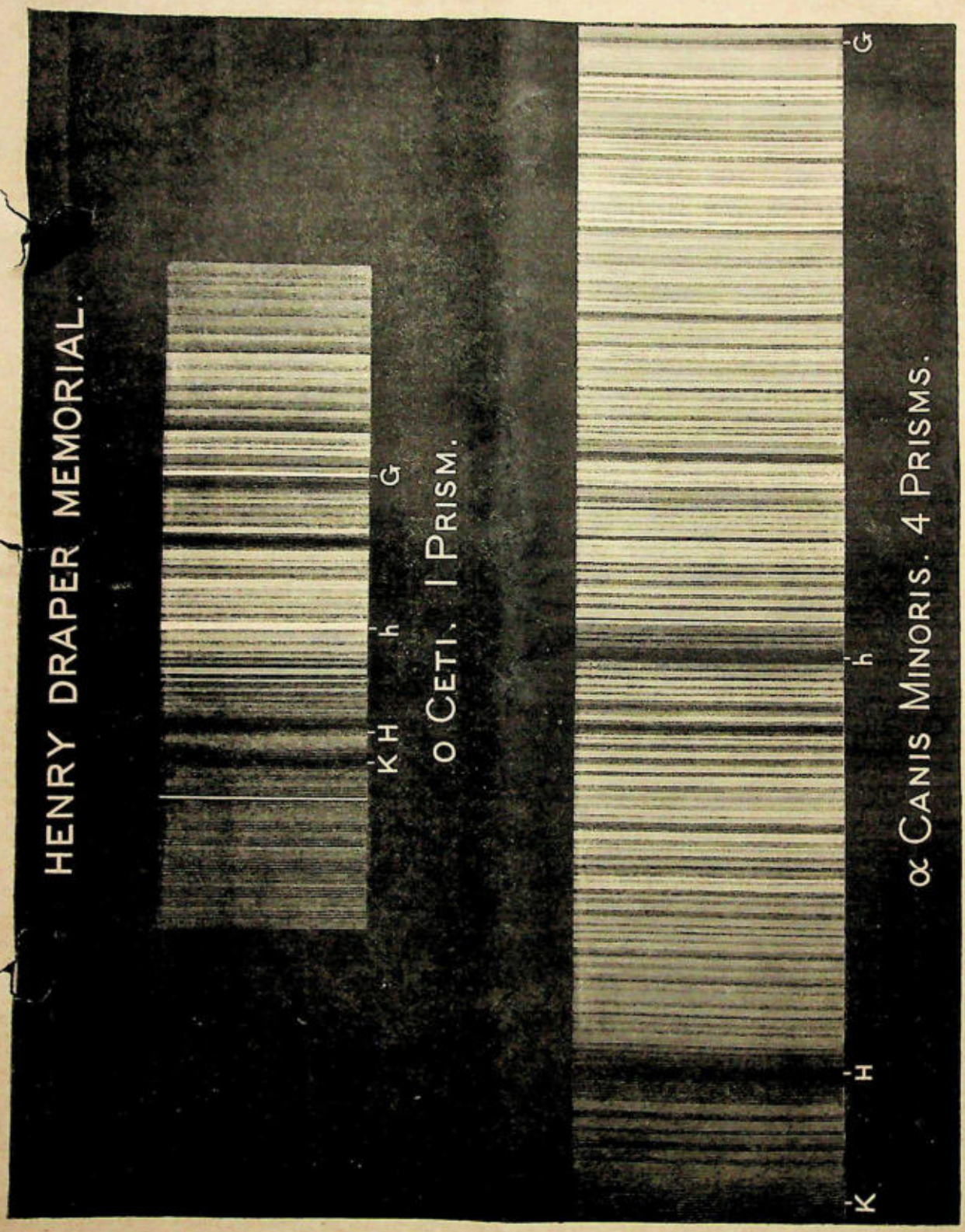
The most rapid plates are needed in this work, other considerations being generally of less importance. Accordingly the Allen and Rowell Extra Quick plates have been used until recently. It was found, however, that they were surpassed by the Seed Plates No. 21, which were accordingly substituted for them early in December. Recognising the importance of supplying this demand for the most sensitive plates possible, the Seed Company have recently succeeded in making still more sensitive plates, which we are now using. The limit does not seem to be reached even yet. Plates could easily be handled if the sensitiveness were increased tenfold. A vast increase in the results may be anticipated with each improvement of the plates in this respect. Apparatus for testing plates, which is believed to be much more accurate than that ordinarily employed, is in course of preparation. It is expected that a very precise determination will be made of the rapidity of the plates employed. Makers of very rapid plates are invited to send specimens for trial.

The photographic work has been done by Mr. W. P. Gerrish, who has also rendered important assistance in other parts of the investigation. He has shown great skill in various experiments which have been tried, and in the use of various novel and delicate instruments. Many of the experimental difficulties could not have been overcome but for the untiring skill and perseverance of Mr. George B. Clark, of the firm of Alvan Clark and Sons, by whom all the large instruments have been constructed.

The progress of the various investigations which are to form a part of this work is given below:—

(1) *Catalogue of Spectra of Bright Stars.*—This is a continuation of the work undertaken with the aid of an appropriation from the Bache Fund, and described in the Memoirs of the American Academy, vol. xi. p. 210. The 8-inch telescope is used, each photograph covering a region 10° square. The exposures for equatorial stars last for five minutes, and the rate of the clock is such that the spectra have a width of about 0·1 cm. The length of the spectra is about 1·2 cm. for the brighter, and 0·6 cm. for the fainter stars. The dispersion on the scale proposed above is 0·1. The spectra of all stars of the sixth magnitude and brighter will generally be found upon these plates, except in the case of red stars. Many fainter blue stars also appear. Three or four exposures are made upon a single plate. The entire sky north of −24° would be covered twice, according to this plan, with 180 plates and 690 exposures. It is found preferable in some cases to make only two exposures; and when the plate appears to be a poor one, the work is repeated. The number of plates is therefore increased. Last summer the plates appeared to be giving poor results. Dust on the prisms seemed to be the explanation of this difficulty. Many regions were re-observed on this account. The first cycle, covering the entire sky from zero to twenty-four hours of right ascension, has been completed. The work will be finished during the coming year by a second cycle of observations, which has already been begun. The first cycle contains 257 plates, all of which have been measured, and a large part of the reduction completed. 8313 spectra have been measured on them, nearly all of which have been identified, and the places of a greater portion of the stars brought forward to the year 1900, and entered in catalogue form. In the second cycle, 64 plates have been taken, and about as many more will be required. 51 plates have been measured and identified, including 2974 spectra. A study of the photographic brightness and distribution of the light in the spectra will also be made.

The results will be published in the form of a catalogue resembling the Photometric Catalogue given in vol. xiv. of the Annals of Harvard College Observatory. It will contain the approximate place of each star for 1900, its designation, the character of the spectrum as derived from each of the plates in which it was photographed,


HENRY DRAPER MEMORIAL.
K H h G
o Ceti. 1 Prism.
K H h G
α Canis Minoris. 4 Prisms.

the references to these plates, and the photographic brightness of the star.

(2) *Catalogue of Spectra of Faint Stars.*—This work resembles the preceding, but is much more extensive. The same instrument is used, but each region has an exposure of an hour, the rate of the clock being such that the width of the spectrum will be as before 0·1 cm. Many stars of the ninth magnitude will thus be included, and nearly all brighter than the eighth. In one case, over three hundred spectra are shown on a single plate. This work has been carried on only in the intervals when the telescope was not needed for other purposes. 99 plates have however been obtained, and on these 4442 spectra have been measured. It is proposed to complete the equatorial zones first, gradually extending the work northward. In all, 15,729 spectra of bright and faint stars have been measured.

(3) *Detailed Study of the Spectra of the Brighter Stars.*—This work has been carried on with the 11-inch photographic telescope used by Dr. Draper in his later researches. A wooden observatory was constructed about 20 feet square. This was surmounted by a dome having a clear diameter of 18 feet on the inside. The dome had a wooden frame, sheathed and covered with canvas. It rested on eight cast-iron wheels, and was easily moved by hand, the power being directly applied. Work was begun upon it in June, and the first observations were made with the telescope in October. Two prisms were formed by splitting a thick plate of glass diagonally. These gave such good results that two others were made in the same way, and the entire battery of four prisms is ordinarily used. The safety and convenience of handling the prisms is greatly increased by placing them in square brass boxes, each of which slides into place like a drawer. Any combination of the prisms may thus be employed. As is usual in such an investigation, a great variety of difficulties have been encountered, and the most important of them have now been overcome.

(4) *Faint Stellar Spectra.*—The 28-inch reflector will be used for the study of the spectra of the faint stars, and also for the fainter portions near the ends of the spectra of the brighter stars. The form of spectroscope mentioned above, in which the collimator and slit are replaced by a concave lens, will be tried. The objects to be examined are, first, the stars known to be variable, with the expectation that some evidence may be afforded of the cause of the variation. The stars whose spectrum is known to be banded, to contain bright lines, or to be peculiar in other respects, will also be examined systematically. Experiments will also be tried with orthochromatic plates and the use of a coloured absorbing medium, in order to photograph the red portions of the spectra of the bright stars. Quartz will also be tried to extend the images towards the ultra-violet.

(5) *Absorption Spectra.*—The ordinary form of comparison spectrum cannot be employed on account of the absence of a slit. The most promising method of determining the wave-lengths of the stellar spectra is to interpose some absorbent medium. Experiments are in progress with hyponitric fumes and other substances. A tank containing one of these materials is interposed, and the spectra photographed through it. The stellar spectra will then be traversed by lines resulting from the absorption of the media thus interposed, and, after their wave-lengths are once determined, they serve as a precise standard to which the stellar lines may be referred. The absorption-lines of the terrestrial atmosphere would form the best standard for this purpose if those which are sufficiently fine can be photographed.

(6) *Wave-Lengths.*—The determination of the wave-lengths of the lines in the stellar spectra will form an important part of the work which has not yet been begun. The approximate wave-lengths can readily be found from a comparison with the solar spectrum, a sufficient number of solar lines being present in most stellar spectra. As a difference of one ten-millionth of a millimetre in wave-length exceeds half a millimetre in Figs. 5 and 6 of the accompanying plate, the readings may be made with considerable accuracy by a simple inspection. For greater precision special precautions are necessary on account of the deviation caused by the approach and recession of the stars. The deviation found by Dr. Huggins in the case of Sirius would correspond to a change in the position of the lines of Figs. 5 and 6 of about half a millimetre. If, then, satisfactory results are obtained in the preceding investigation, the motion of the stars can probably be determined with a high degree of precision. The identification of the lines with those of terrestrial substances will of course form a part of the work, but the details will be considered subsequently.

From the above statement it will be seen that photographic apparatus has been furnished on a scale unequalled elsewhere. But what is more important, Mrs. Draper has not only provided the means for keeping these instruments actively employed, several of them during the whole of every clear night, but also of reducing the results by a considerable force of computers, and of publishing them in a suitable form. A field of work of great extent and promise is open, and there seems to be an opportunity to erect to the name of Dr. Henry Draper a memorial such as heretofore no astronomer has received. One cannot but hope that such an example may be imitated in other departments of astronomy, and that hereafter other names may be commemorated, not by a needless duplication of unsupported observatories, but by the more lasting monuments of useful work accomplished.

EDWARD C. PICKERING,
Director of Harvard College Observatory.
Cambridge, Mass., U.S.A., March 1, 1887.

SCIENCE AND GUNNERY.

I.

IN the last lecture which Prof. Tyndall delivered at the Royal Institution, he expressed a doubt as to whether extensive reading and study had not a tendency to hamper original genius, whether doctrines handed down for generations as articles of faith, which it would be heresy to dispute, had not materially checked the progress of science. Had he wished to illustrate his theory, he could not have had better examples than are to be found in the administration of our naval and military systems. It has been a reproach to us, as by far the greatest maritime nation of the world, that we have no School of Shipbuilding, that, until quite recently, naval officers have had no instruction except such as they could get in the practical execution of their duties, and no method existed of testing their knowledge except such rough-and-ready examinations as their superior officers could administer. Yet under these seeming disadvantages the Navy and the merchant service have kept in the forefront of progress, and have adopted all the newest discoveries of science, or of practical skill, as fast as they have been brought to light.

On the other hand, the officers of Artillery and Engineers have long been considered as belonging to the scientific branches of the service; they have been regularly trained in schools in which theory and history have been taught, and the consequence seems to be that it is most difficult to make the departments with which they are connected move with the times. How else can it be explained that we have adhered to wrought iron as a material for guns, and to muzzle-loaders, long after nations esteemed semi-barbarous have used steel and constructed breech-loaders? or how can we explain the waste of millions in constructing fortifications of patterns long obsolete, and which show no more originality than that exhibited in using

in some places iron instead of stone to resist the greater energy of modern projectiles? Not but that there have been many men both in the Artillery and Engineers who have seen the unfitness of what we have been doing, and have energetically protested against it, but they have not had force enough at the War Office to overcome the inertia due to the complacency derived from, perhaps, just pride in a profound knowledge of books.

We do not go quite the length of Dr. Tyndall's opinions, though we admit that there is much truth in them; we recognise the difficulty of teaching in advance, if we may use the expression; but there can be no doubt that precedent and routine have much to answer for, and account for the reluctance of Professors to admit that many of the old methods of fortification and artillery are as dead and useless as the matchlock or the old castle. Besides these considerations derived from experience of the services, we have the fact that most of the original inventions in the construction of guns and carriages have been the work of civil engineers and mechanics, who have been unhampered by precedent and unchecked by authority, and this circumstance must be our apology, as a non-professional paper, for devoting some space to a discussion of the present state of the science of fortification, especially with regard to our own coast defences.

It cannot be disputed, in the first place, that the projectiles delivered by modern guns are distinguished by greatly extended range, by much greater accuracy of flight, by immensely greater weight and destructive power, and by increased rapidity and precision of firing; but on the other hand it must also be admitted that in fighting at long ranges there will be greater waste of ammunition, and that, to put it plainly, excitement and fright go far to neutralise the advantages gained by our improved weapons, and that, consequently, defensive works should be planned so as to give the utmost possible security and sense of safety to the garrison. It is only necessary to study the records of recent naval actions, such as those during the War of Secession in the United States, the bombardment of Alexandria, or fights with dense hordes of savages in the Soudan and elsewhere, to be satisfied of the fact that the amount of destruction caused is small compared with the terrific fire employed. In the case of attack by artillery on shore the results are not so unsatisfactory, the steadiness of the platform, the accurately known range, the immovability of the gun and object fired at, the fact that the best and steadiest soldiers can be selected to aim, and that any nervousness in the gunner does not unsteady the gun, makes the fire of field and siege artillery approach much more nearly to what can be attained in times of peace; but even then, as in the Navy, smartness and rapidity of fire, the descendants of time-honoured drill, aggravated by excitement, are often the cause of a lamentable sacrifice of accuracy.

To make good shooting it is imperative that the men should be reasonably safe, especially against wholesale slaughter such as is caused by the bursting of a shell in a casemate, and this necessity is all the more imperative at the beginning of a war, when most of the soldiers have as yet never heard the shriek of a shell at their ears, or witnessed its terrifying effects. The shooting should be slow and deliberate in order to be effective, the result of each shot should be ascertained, for it must be remembered that the costly charges now fired are no more effective than those of the old smooth-bore artillery unless they reach their destination.

Next, the advantage of long range, accuracy, and rapidity of fire is in a great degree neutralised by the dense volumes of smoke produced by the modern large charges of powder, and although smoke may prove a valuable protection against the accuracy of an enemy's fire, it undoubtedly limits one's own offensive power except under certain conditions to which we will refer again.

In the last place, it may be conceded that an object which you cannot see you cannot aim at; that to be invisible is better than to be protected by armour, and this desirable condition of safety is easily attained in the case of coast defences against ships, because a ship, being always more or less in motion, even when at anchor, can never mark accurately any object of which it can get only an occasional peep. Thus, at the bombardment of Alexandria, one of the undoubted advantages on the side of the defenders was that some of their batteries were not to be distinguished from the irregular features of the rocky coast, and their presence could only be detected by the puffs of smoke from their guns. Even the old-established rules relating to fortifications admit the necessity of concealment; the greatest secrecy is maintained as to the internal economy of forts; access to them cannot be obtained without great difficulty, although we believe that little or nothing is to be gained by such precautions. What should be concealed is the fort itself, and its construction should be of such a nature that the fire of an enemy could not reach the essential mountings and stores it is intended to protect. Even Nature teaches us a lesson in this respect: animals liable to be the prey of others construct their nests of a form and colour and dispose of them so as to be invisible from a short distance, and even the colour of their plumage or their fur is made to assimilate to the tints which surround them; and the tactics they employ when in danger are to lie still so as not to attract attention.

The propositions which we have laid down, and which we do not imagine can be disputed, are of a nature to condemn at once the old systems of fortification, which appear to us to be specially contrived to afford the peculiar advantages which an enemy would desire; nor are alternative and more rational methods wanting, for as far back as May 7, 1869, at the Royal Institution of Great Britain, a paper, describing a new system of coast fortification calculated to meet the changes in artillery and the modern conditions of naval attack, was read by Colonel Moncrieff. In that paper the principle of concealment was laid down, the manner of carrying out the system explained, and the first workable disappearing gun-carriage, which made the realisation of the principles enunciated practicable, was described.

The time for bringing the matter before the public was also opportune, because the loan which had been contracted for strengthening the defences of the country had not all been expended, while the advance in the range and power of artillery was beginning to be fully realised. The authorities, however, were blind to the principles involved; they accepted, indeed, the disappearing gun, but they rejected the system of which it was only a detail. It would have been better had they accepted the system, and rejected the gun-carriage. The consequence of this incredible want of common-sense and discernment has been that a series of misapplications of the methods advocated by Colonel Moncrieff have been perpetrated by the War Office, as, for example, at Milford Haven, Hubberston, Newhaven, Popston, &c. In some of these forts the emplacements for the disappearing guns are actually formed on the top of casemates, crowded into the most conspicuous positions possible.

Those who have had an opportunity of witnessing the trials of guns and their carriages at the Royal Arsenal, must have been struck with the marvellous resistance which a heap of earth opposes to the proof shots fired into it. An insignificant mound stops the heaviest projectiles fired at a few yards' range from the most powerful guns loaded with proof charges, the mound remains uninjured, though daily subjected to blows which would soon wreck any structure made of the most solid materials. The Moncrieff system is specially adapted to take advantage of this stubborn resistance of earth, and that circumstance alone should have commended it to the official mind long years ago, especially as, in addition, the necessarily slight

inclination of the slopes affords the farther protection derived from the shot glancing off them.

But even the partial recognition of the principle of concealment, the principle of opposing a bank of earth rather than walls of masonry or iron to the tremendous missiles of the present day, flickered and died out; and the War Office, returning to its evil ways, has, within the last few years, erected at enormous cost batteries made as conspicuous as possible, often more than one story high, and has sought to keep out the fire, which these arrangements are calculated to draw, by clothing the batteries with more iron armour, or protecting the embrasures with stronger iron shields; while to make the work of the enemy more easy, and our defence more difficult, the guns have been massed together in the orthodox style, so that but a portion of them are ever likely to come into action, while the men in the whole battery will be "demoralised"—this, we believe, is the technical expression—by a shell bursting in any one of the convenient funnel-shaped openings considerately presented for their reception.

The smoke, likewise, of so many guns is certain to prove most prejudicial to good shooting, and within the forts themselves are generally placed the barracks, which must necessarily soon be reduced to ruin, either by direct or by curved fire, and thus increase the confusion and loss of life in action. No human being, it seems to us, can with impunity stand the constant strain of such conditions on the nervous system. When off work, the garrison of a fort should be safe, their lodging should be secure, their meals should be eaten in peace and security, and the sick and wounded should not be harassed by noise and turmoil. For these reasons the barracks should be at a distance from the battery, and should be hid away out of the enemy's sight, and connected with the battery by covered or screened ways.

In elevated positions, such as are occupied by some of the forts in the Isle of Wight, the natural features of the ground should have been taken advantage of, so as to render them invisible, the guns mounted in open barbette should be painted such a colour as to render them inconspicuous, instead of the uniform black now adopted, and Nature should be allowed to obliterate as much as possible, by the growth of brushwood and grass, the changes which the Engineers may have been compelled to make in the contour of the country. The Inspecting-General and the public generally, would, no doubt, not be able to gaze with delight on the trim slopes, the regular lines, and the frowning cannon, but ample compensation for this will be found in the circumstance that, in time of need, the enemy would be equally at fault.

Again, in coast defences near to the water, the guns, instead of being concentrated, should be dispersed, each gun should have a wide lateral range, the guns should retire out of sight and of exposure, except for the few moments required to lay and fire them. The emplacements should be connected with each other and with the barracks by screened roads, and bomb-proof rooms should be provided for the use of the men on duty when not required to work the guns. The screened roads, having parapets towards the sea, and towards the land also if necessary, would serve the triple purpose of intrenchments, interior lines of communication, and emplacements for light artillery to repel landings.

It may be urged that such work would prove costly on account of the large area of land required, but that would not be the case. The strips of land for roads or military tramways, and the small plots for emplacements, would be as cheaply obtained as for a railway, and by virtue of similar powers; in most places the cost of land would not be greater than that of armoured structures, the slopes and glacis would be just as available after as before for cultivation, and need not even be purchased, while, if definite plans could at once be adopted for our extensive coasts, a most useful class of work would be available in bad times, such as now press upon us, for the unemployed, and the relief would be widely felt because works are needed all over the kingdom.

The recent experiments at Portland have proved beyond all question that it is next to impossible for a ship at even so small a range as 800 yards, to hit a gun appearing out of a pit for three minutes, when the pit is so arranged, as it is the essential feature of the Moncrieff system that it should be, that its position cannot be detected from the sea. But three minutes is at least six times as long an exposure as is necessary; indeed, the art of determining the exact position of ships approaching coast batteries has been brought to such perfection that the officer in command of each gun would receive from the observing station messages as to the exact position of the enemy, the training and elevation to be given to the gun, the proper moment for raising it into action, and even by means of electric fuses, the guns may be fired by the observing officer without risk to a single man, and with an exposure of the guns of less duration than the time required for the flight of a projectile at long range. Contrast such arrangements as these with the open barbette battery at Inchkeith, constructed as if on purpose to offer a conspicuous target, and which recent experiments have proved to be correspondingly vulnerable; or with the quite recently constructed turret, mounting a 10-inch gun at Eastbourne, where the projectile of a machine-gun disabled the 27-ton cannon, and one shot from a 6-inch breech-loader knocked off several feet of its barrel.

A careful study of the numerous papers on coast defence read before the United Service Institution, and the discussions, in which many eminent officers of all branches of the service took part, convinces us of the correctness of the views we are maintaining, and the need which exists for laying down organised plans of defence not only for places already protected, but for our long, and in many cases easily accessible, coast-lines. The smoke, which all the speakers agreed in recognising as a great evil in concentrated batteries, would scarcely be any impediment when the guns are scattered, partly because, under most circumstances, the smoke would blow away from each emplacement without obscuring its own gun, or the others, and partly because the observing officer would be above the smoke, and could always make out the enemy.

The smoke itself offers a very feeble indication of the precise locality of the gun which produced it, partly because it is projected a good way from the emplacement at once, partly because the wind in most cases will blow it away to one side or the other. This was fully proved at Portland, when the puffs of smoke sent up as the gun disappeared proved of no assistance to the attack.

But it may be urged, by those unacquainted with the subject, that so formidable a work as raising a heavy gun into the firing position, and checking its recoil and its fall at the same time, would involve cumbersome machinery and the employment of steam or other power. The answer is, that the energy of the discharge itself has been used to do all that is required.

The public has been much interested of late in the beautiful mechanism by means of which Mr. Maxim has utilised the energy of recoil, not only to run out the barrel of his gun at every shot, but also to perform all the operations of loading and firing automatically, and that at a rate which almost baffles the imagination. Six hundred shots per minute can be fired without any external power being used. The energy imparted to the shot must have its counterpart in the movement of the gun and carriage in the opposite direction; and Colonel Moncrieff, twenty years ago, showed how, by suitable mechanical arrangements, guns of all sizes could be made to recoil under cover and be raised again into the firing position without the application of external force. There are two systems by which this is accomplished, by means of counter-

weights and by means of metallic or air springs. In the former case it is easy to see how the counterweight can be so arranged that the work represented by the falling of the gun may be exactly balanced by the work of lifting the balance weight; the energy of recoil, therefore, need only be drawn upon to overcome the friction of the descent and the subsequent friction of ascent, together with the accelerating force necessary to start the gun into smart upward movement. The total amount of work expended in friction does not probably exceed 20 per cent. of the work of raising the gun, and consequently the old muzzle-loaders, with their comparatively small charges and low muzzle velocities of projectile, yield ample power to allow the guns to be lowered completely beyond the reach of hostile shot.

This is a consideration of great importance, because year by year a large number of excellent muzzle-loading guns of all calibres will be returned into store from the Navy, and may at once be utilised for strengthening our coast defences, for they are quite powerful enough to act against unarmoured vessels, light-draught transports, and such like, as well as against the unprotected parts of ironclads; while as howitzers they would be invaluable for preventing landing from boats, and for this service would be quite as effective as the longer, more costly, and more delicately-made breech-loaders, which, however, should be associated with them to resist ironclads. It so happens, also, that the short muzzle-loader is particularly well suited to the Moncrieff carriage, because the men engaged in loading, training, and elevating, working completely under the parapet, are in absolute safety from the enemy's fire, and the only man exposed is he who lays the gun, and even that exposure, as we have already remarked, can often be dispensed with. The muzzle-loaders are also much more simple weapons to manage than the modern, more powerful guns, and would therefore be better fitted for coast batteries, which would undoubtedly have to be manned and worked by Volunteers and men not so highly trained as the Artillery of the regular army.

Some years ago, the War Office definitely adopted the Moncrieff counterweight carriage, and mounted, successfully, guns as large as the 9-inch of 12 tons weight; but after a time evil counsels prevailed, inveterate prejudice triumphed, and the nation has been saddled with a vast expenditure on forts, which are already obsolete, for by no sort of ingenuity can they be made to carry artillery fitted to cope with that which will be opposed to them. Not that the system was ever rightly applied: Colonel Moncrieff, though attached to the War Department for the express purpose of developing his views, does not appear to have been consulted as to the arrangement of his batteries, or, if consulted, his views were ignored, and the consequence is that, in the case of the comparatively few guns which have been mounted, most of the emplacements are made as conspicuous as possible, and in that way the inestimable advantages of concealment have been thrown away.

The counterweight system, however, becomes very cumbersome when guns exceed some 20 tons in weight. Recourse can then be had to compressed air as a means of storing the energy of recoil. But the work done in compressing air reveals itself in the form of heat, which raises its temperature, and is slowly dissipated as it cools. Again, the air, in expanding to raise the gun, is cooled by the amount of heat converted into work, and its pressure is thereby reduced, so that the losses on these two accounts, added to the somewhat increased friction of the machinery, set a limit to the height to which the stored energy of recoil can raise the gun: the increased charges used in modern artillery, however, compensate for these losses, and it is possible by hydro-pneumatic arrangement to give efficient cover to the heaviest guns. The natural fear arises lest the introduction of water and compressed air may not add elements of danger in the facility with which dirt and debris, not sufficient to injure an ordinary mounting, may affect the more complicated arrangement. There is no doubt that a breech-loading gun requires more care in its use than a muzzle-loader, and a hydro-pneumatic mounting is not so simple as a carriage with an ordinary friction or hydraulic compressor, but experience with the 6-inch hydro-pneumatic siege carriage has shown that the system is capable of enduring very rough usage, and is by no means easily deranged.

The Australian colonies, acting under the advice of the late General Scratchley and General Steward, seem to be more intelligent and far-seeing than the mother country, and have acquired a considerable number of breech-loading guns, mounted on the system recommended, and carried out completely in all its details. It is difficult to see how official opposition can long brave the assaults made on it by common-sense, and the glaring defects of the old methods.

(*To be continued.*)

THE TEMPERATURE OF THE CLYDE SEA-AREA.

I.

IN the spring of 1886 a regular system of temperature observations was commenced in the water of the Clyde sea-area, by the staff of the Scottish Marine Station, under the personal superintendence of Mr. John Murray of the *Challenger* Commission. The work has since proceeded steadily, and will probably be continued to the close of the present year. Previous to 1886, few temperature observations had been recorded dealing with the deep water on the west coast of Scotland; these were almost entirely the work of Mr. J. Y. Buchanan on occasional summer cruises.

The scope of the present investigation is limited chiefly by the capabilities of the Marine Station's steam-yacht *Medusa*. She is a vessel of 30 tons, yacht measurement, steaming 6 knots in ordinary circumstances; but not adapted for working amongst the tremendous tidal currents of the North Channel except in the calmest weather. On the other hand, her small size, and the convenient arrangement of a steam-winch for working the sounding-line enables observations to be made with great rapidity in quiet water. Inside of Cantyre, soundings have been obtained in almost every kind of weather, and the present article will deal with this part of the west coast only.

The Clyde sea-area [1] comprises all the connected water-system, 1300 square miles in extent, lying to the north of a line drawn from the Mull of Cantyre to Corsewall Point in Wigtownshire. This line corresponds nearly to the 50-fathom contour; outside it the depth increases rapidly to over 80 fathoms; towards the inner or northern side it diminishes at first, and then remains at about 27 fathoms over an area of 270 square miles. This bank is termed the Clyde Barrier Plateau; it crosses from Cantyre to Ayrshire, past the south end of Arran, and around Ailsa Craig. The shallowest water covers a ridge at a depth of about 20 fathoms from the surface. The water deepens on the inside of the Plateau to form the Arran Basin, which in form resembles the letter λ, surrounding Arran on the west, east, and north, and running up into Lower Loch Fyne. The depth in this basin exceeds 50 fathoms over 100 square miles; the deepest water, 107 fathoms, occurs off Skate Island, near Tarbert. A much smaller depression runs in a straight line from the Cumbraes to Dog Rock at the mouth of Loch Goil. It is known as the Dunoon Basin, and has an average depth of 40 fathoms and a maximum of 56. Of the numerous lochs, reference will be made to two only, Upper Loch Fyne and Loch Goil. The former measures 25 miles from Otter Ferry to the head; it consists of a basin 30 fathoms deep, bounded by channels having an

[1] For detailed description and map see *Scottish Geographical Magazine* for January 1887.

average depth of less than 15 fathoms at Otter Ferry and Minard Narrows, and of a much longer and deeper basin beyond; the maximum depth of the latter (80 fathoms) is found off Strachur. Loch Goil, only 7 miles long and 47 fathoms deep in the centre, is cut off from the Dunoon Basin by a barrier rising to within 10 fathoms of the surface, and is thus exactly similar in its situation to Upper Loch Fyne. The average depth over the whole Clyde sea-area is 31 fathoms, and it contains approximately 150,000 million tons of sea-water. The estuary of the River Clyde is both narrow and extremely shallow, and the river does not appear to affect the Firth to such an extent as the Forth does the firth bearing its name.

The submarine features of the Clyde sea-area are varied and complicated; and this character is shared by the surface of the intervening land, producing a diversity of mountain, glen, and plain, and corresponding effects of sunshine, cloud, and mist, that lend to the temperature cruises a picturesque charm such as rarely invests physical research.

The cruises take place at intervals of about 50 days, and each occupies a little more than a week. Observations are repeated at about sixty stations, distributed over the whole area. The temperature is ascertained at the surface, at 5 and 10 fathoms, and at distances of 10 fathoms down to the bottom. Whenever a considerable difference is noted in the readings of two adjacent thermometers, observations are repeated at close intervals between them, so that when the curve of vertical distribution of temperature is drawn, points are most numerous where they are most wanted, at the regions of change of curvature. All temperature observations are made with Messrs. Negretti and Zambra's patent standard deep-sea thermometers. These are mounted in the Scottish frame, and are reversed by the fall of a brass messenger. Three thermometers are used on the line at once. The readings may be relied upon to one-tenth of a degree Fahrenheit, except when the sea is rough; then the very lively motion of the *Medusa* introduces a little uncertainty, on account of the difficulty of reading. A slight correction for change of volume of the detached column of mercury is necessary when the temperature of the water differs more than 5° F. from that of the air; the air-temperature being observed by the wet-bulb sling-thermometer.

A slip water-bottle is used on the line along with the thermometers, and samples of water are secured from various depths.

The entire set of observations made on the Clyde sea-area, up to November 1886, have been published in the last number of the Scottish Meteorological Society's Journal; and for the purpose of giving a general idea of the main results as yet ascertained, it will suffice to describe the varying seasonal conditions in three typical regions, and then to indicate the general distribution of temperature in the whole area throughout the year.

In the *North Channel*, near the Mull of Cantyre, observations could only be made on five cruises, and of these only two could be extended far enough to reach deep water, that of April 16, when the weather was remarkably fine, and that of September 22, when Mr. Mathieson, of Liverpool, was kind enough to give the use of his large steam-yacht *Oimara* for the purpose. The result of all the observations is shown graphically in Fig. 1. The distribution was always uniform from surface to bottom (except for a variation of not more than 1° in the superficial layer); and, as the accompanying figures show, there was a steady rise of temperature from April to September, while by December there had been a marked fall. It is noticeable that in all cases except December the surface water was a little warmer than that beneath; in December it was a little colder. Temperature:—

April 16	June 19	August 12	September 22	December 25
42°0	47°4	52°5	54°5	45°5

The annual range, so far as observations go, appears to be about 12°·5 F. The uniformity of temperature throughout the mass of water continues over the Plateau, but gives place to a slightly different distribution in the deep Arran Basin.

Off *Skate Island* eight observations have been made between March 1886 and February 1887, and the curves presenting their results are given in Fig. 2. The actual figures observed for surface and bottom are:—

	March 27	April 19	June 21	Aug. 10
Surface	41°4	43°8	48°3	53°6
Bottom	41°5	41°3	44°0	45°6

	Sept. 26	Nov. 16	Dec. 29	Feb. 7
Surface	54°7	49°3	46°6	43°7
Bottom	47°4	51°1	47°4	[illegible]

The range of temperature on the surface thus appears to be 13°·3, and on the bottom 9°·8. The maximum surface

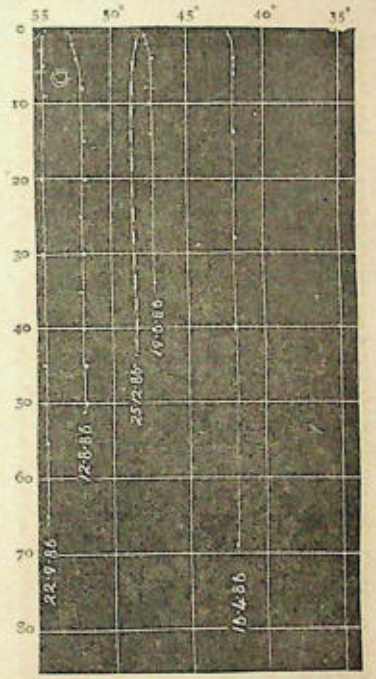


FIG. 1.—Channel.

temperature was observed in September, the maximum bottom temperature in November. The continuous curves (Fig. 2) show the course of heating; the broken lines that of cooling. They illustrate the development of conditions hinted at in the curves for the Channel. Starting with a practically uniform temperature of 41°·4 in March, the water had heated considerably on the surface, and cooled very slightly at the bottom, by April. From that time it warmed throughout, the surface most rapidly, and a mass of water next the bottom was warmed uniformly. The depth of this mass steadily decreased, until in September there was an unbroken gradient of temperature, falling from surface to bottom. By November the surface had chilled considerably; but at 24 fathoms the temperature was the same as in September, and below that depth higher; there being little change from 30 fathoms to the bottom. In succeeding months the fall of temperature has proceeded nearly uniformly, the curve approaching the form of a straight line, gradually becoming more nearly perpendicular. It will be noticed that the curves are not in all cases perfectly regular, but the deviations

are so slight that they might almost be attributed to errors of observation, or to the use of slightly erroneous corrections for the thermometers. This is not the true explanation, as the next group of curves illustrates.

Strachur is near the deepest part of Upper Loch Fyne; the water which the depression contains is cut off from communication with the outside by the double doors of Otter and Minard with a shallow hollow between. Eight sets of observations have been made, as follows:—

	April 20	June 21	Aug. 11	Aug. 25
	°	°	°	°
Surface	42·6	49·2	54·1	53·5
Bottom	41·9	44·1	44·2	44·2

	Sept. 27	Nov. 17	Dec. 29	Feb. 4
	°	°	°	°
Surface	52·4	46·4	41·0	43·0
Bottom	44·1	44·2	44·7	45·9

The surface range was 13°·1, with a maximum in August;

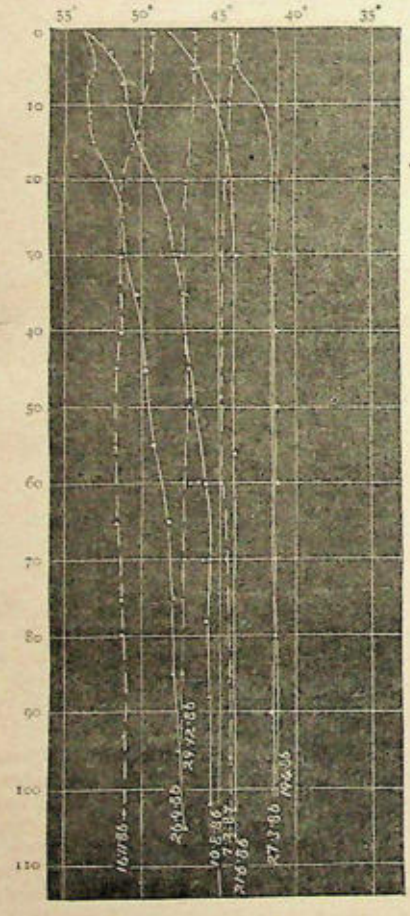


Fig. 2.—Skate Island.

the range of temperature on the bottom has as yet been only 4°; but it is impossible, until further observations have been made, to speak definitely about this. The most remarkable thing apparent from the above figures is that from June to December there should only have been a change of half a degree Fahrenheit in bottom temperature; but an examination of the curves in Fig. 3, will bring out some other curious relations. In April a uniform temperature of 41°·9 was found under 10 fathoms, and this was quite analogous to all the other April observations. In June the surface was found greatly warmed, but at 15 fathoms the temperature was only half a degree higher than it was two months before (42°·5): beneath that point there had been considerable rise of temperature (to 44°·1), so that the phenomenon was presented of a layer of cold water with warmer water above and beneath. It may be mentioned in passing that but for Negretti and Zambra's outflow thermometers this singular distribution could not have been traced out, perhaps not even detected; as, using the deep-sea thermometers on Sixe's principle, the natural induction would have been that below 15 fathoms the temperature was uniform at 42°·5. In August this minimum had almost disappeared, though a trace of it remained at 35 fathoms, the point where the August curve merges with that for June. By September surface cooling had begun, but below 2 fathoms and down to 50 there was

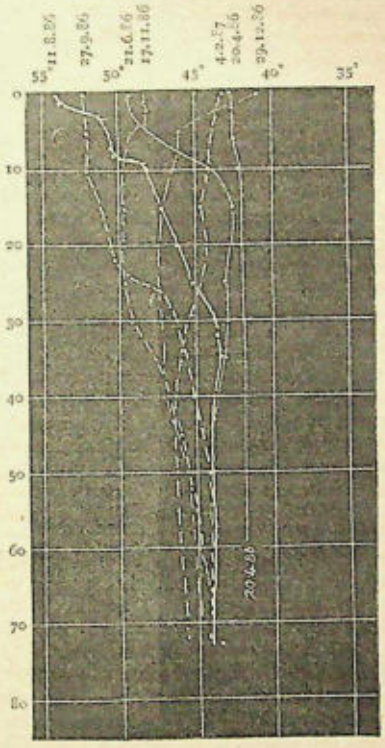


Fig. 3.—Strachur.

a rise of temperature. At the latter depth the temperature became constant to the bottom at 44°·2 as before. November and December showed the gradual cooling of the surface, and the still more gradual motion downwards of the point of maximum temperature. In December the bottom water had begun to warm, and in February the much attenuated maximum had reached to 45 fathoms, and the remains of summer heat had fairly influenced the bottom temperature. Many more very interesting relations will become apparent from the study of the interlacing curves of Fig. 3, which, with some modifications, are applicable also to Loch Goil, a rock basin "similar and similarly situated" to Loch Fyne.

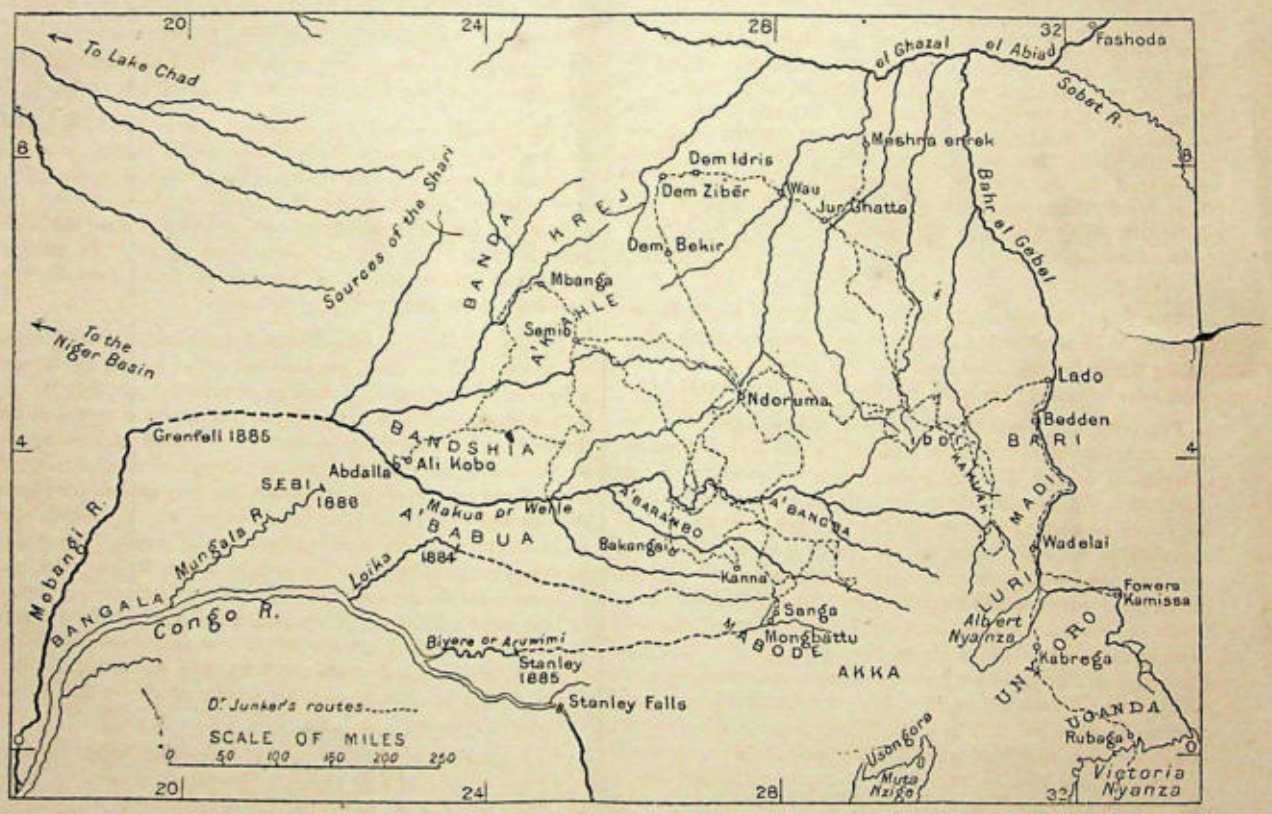
HUGH ROBERT MILL.

(To be continued.)

DR. JUNKER.

NOT since Greely told his story to the Royal Geographical Society has there been so crowded and enthusiastic an audience at Burlington Gardens as assembled on Monday night to welcome Dr. Junker, who, during the last ten years, has done so much good work for geography and science in the important region between the Upper Nile,

the Congo, and Lake Chad. Dr. Junker said little of himself and his own work on Monday night; he spoke mainly of the Mahdi rebellion and of his friend Emin Pasha. By the aid of the fine large maps which were shown (one of them drawn by Schweinfurth), and the few details which Dr. Junker did give, the audience obtained a fair idea of the extent and value of his work. Dr. Junker, who was born in 1840, and had an excellent scientific training at St. Petersburg, Göttingen, Berlin, and Prag, first went to Egypt in 1875, and between that and 1879 travelled extensively in the region of the Western Nile tributaries, as far as the Tondi and Wau affluents of the Bahr-el-Ghazal. On Monday night, however, he confined himself to the journeys of the last six years, which have been spent in exploring the Niam-Niam and Monbuttu countries, settling the problem of the course of the Wellé-Makua, and endeavouring to ascertain the watershed that divides the basin of the Congo from that of the Nile and Lake Chad. Dr. Junker's journeys have gone far to solve this problem, and to settle that the Wellé-Makua discharges its waters into the Congo through the Mobangi, which has been explored by Mr. Grenfell. As will be seen from the map, the region traversed by Dr. Junker is a complicated network of rivers, which it will take many journeys to unravel and chart with accuracy. To reach the field of his last six years' exploration, Dr. Junker went up the Bahr-el Ghazal to Djur Ghatta, and hence across the various southern affluents of the Ghazal to Dem-Zebehr, and then southwards to the town of Ndoruma, the powerful prince of the Niam-Niams. Junker's considerate and generous treatment of the natives gained for him a welcome wherever he went. Ndoruma may be said to have been his head-quarters, where he built his houses and planted his gardens, though he himself could not rest there for many weeks;



he was always eager to be on the march into new fields. While he was away exploring, his assistant Bohndorff occupied himself in preparing the natural history specimens collected; and it is sad to think that all this labour has been lost, as, partly owing to a fire and partly owing to the depredations of the Mahdi's people, none of these collections have reached Europe. After being established at Ndoruma, Dr. Junker made a journey of four months to the southwards, to the Monbuttu country, crossing the Wellé at two points. The details as to his discoveries on this and on subsequent journeys he reserves for the book which he hopes to write when he finds leisure. His next journey was in the same direction, to the country of the A-Mahdi, on the Upper Wellé, where he was detained several months. In November 1881, Junker was able to carry out his project of visiting the country of the Bakangai. From this time he was almost constantly on the march, and until June 1882 he was exploring the countries on the south of the Wellé. He made the acquaintance of many peoples whose language, manners, and customs differ essentially from those whom he had previously known. He was well received by the Niam-Niam princes, Bakangai and Kanna, to the south of the large river Bomokandi. Women are very differently treated among the Niam-Niams or A-Sandeh from what they are among the Monbuttus; among the former they are simply slaves, whereas among the latter they are in many respects treated on a footing of equality with the men. The Monbuttu women paint and tattoo their bodies in a most elaborate fashion, which Dr. Junker described in detail. When he left Prince Kanna and the southern A-Sandeh, Junker returned to the Monbuttu country, and spent some days at the station of Tangasi with the Italian traveller Casati. He then traversed the A-Bangba and Momfu countries to the south of the Wellé, crossed again the Bomokandi, and discovered the Nepoko, which he is inclined to identify with the

Aruwimi of Stanley. Here, while detained for months by a Monbuttu chief, A-Sanga, Dr. Junker suffered much from want of proper food and other causes. On the south of the Bomokandi he met with the pygmy people known as Akka or Tikki-Tikki, whom he found clever hunters, leading a nomad life. He was glad to get back to Tangasi to recruit. Crossing the Wellé in a north-west direction, he reached his new station at Semio's in September 1882. Setting out in December, he pushed southwards and westwards, touching the Wellé again at two different points, one of them being his farthest west point on this river.

The remainder of Dr. Junker's paper was occupied with the troubles caused by the Mahdi insurrection to his friends Emin Pasha and Lupton Bey. These troubles prevented Junker himself from proceeding to Europe northwards. He spent much time at Lado, where, under great difficulties, he constructed a large and beautiful map of his explorations. After being with Emin Pasha at Dufilé and Wadelai, and being detained for some time in Unyoro and Uganda, he at last persuaded King Mwanga to let him go. Crossing the Victoria Nyanza, he proceeded by one of the caravan routes to Zanzibar, and thence to Cairo, and so to Europe, where he arrived only a few weeks ago. Besides Dr. Junker's own paper, the only records of his ten years' work are a few letters which appeared at intervals in *Petermann's Mitteilungen*, so that his forthcoming work will abound with novelty. Its scientific value will be unusually great.

NOTES.

THE Royal Society's first *soirée* of the session was held last night. More trouble than usual had been taken to bring interesting things together, and the result was most satisfactory. We shall refer to some of the most striking objects next week.

WE print this week the firstfruits of a new organization for the furthering of astronomical research, which Mrs. Draper has established at the Harvard Observatory in memory of her husband. We do not think that a more noble memorial has ever been suggested to perpetuate the memory of any man, and certainly, if the fair promise of the opening work is kept up, Draper's name will go down to long distant ages. In addition to the first memoir, which we reprint, we have received from Prof. Pickering several enlarged copies of the stellar photographs already obtained. The scale of these photographs and their perfection will be gathered from the illustration which we give, and it does not seem too much to hope that within no very great number of years we shall possess photographs of the different orders of stars, with photographic spark comparisons, in which it may be quite easy to trace the lines due to the absorption of any particular element, and have, in fact, for stars of the various classes an exact equivalent of Angstrom's *spectre normal* of the sun with the metallic coincidences. The friends of the late Henry Draper, and they are many in this country and on this side of the Atlantic, will thank his widow for the noble memorial she is erecting to his memory.

THE foundation-stone of the Imperial Institute will be laid by the Queen on Monday, July 4.

THIS afternoon the Croonian Lecture will be delivered before the Royal Society by Prof. H. G. Seeley, F.R.S. The subject is "*Pariasaurus bombidens* (Owen), and the Significance of its Affinities to Amphibians, Reptiles, and Mammals." On Thursday, May 26, the Bakerian Lecture will be delivered before the Royal Society by Prof. J. J. Thomson, F.R.S.

AT the general monthly meeting of the Royal Institution on Monday last, Prof. Tyndall was elected Honorary Professor of Natural Philosophy. Lord Rayleigh was elected Professor of Natural Philosophy.

THE visitation of the Royal Observatory at Greenwich takes place this year on June 4.

MR. WOODS, the President of the Royal Institution of Civil Engineers, and Miss Woods, have issued cards of invitation to a *conversazione* to be held at the South Kensington Museum on the 25th inst.

THE general meeting of the Institution of Mechanical Engineers will be held on Monday evening, May 16, and Tuesday afternoon, May 17, at 25 Great George Street, Westminster. The President, Mr. Edward H. Carbutt, will deliver his inaugural address on Monday evening. The following papers will be read and discussed, as far as time permits:—"On the Construction of Canadian Locomotives," by Mr. Francis R. F. Brown, Mechanical Superintendent of the Canadian Pacific Railway; "Experiments on the Distribution of Heat in a Stationary Steam-Engine," by Major Thomas English, R.E., of the War Office; and "On Irrigating Machinery on the Pacific Coast," by Mr. John Richards, of San Francisco.

ON Saturday evening next a lecture on "Savages" will be delivered by Sir John Lubbock in the New Schools, Oxford.

THE Deutsche Seewarte at Hamburg has published a chart showing the positions of the icebergs in the North Atlantic, compiled from reports received up to the middle of April. The chart is issued without charge to captains applying for it. As early as the first half of March several icebergs were met with south of 42° N. lat., and one even south of 41°. In drifting southwards, the icebergs, as always, are found between the meridians of 46° and 52° W.

THE fifth Bulletin of Miscellaneous Information, issued from the Royal Gardens, Kew, gives an account of bowstring hemp. This is not at present an article in commercial use, but Mr. J. G. Baker, the writer of the paper, thinks attention may well be directed to the capabilities of numerous species of *Sansevieria* for producing fibre of great value. Plants of *Sansevieria*, of which there are ten or twelve species, are very abundant on both the east and west coasts of tropical Africa, which, indeed, may be looked upon as the head-quarters of the genus. One well-known species (*S. zeylanica*) is indigenous to Ceylon; and this and others are found along the Bay of Bengal, extending thence to Java and to the coasts of China. The leaves of these plants are more or less succulent, and abound in a very valuable fibre, remarkable alike for fineness, elasticity, and for strengh. Mr. Baker gives a description of those species which are now under cultivation at Kew.

THE other day Dr. Robert W. Felkin, of Edinburgh, received three letters from Emin Pasha. The latest of them is dated Wadelai, October 26, 1886, and no more recent news from the writer has reached this country. Before starting for the coast from Uganda, Dr. Junker had collected a caravan and obtained permission from King M'Wanga to send it to Wadelai. "Besides bringing me a good quantity of cloth," writes Emin Pasha, "there were many presents from yourself, as well as newspapers from 1884 to 1886, a few books, *Graphics*, and, what pleased me most and will prove most valuable, a good many numbers of NATURE, so that at last I am permitted once more to see what is taking place in the scientific world." Along with this letter Dr. Felkin received a scientific paper which will be published in the *Scottish Geographical Magazine*. It is an account of a tour to the Albert Nyanza.

IT has been decided to remove the Royal Observatory of Brussels to Uccle, about 3½ miles to the south-west of its present position. The new buildings were commenced in September 1883, and are now so far advanced that the transfer of the instruments, &c., is arranged to take place next year. Observations

have already been taken at the new Observatory for about a year for the purpose of deducing corrections to be applied to the temperature-observations made in the town since 1833, to reduce them to the temperatures taken in the country.

A GERMAN mathematician has, from certain measurements effected, calculated that the quantity of snow which fell in Central Germany from December 19 to 23, between 50° and 52° 5 N. latitude and between 7° and 18° E. longitude, weighed no less than ten million tons.

THE Lord Mayor, sometime a member of the school, has arranged to be present at the opening, on May 24, of the new science and art buildings of Sir Andrew Judde's School, Tunbridge.

DR. F. DAY, F.R.S., author of "The Fishes of Great Britain and Ireland," will shortly publish with Messrs. Williams and Norgate his monograph on the Salmonidæ. It will be illustrated by coloured plates, and, in the first instance, be published for subscribers. It will be ready in July.

MESSRS. MACMILLAN will publish immediately a volume of "Essays and Addresses," by the Rev. J. M. Wilson, Head Master of Clifton College. The writer discusses the relation between ethical and theological questions and the ideas of modern science.

THE Council of the London Mathematical Society have sanctioned the issue of a complete index of all the papers printed in the Proceedings of the Society since its foundation. Seventeen volumes have been published. All persons who take an interest in mathematical researches and who wish to know what has been done by the Society in their respective branches are invited to apply to the Secretaries (22 Albemarle Street, W.) for a copy of the index.

The Clothworkers' Company of London have shown lately that they thoroughly understand the necessity for an improved system of technical education. At Dewsbury the Jubilee is to be celebrated by the establishment of a technical school, and the Clothworkers' Company have agreed to raise the local fund for the building and equipment of the institution from £10,000 to £11,000. In addition to this they have promised an annual subscription of £50 towards the maintenance of the school. The same Company, having contributed £3,500 to the fund for the erection of the Bradford Technical College, as well as £500 per annum towards its maintenance, have now promised to contribute £500 to a fund which is being raised to pay off the debt still remaining on the building. The additional buildings of the Textile Industries and Dyeing Departments of the Yorkshire College, now completed and equipped, were erected by the Clothworkers' Company at an expense of £30,000.

WE regret to learn that the amount of support given to the proposed memorial to the late Thomas Edward, the Banff naturalist, has been so small that the project is in abeyance; and the Committee are contemplating the return of the subscriptions received. It will be much to be regretted if some means of commemorating Edward cannot be found, similar to the John Duncan Prizes in the Vale of Alford. It will be remembered that a considerable proportion of the sum subscribed for Duncan in his old age was placed by him in the hands of trustees just before his death to found prizes for the encouragement of the study of botany in his own locality. Edward accomplished much more for science than Duncan, and it will be lamentable if no memorial of him can be established. Any persons who may wish to prevent the threatened abandonment of the memorial should communicate at once with Mr. John Allan, Town Clerk of Banff.

IN the *Monatshefte* of the Berlin Chemical Society (viii. 73) Dr. K. Olszewski has a paper on the "Absorption-Spectrum of Liquid Oxygen and of Liquid Air." On examining the absorption-spectrum of liquid oxygen with the help of a small direct-vision spectroscope—employing solar light—two strong dark lines were noticed in the orange and yellow portions of the spectrum, and these did not completely disappear after the volatilization of the oxygen. They were in fact found to be present in the ordinary solar spectrum, being faint at midday, but very distinct towards sunset. On employing greater dispersion, the oxygen absorption-lines expanded to bands like the telluric bands of the solar spectrum, and they were noticed, not only when solar light was employed, but also when the electric arc or the lime-light was made use of. In these experiments the oxygen layer was 7·mm. thick, and on increasing this to 12 mm. two more bands made their appearance; namely, a very faint one in the green, and another somewhat stronger in the blue. The positions of the four oxygen bands were determined with a Vierordt's spectroscope, the wave-length numbers being—

Band in orange	634—622
,, ,, yellow	581—573
,, ,, green	535
,, ,, blue	481—478

or, taking the middle of the lines, 628, 577, 535, and 480. Line 628 is distinguished by its breadth, and 577 by its intensity; the more feeble bands, 535 and 480, appear to be absent from the solar spectrum. With the view to determine the spectrum of the other main constituent of the atmosphere, pure nitrogen was not employed, but merely air carefully freed from moisture and carbonic acid. The spectrum of the liquefied air was examined under the same conditions as in the case of the oxygen, but no new bands made their appearance. The spectrum consisted merely of the bands 628 and 577 mentioned above, and these were but faint; they became stronger as the air became richer in oxygen through the volatilization of nitrogen, but were still far less intense than in the spectrum of pure oxygen. The determination of the absorption-bands of liquid oxygen is of importance in connexion with the discussion of the origin of the telluric lines of the solar spectrum. Janssen and Secchi have shown that most of these are due to aqueous vapour, and, according to Ångström, the bands which on account of their stability cannot well be due to aqueous vapour are A, B, α, and δ, the two latter coinciding with the two strongest oxygen bands. According to Egoroff, who recently examined the spectrum of compressed gaseous oxygen, the telluric bands A, B, and probably α, are due to oxygen. Janssen obtained similar results, but found also some other bands in the spectrum of compressed oxygen. Olszewski cannot confirm either the presence or absence of the groups A and B from the absorption-spectrum of liquid oxygen, as he has been unable to make exact observations in this part of the spectrum.

ANOTHER paper by Dr. K. Olszewski in the *Monatshefte* (viii. 69) is on the "Determination of the Boiling-Point of Ozone." It has been shown by Hautefeuille and Chappuis that when ozonized oxygen is exposed to a pressure of 125 atmospheres and to the temperature of boiling ethylene (−102°·5), the ozone is obtained in the form of a dark-blue liquid which retains the liquid form for a short time at the above temperature, after the removal of the pressure. It seemed, therefore, that the boiling-point of ozone could not be much below that of ethylene, and attempts were therefore made by Olszewski to liquefy ozone at the atmospheric pressure merely by the application of cold. At a temperature of −150° no liquid was obtained, the large proportion of oxygen present probably hindering the condensation of the small percentage of ozone. When a lower temperature (−181°·4) was employed—that of boiling oxygen—the ozone readily condensed to a dark-blue liquid. At this tem

perature it is transparent in very thin layers, but is almost opaque in layers 2 mm. thick. In order to determine its boiling-point, the tube containing it was introduced into a vessel containing liquid ethylene cooled to about − 140°. The ozone still retained the liquid form, and only began to vaporize when the temperature of the ethylene had risen to near its boiling-point. The temperature of the ethylene was determined by means of a carbon bisulphide thermometer, which at the moment of incipient ebullition of the ozone indicated a temperature of − 109°, this corresponding to − 106° of the hydrogen thermometer. The boiling-point of pure ozone is therefore approximately − 106°. Experiments with liquid ozone require great caution on account of the readiness with which explosions occur. If, for instance, liquid ozone comes into contact with ethylene gas, an extremely violent explosion occurs in spite of the low temperature. It is therefore necessary to exclude the inflammable gas from contact with the ozone, and then explosion need not be feared.

Not less interesting than syntheses of vegetable or animal principles are the attempts which are made from time to time to build up minerals of the same crystalline form and chemical composition as those occurring upon the surface of our planet. One of the most widely distributed minerals—the historic magnetite—found so universally throughout the whole of the more basic rocks, and the square or triangular sections of which are familiar to every micro-petrologist, has long been a favourite subject for attempts, partially successful, at artificial reproduction. But probably the best method of effecting this has of late been devised by M. Alex. Gorgeu (*Comptes rendus*, No. 17, 1887), who has obtained fine crystals, sufficiently large to enable him to prove their complete identity with those of native magnetite. His method was to drop iron wire or filings into a bath of fused sulphite and sulphide of sodium, when a double sulphide of iron and sodium was formed, together with an oxide of iron richer in protoxide than magnetite; in a short time this oxidized to magnetite, and the sulphide and sulphite were converted to sulphate of sodium. The crystals of magnetite obtained, when washed free from the sodium sulphate, were a millimetre in section, of octahedral form modified by faces of the rhombic dodecahedron, and attracted by the magnet; they possessed the metallic lustre and the same specific gravity and hardness as crystals of naturally occurring magnetite.

We have received the second edition of Miss Clerke's "Popular History of Astronomy during the Nineteenth Century," published by Messrs A. and C. Black. We regard it as a most encouraging sign of the times that in a period of not over eighteen months, the first edition of such a book as this should have been exhausted. It shows that the number of persons interested in astronomical science who care to read sound treatises requiring a considerable amount of attention is on the increase, and we know no book which is likely to foster the love of the subject among such people better than Miss Clerke's. The mere process of bringing up to date has involved the insertion of a considerable amount of new matter. Celestial photography naturally comes in for an added share of attention, directed chiefly to the discoveries of nebulæ in the Pleiades by the MM. Henry and Mr. Roberts; to the work in stellar spectral photography in progress at Harvard College; and to the preliminary essays in photographic charting made at Paris, Liverpool, and the Cape of Good Hope. Other new or extended passages relate to the bright-line spectra of γ Cassiopeiæ and β Lyræ, stellar photometry, the effects of tidal friction on the satellite system of Mars, and the daylight photography of the sun's corona. The theory of sunspots unfolded by Mr. Lockyer in his "Chemistry of the Sun" finds a place in the chapter on "Solar Observations and Theories," and that on "Solar Spectroscopy" includes an account of the observations of the spectra of sunspots at South Kensington, 1879-85, with their results for solar chemistry. We notice some modification in the author's views regarding the dissociation of terrestrial elements in the sun, the presence of the bright-line spectrum of oxygen in the solar spectrum, and Young's "reversing layer." She moreover (apparently on good grounds) withdraws the statement that comets, moving sensibly in the same track in the parts of their orbits near the sun, must have nearly identical periodic times. Paragraphs in the new edition are assigned respectively to the last comet (Comet 1887 I.) of the remarkable group connected with the comet of 1843, and to the singularities of Comet Pons-Brooks; while the observations on the meteors of November 27, 1885, on the new star in Andromeda, and at Grenada during the total eclipse of August 29, 1886, are fully particularized. We are glad to perceive that Miss Clerke has taken advantage of many of the hints of her critics, supplying, for instance, the few omissions in her work pointed out by Sir Robert Ball in NATURE (vol. xxxiii. p. 314). A completely new feature is a chronological table of the principal astronomical events between the years 1774 and 1887; and a frontispiece and vignette, reproducing Mr. Common's and the MM. Henry's photographs of the Orion Nebula, Jupiter, and Saturn, add to the attractions of the second edition.

The additions to the Zoological Society's Gardens during the past week include a Bonnet Monkey (*Macacus sinicus*) from India, presented by Mr. G. Lester; a Brazilian Tree-Porcupine (*Sphingburus prehensilis*) from Brazil, presented by Dr. William Studart; a Vervet Monkey (*Cercopithecus lalandii*) from South Africa, presented; a Domestic Sheep (*Ovis aries*, four-horned var.) from Arabia, presented by Mr. C. E. Kane; a Tooth-billed Pigeon (*Didunculus strigirostris*) from the Samoan Islands, presented by Mr. Wilfred Powell; a Great-crested Grebe (*Podiceps cristatus*) from Norfolk, presented by Mr. T. E. Gunn; a Goldfinch (*Carduelis elegans*), a Greenfinch (*Ligurinus chloris*), a Red Bunting (*Emberiza schœniclus*), British, presented by Master H. J. Walton; an Eyed Lizard (*Lacerta ocellata*) from Cannes, presented by Mr. J. E. Warburg; a Smooth Snake (*Coronella lævis*) from Hampshire, presented by Mr. H. B. Pain; a Green Turtle (*Chelone viridis*) from Ascension, presented by Dr. Keenan; a Squirrel Monkey (*Chrysothrix sciurea*) from Guiana, a Servaline Cat (*Felis servalina*) from West Africa, a Black-necked Swan (*Cygnus nigricollis*) from Antarctic America, two Natterer's Snakes (*Thamnodynastes nattereri*) from Brazil, purchased; four Prairie Marmots (*Cynomys ludovicianus*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

The Melbourne Observatory.—Mr. Ellery has recently issued his Annual Report referring to the year ending June 30, 1886. From it we learn that the new transit-circle has been in constant use during the year, and is in excellent order. There appears, however, to be a very gradual lowering of the west pier of the instrument since its erection in August 1884. There also appears a decided diurnal change in the level, the east pivot being higher in the morning and lower in the evening—probably due to the heating effects of the sun on the earth's crust, or on the building. The objects observed with the transit-circle during the year comprised fundamental clock stars, standard circumpolar stars, faint stars selected from the Melbourne zones, comet stars, refraction stars, and a list of stars proposed for insertion in the *Connaissance des Temps*. The great telescope was almost exclusively devoted to the revision of the southern nebulæ. During the year 214 of Sir J. Herschel's nebulæ were finally revised, 7 were searched for but not found, whilst 30 new nebulæ were discovered. There now remain only 95 nebulæ, which were observed by former observers, requiring final revision before publication. The photoheliograph was not in working order for several months during the year, owing to difficulties arising from the change in the size of the sun pictures

taken, from 4 to 8 inches diameter. The number of photographs of the sun obtained during the year was therefore only 92.

THE TRANSIT OF VENUS IN 1882.—Mr. Stone's Report exhibiting the results deduced from the British observations of the transit of Venus in December 1882 has been published. The resulting values for the sun's mean equatorial horizontal parallax from the different phases of the transit, are as follow :—

External contact at ingress $\pi = 8''.760 \pm 0''.122$
Internal ,, ,, ,, $\pi = 8''.823 \pm 0''.023$
,, ,, ,, egress $\pi = 8''.827 \pm 0''.050$ (α)
,, ,, ,, $\pi = 8''.882 \pm 0''.043$ (β)

(α) or (β) are the values resulting from this phase according to the phenomenon selected to represent true contact. The mean of these gives for

Internal contact at egress $\pi = 8''.855 \pm 0''.036$
External ,, ,, ,, $\pi = 8''.953 \pm 0''.048$

The combination of the values deduced from the internal contacts at ingress and egress gives $\pi = 8''.839 \pm 0''.021$ or $\pi = 8''.825 \pm 0''.028$ according as (α) or (β) is used. In the mean from internal contacts $\pi = 8''.832 \pm 0''.024$.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1887 MAY 15-21.

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on May 15.

Sun rises, 4h. 10m. ; souths, 11h. 56m. 8·1s. ; sets, 19h. 42m. ; decl. on meridian, 18° 51′ N. : Sidereal Time at Sunset, 11h. 15m.

Moon (one day after Last Quarter) rises, 1h. 35m. ; souths, 6h. 34m. ; sets, 11h. 40m. ; decl. on meridian, 12° 20′ S.

Planet.	Rises. h. m.	Souths. h. m.	Sets. h. m.	Decl. on meridian. ° ′
Mercury ...	3 49	11 3	18 17	13 33 N.
Venus	6 6	14 38	23 10	25 29 N.
Mars	3 59	11 36	19 13	17 33 N.
Jupiter... ...	16 57	22 13	3 29*	9 27 S.
Saturn... ...	7 40	15 48	23 56	22 13 N.

* Indicates that the setting is that of the following morning.

Occultation of Star by the Moon (visible at Greenwich).

May.	Star.	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image. ° °
19 ...	29 Ceti	6½ ...	2 52 ...	3 50 ...	63 260

Variable Stars.

Star.	R.A. h. m.	Decl. ° ′			h. m.	
T Cassiopeiæ ...	0 17·1	55 10 N.	...	May 20,		*m*
U Cephei	0 52·3	81 16 N.	...	,, 19,	2 38	*m*
R Sculptoris ...	1 21·8	33 8 S.	...	,, 17,		*M*
S Cancri	8 37·5	19 26 N.	...	,, 17,	20 28	*m*
U Ophiuchi... ...	17 10·8	1 20 N.	...	,, 15,	0 16	*m*
β Lyræ...	18 45·9	33 14 N.	...	,, 19,	2 0	m_2
R Lyræ	18 51·9	43 48 N.	...	,, 16,		*m*
R Cygni	19 33·8	49 57 N.	...	,, 21,		*M*
S Vulpeculæ ...	19 43·8	27 0 N.	...	,, 18,		*M*
η Aquilæ	19 46·7	0 43 N.	...	,, 19,	23 0	*m*
S Sagittæ	19 50·9	16 20 N.	...	,, 17,	1 0	*M*
T Delphini	20 40·1	15 59 N.	...	,, 20,		*M*
δ Cephei	22 25·0	57 50 N.	...	,, 17,	0 0	*M*

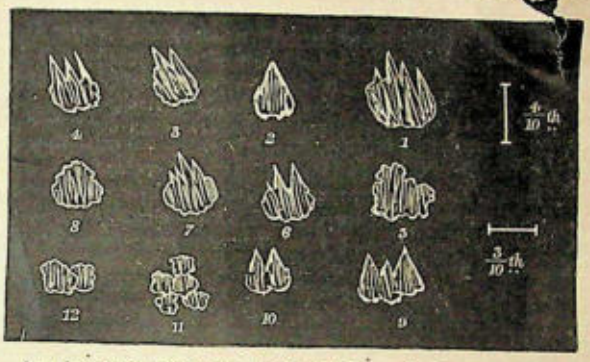
M signifies maximum ; *m* minimum ; m_2 secondary minimum.

Meteor-Showers.

	R.A.	Decl.	
Near α Coronæ	231	27 N.	Rather slow and faint.
,, η Aquilæ	294	0	Very swift.
From Delphinus ...	315	15 N.	Very swift.

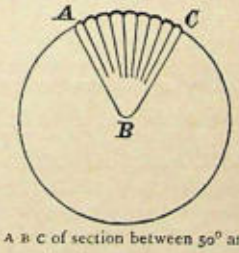
REMARKABLE HAILSTONES.

MR. E. J. LOWE writes to us from Shirenewton Hall, Chepstow, that remarkable hailstones fell there on April 5 from 1 55 p.m. till 2 p.m. They were far apart, and fell with but little force, and were entirely opaque, and had a vertical cleavage. Some were conical, with an irregular base ; some were spiked at the apex, and of these no two were alike ; others were very irregular in form. A great number were composed of two or three united ; in one case as many as five were fast together. The longest were four-tenths of an inch long, and three-tenths of an inch broad. They melted very slowly, lasting as much as two minutes. The temperature was 39°·5, wet bulb 35°·4, and temperature on grass 36°·7. The hailstones were quite different from anything that Mr. Lowe had ever seen. The accompanying figure records a few of them.



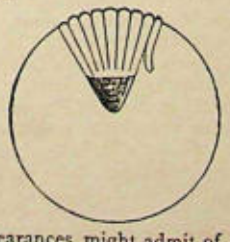
Another account of remarkable hailstones has been sent to us by Mr. Reginald G. Durrant, of Marlborough College :—

"On April 24, about 12.30," Mr. Durrant writes, "while walking between Melrose and Kelso, a friend and myself were overtaken by a sudden and very violent hailstorm, accompanied by thunder. The violent burst lasted about two minutes, in which time the ground was completely covered with large hailstones rather more than half an inch long. I say 'long' advisedly, for all the specimens I examined were conical, and were all of them formed in the same way. The points had all the appearance of snow, being softer than the main bulk of the 'stones.' These snow portions occupied about one-third of the whole length, being white and non-transparent. The main portions of the hailstones were hard and ice-like, stranded lengthwise with from forty to fifty fibres of ice—each fibre curved separately at the top—and together forming a curved surface, as of a sphere having the snow point for its centre. Thus—



Angle A B C of section between 50° and 60°.

"On melting, the pointed part became translucent, while the other part became more opaque than at first, strands often remaining for a time, partially separated and curving outwards, as though they had been freed from compression in their lower extremities. Thus—



"The above appearances might admit of the hypothesis that these hailstones were fragments of radiated crystalline spheres,

but one would expect in that case to find pyramidal rather than conical shapes, or at least to find some shaped so as to complement the cones. I failed to notice any indications of such shapes in the specimens (about thirty) which I examined. I should be inclined to believe that the soft, snow-like portions had been formed during the passage of the harder stranded stones through a moist and possibly clouded stratum of air.

"I was unable to see how they reached the ground, whether point or blunt end downwards. If in the latter way, one could account for the soft part, as being formed from previously unfrozen particles, cooled by contact with the nucleus, and, so to speak, sliding back to a position sheltered from the air, as it swept by the sides of the cone.

"But if the narrower end were foremost (and that would be the more natural position), then, unless the little mass—like an iceberg—could freeze particles in front of it before reaching them, it would seem that the snow point must have resulted from the accretion of small particles already frozen, and the pointed shape would be what we should expect. The only rotatory motion possible would be that in a plane perpendicular to the direction of the path through the air, and might account for the conical shape, the edges of any pyramid being rounded off."

M. A. Wentzil, of Izdebno, near Warsaw, writes to us of a hailstorm which occurred there on the 4th inst. "At 3 o'clock in the afternoon," he says, "hail began to fall, at first of small size, but in a few minutes the hailstones increased to the size of walnuts. Nine such which I picked up at hazard weighed together 13 lut (0·165 kilo). They were almost spherical with a mean diameter of $1\frac{3}{4}$ English inches. In the centre of each was a kernel of clear ice about the size of a pea, and from this kernel radiated conical masses of white ice, so that the surface of the hailstone was like that of a mulberry, the interspaces being filled with clear ice. The damage in the gardens and to glass panes was, as may be imagined from the size of the stones, considerable

On March 3 we printed a letter from Mr. C. S. Middlemiss, describing a fall of top-shaped hailstones near Ramnagar, in the North-West Provinces of India (NATURE, vol. xxxv. p. 413). Writing to us on March 7, Mr. T. Spencer Smithson said (p. 438) that a fall of hailstones, almost exactly similar to those described by Mr. Middlemiss, had taken place in the neigbourhood of Rochdale on August 6, 1885. Mr. Smithson, however, pointed out that besides the horizontal stratification in these hailstones there was a perpendicular one, giving each hailstone the appearance of being composed of alternate cylinders of clear and white ice; and he asked Mr. Middlemiss to state whether the hailstones seen at Ramnagar had this peculiarity. Mr. Middlemiss now writes to us, in reply to Mr. Smithson's question, that the broad end of the hailstones showed no trace of any divisional planes whatever, being perfectly amorphous as originally stated. "The banded portion, so far as my memory serves me," he says, "may have possessed a faint longitudinal *striation*, just sufficient to run the bands together and to induce me to shade the diagrams vertically rather than horizontally, but I cannot be certain of it. It was not a marked feature, I feel sure."

SCIENTIFIC SERIALS.

Rivista Scientifico-Industriale, February.—The total solar eclipse of August 19, 1887, by Prof. Cacciatore. Prof. Tacchini having at the last eclipse established the presence round the sun of delicate white protuberances different from the ordinary rose-coloured protuberances daily visible under the spectroscope, it is announced that the Minister of Public Instruction will send Prof. Tacchini and Prof. Riccò to observe the August eclipse in Siberia for the express purpose of studying these new manifestations.—On the origin of the variations of intensity in the dry pile, and on the means of preventing them, by Prof. Luigi Palmieri. The author's experiments lead to the conclusion that the dry pile is not only the most durable, but also the most constant, and that the variations of intensity are due to dispersions. These dispersions are independent of the moisture and temperature of the surrounding atmosphere, at least within certain limits, while the pile enveloped in a volume of air will preserve its force almost unaltered for years, and not only not diminished, but even slightly increased, by the atmospheric moisture.

March.—A new method of measuring the specific weights of fluids, by Dr. Alessandro Sandrucci. A new method is described, for which a single apparatus alone is needed, and for which the author proposes the name of areovolumeter, combining as it does the functions of the areometer and volumeter. Although somewhat less accurate than Marangoni's recently invented double volumeter, this process reduces the disturbing influence of superficial tension to a minimum, while completely dispensing with the empirical scales on the volumeters, the determination of which involves considerable difficulty.

Bulletin de l'Académie Royale de Belgique, February.—Determination of the direction and velocity of the movement of the solar system in space, by M. P. Ubaghs. For the direction, the same method is adopted as that already known through the labours of M. Folie. For the velocity, use is made of three groups of stars of the second, third, and fourth magnitudes, the first group belonging probably to the solar nebula itself. The resulting velocity is only 16,500,000 kilometres for the year as compared with the 850,000,000 obtained by Homann working on the spectroscopic observations of Greenwich.—On the influence of diurnal nutation on the questions connected with the observations of γ Draconis made at the Observatory of Greenwich, by L. Niesten. By employing M. Folie's formula of diurnal nutation the author has determined a source of error long suspected in the calculations of Main and Downing. By introducing the necessary correction he arrives for the first time at a positive parallax for γ Draconis. He thus also, for the first time, determines beyond all doubt the real existence of diurnal nutation.—On the two tetrabromureted hydrocamphenes, by W. De la Royère. It is shown that by the action of the chlorobromide of phosphorus on camphor there are produced two tetrabromureted hydrocamphenes differing in their physical properties, specific weights, points of fusion, and molecular rotatory power. By subjecting them to the action of the nitrate of silver, heat, and chlorine, the author transforms the two isomeres into one and the same tribromureted camphene; while metallic silver reduces them to an identical bibromureted camphene, chlorine producing a bichlorureted and tetrabromureted hydrocamphene also identical for both.

Rendiconti del Reale Istituto Lombardo, February.—State of education in Italy, by Prof. A. Amati. The results of the recent official returns are given in tabulated form for the 284 circuits of the kingdom, showing in separate columns the percentage of "analfabeti" (illiterate) in each communal district and its chief town. The general result appears to be more unsatisfactory than had been anticipated, the disparity especially between the towns and rural districts being still excessive, even in Piedmont, Liguria, and some of the other best regulated departments.—Measurement of the muscular force in man, by Prof. G. Zoja. A brief account is given of the various instruments devised for determining scientifically the degree of muscular force in individuals, according to sex, age, and other conditions, from Regnier's dynamometer to the present time. The author also proposes a scheme of classification based on the degree of muscular energy possessed by the individual, and ranging from a given mean (Mesostheni) upwards and downwards through the Megastheni and Microstheni to the two extremes of Heraclestheni and Astheni.

March.—Observations on the luminous solar rays, by Giovanni Cantoni. The attention of meteorologists is called to the lucimeter recently constructed at Milan, which is stated to give more satisfactory results than the English heliograph with glass sphere or Craveri's chemical photometer. It determines with great accuracy the relative measure of the luminous rays at all hours of the day in relation to the altitude of the sun above the horizon of the place of observation. It also gives the integral of the successive and varying luminous influences of the sun during the course of a whole day. With regard to the instrument described by Clark in NATURE (vol. xxxii. p. 233) for measuring the radiant energy of the sun, its principle is stated to be based not so much on Wollaston, as on the discovery made many years ago by Bellani, and for some time applied by the author to agricultural meteorology.—Meteorological observations made at the Brera Observatory, Milan, for the month of February.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, April 21.—"Some Applications of Dynamical Principles to Physical Phenomena. Part II." By J. J. Thomson, M.A., F.R.S., Fellow of Trinity College and

Cavendish Professor of Experimental Physics in the University of Cambridge.

This is a continuation of a paper with the same title published in the Phil. Trans., 1885, Part II. In the first paper dynamical principles were applied to the subjects of electricity and magnetism, elasticity and heat, in order to establish relations between phenomena in these branches of physics. In this paper corresponding principles are applied to chemical and quasi-chemical processes such as evaporation, liquefaction, dissociation, chemical combination, and the like.

Many of the results obtained in this paper have been or can be obtained by means of the Second Law of Thermodynamics, but one of the objects of the paper is to show that there are other ways of attacking such questions, and that in many cases such problems can be solved as readily by the direct use of dynamical principles as by the Second Law of Thermodynamics.

A great deal has been written on the connexion between the Second Law of Thermodynamics and the principle of Least Action; some of these investigations are criticised in the first part of the paper, after this it is shown that, for a collection of molecules in a steady state, the equation (which for ordinary dynamical systems is identical with the well-known Hamiltonian principle)—

$$\delta(\overline{T} - \overline{V}) = 0,$$

is satisfied; where $\overline{T}$ and $\overline{V}$ are respectively the mean values of the kinetic and potential energies taken over unit time, and where the variation denoted by δ is of the following kind.

The co-ordinates fixing the configuration of any physical system, consisting according to the molecular theory of the constitution of bodies of an immense number of molecules, may be divided into two classes:—

(*a*) Co-ordinates, which we may call molar, which fix the configuration of the system as a whole; and

(*b*) Molecular co-ordinates which fix the configuration of individual molecules.

We have the power of changing the molar co-ordinates at our pleasure, but we have no control over the molecular co-ordinates.

In the equation—

$$\delta(\overline{T} - \overline{V}) = 0,$$

only the molar co-ordinates are supposed to vary, all velocities remaining unchanged. Hence in applying this equation we need only consider those terms in $\overline{T}$ and $\overline{V}$ which involve the molar co-ordinates. Expressions for these terms for gases, liquids, and solids are given in the paper; the rest of the paper after these have been obtained consists of applications of the above equation.

The density of a vapour in equilibrium with its own liquid is obtained as a function of the temperature, and the effect upon the density of such things as the curvature or electrification of the surface of the liquid is determined.

The phenomenon of dissociation is next investigated, and an expression for the density of a dissociated gas obtained which agrees substantially in form with that given by Prof. Willard Gibbs in his well-known paper on the "Equilibrium of Heterogeneous Substances."

The effect of pressure upon the melting-point of solids and the phenomena of liquefaction are then investigated, and the results obtained for the effect of pressure upon the solubility of salts are shown to agree with the results of Sorby's experiments on this subject. The effect of capillarity upon solubility is investigated, and it is shown that if the surface-tension increases as the salt dissolves then capillarity tends to diminish the solubility, and *vice versâ*.

The question of chemical combination is then considered, particularly the results of which is called by the chemists "mass-action," and of which a particular case is the division of a base between two acids.

The general problem investigated is that in which we have four substances, A, B, C, D, present, such that A by its action on B produces C and D, while C by its action on D produces A and B. The relation between the quantities of A, B, C, D present when there is equilibrium is obtained and found to involve the temperature; when the temperature is constant it agrees in some cases with that given by Guldberg and Waage, though in others it differs in some important respects. Thus, if $\xi, \eta, \zeta, \epsilon$ be the number of molecules of A, B, C, D respectively, when there is equilibrium, θ the absolute temperature, H the amount of heat given out when the chemical process which results in the increase of ξ by unity takes place, and k a quantity which is the same for all substances, then it is proved that—

$$\frac{\xi^p \eta^q}{\zeta^r \epsilon^s} = CE^{\frac{H}{k\theta}},$$

where C is a constant; p, q, r, s are quantities such that if (A) represents the molecule of A, with a similar notation for the other molecules, then the chemical reaction can be represented by the equation—

$$p\{A\} + q\{B\} = r\{C\} + s\{D\}.$$

Thus if A, B, C, D be respectively sulphuric acid, sodium nitrate, nitric acid, and sodium sulphate, in which case the reaction is represented by—

$$H_2SO_4 + 2NaNO_3 = 2HNO_3 + Na_2SO_4,$$

then, if the molecules of sodium nitrate and nitric acid be represented by $NaNO_3$ and HNO_3—

$$p = 1, \quad q = 2, \quad r = 3, \quad \text{and } s = 1.$$

If, however, the molecules of sodium nitrate and nitric acid are represented respectively by $Na_2N_2O_6$ and $H_2N_2O_6$, then since the chemical reaction may be written—

$$H_2SO_4 + Na_2N_2O_6 = H_2N_2O_6 + Na_2SO_4,$$

$$p = 1, \quad q = 1, \quad r = 1, \quad \text{and } s = 1.$$

According to Guldberg and Waage the relation between $\xi, \eta, \zeta, \epsilon$ is—

$$\xi\eta = k\zeta\epsilon;$$

this, when the temperature is constant, agrees with the above expression if $p = q = r = s$.

We see that the state of equilibrium will vary rapidly with the temperature if H be large, that is, if the chemical process is attended by the evolution of a large quantity of heat.

The effect of alterations in the external circumstances such as those which may be produced by capillarity, pressure, or electrification are investigated, and it is shown that anything giving rise to potential energy which increases as the chemical combination goes on tends to stop the combination.

The last part of the paper is taken up with the consideration of irreversible effects such as those accompanying the passage of electric currents through metallic conductors or electrolytes. These are looked upon as the average of a large number of discontinuous phenomena which succeed each other with great rapidity. The ordinary electrical equations with the usual resistance terms in, represent on this view the average state of the system, but give no direct information about its state at any particular instant. It is shown that if we take this view we can apply dynamical principles to these irreversible effects, and the results of this application to the case of electrical resistance are given in the paper.

"On Parts of the Skeleton of *Meiolania platyceps*." By Sir Richard Owen, K.C.B., F.R.S.

The subjects of the present paper are additional fossil remains of *Meiolania platyceps* from Lord Howe's Island, transmitted to the British Museum since the author's previous paper on that extinct reptile. Additional cranial characters are defined and illustrated by drawings of more or less perfect specimens of the skull, of vertebræ of the neck, the trunk, and tail, of limb-bones, and portions of the dermal skeleton.

The author sums up the affinities, deducible from the above parts of the skeleton, to the orders *Chelonia* and *Sauria*, with grounds for the conclusion, mainly based on the absence of evidence of a carapace and plastron, that the genera *Megalania* and *Meiolania* are more nearly akin to the Saurian division of the class REPTILIA; in which he proposes to refer those extinct genera to a sub-order called *Ceratosauria*.

"Conduction of Heat in Liquids." By C. Chree, B.A., King's College, Cambridge. Communicated by Prof. J. J. Thomson, F.R.S.

Linnean Society, April 21.—Mr. W. Carruthers, F.R.S., President, in the chair.—Mr. E. M. Holmes exhibited specimens of various species of *Shorea* from Borneo and Sumatra, which plants yield vegetable fats used for technical purposes. Several species of *Dichopsis* affording gutta-percha from the bark and fat from the seeds were also shown. Mr. Holmes pointed out the importance of the cultivation of the more valuable of these trees, among others, *D. oblongifolia* and *Ceratophoru*

Leerii, since they are being rapidly destroyed by the natives. Their cultivation has already been commenced by the Dutch, but not a day too soon, as the trees take at least twenty years ere they are productive and valuable.—Mr. Patrick Geddes read a paper on the nature and causes of variation in plants and animals. The fact of organic evolution is no longer denied, but its physiological factors have not yet been adequately analyzed. Even those who regard natural selection as at once the most important and the only ascertained factor of the process admit that, such an explanation being from the external standpoint—that of the adaptation of the organism to survive the shocks of the environment—stands in need of a complementary explanation which shall lay bare the internal mechanism of the process, *i.e.* not merely account for the survival, but explain the origin, of variations. The relative importance of the external and internal explanations will, moreover, vary greatly in proportion as variations are found to be "spontaneous," *i.e.* in any direction indifferently, or "determinate," *i.e.* in some given direction continuously. Avoiding any mere postulation of an "inherent progressive tendency," common to both pre- and post-Darwinian writers, the definite analysis of the problem starts with that conception of protoplasm which is the ultimate result of morphological and physiological analysis, viz. to interpret all phenomena of form and function of cells, tissues, organs, and individuals alike in terms of its constructive and destructive ("anabolic and katabolic") changes. While the external or environmental explanation of evolution starts with the empirical study of the effect of human selection upon the variations of animals and plants under domestication, the internal or organismal one as naturally commences with the fundamental rhythm of variation in the lowest organism in nature. It also investigates the nature of the simple reproductive variation upon which the origin of species as well as individuals must depend, before attempting that of individual variations. The interpretation of all the phenomena of male and female sex as the outcome of katabolic and anabolic preponderance is shown largely to supersede the current one of sexual selection, and in some cases at least that of natural selection, *e.g.* the specially important one of the origin of such polymorphic communities as those of ants and bees. In such cases natural selection acts not as the cause of organic evolution, but as the check or limitation of it, and acquires importance rather as determining the extinction than the origin of species. The process of correlation, especially that between individualization and reproduction, is mooted by the author, and its application to the origin and modification of flowers, &c., outlined. A discussion is given of the embryological and pathological factors of internal evolution, with an application of the whole argument to the construction of the genealogical tree of plants and animals.—A report on the Gephyreans of the Mergui Archipelago, by Prof. Emil Selenka, of Erlangen, was read; this communication dealing chiefly with a technical description of species.

Zoological Society, April 28.—Fifty-eighth Anniversary Meeting.—Prof. Flower, LL.D., F.R.S., President, in the chair.—Many members of the Council and other Fellows of the Society were present. After some preliminary business, the report of the Council on the proceedings of the Society during the year 1886 was read by Mr. P. L. Sclater, F.R.S., Secretary to the Society. It stated that the number of Fellows on January 1, 1887, was 3146, showing a decrease of 47 as compared with the corresponding period in 1886. The total receipts for 1886 had amounted to £25,787 0*s.* 4*d.*, showing a decrease of £22 9*s.* 9*d.* as compared with the previous year. This slight decrease was mainly due to the falling off of the number of Fellows, and consequently of the receipts for subscriptions. The balance brought from 1885 was £972 8*s.* 1*d.*, making a total of £26,759 8*s.* 3*d.* available for the expenditure of 1886. The ordinary expenditure for 1886 had been £24,438 17*s.* 9*d.* Besides that, an extraordinary expenditure of £129 15*s.* had been incurred, which brought up the total expenditure for the year to £24,568 12*s.* 9*d.* The usual scientific meetings had been held during the session of 1886, and a large number of valuable communications had been received upon every branch of zoology. These had been published in the annual volume of Proceedings for 1886, which contained 716 pages, illustrated by 60 plates. Besides this, five parts of the twelfth volume of the Society's Quarto Transactions had been issued, thus making up all the arrears in this branch of the publications. A new edition of the Library Catalogue had also been prepared and issued. The Society's library now contained about 15,000 separate volumes. The "Zoological Record," which consisted of an annual volume containing a summary of the work done in the various branches of zoology in each year, would in future be published by the Society under the superintendence of a committee of the Council appointed for the purpose, and edited by Mr. F. E. Beddard, Prosector to the Society. The visitors to the Society's Gardens during the year 1886 had been altogether 639,674. The corresponding number in 1885 was 659,896. A slight alteration in the arrangements for the Davis Lectures on zoological subjects had been made for the present year. Mr. F. E. Beddard, Prosector to the Society, had been appointed Davis Lecturer, and had commenced a course of ten lectures on the Classification of Vertebrate Animals. The lectures were a continuation of a series given last year in connexion with the London Society for the Extension of University Teaching. The number of animals in the Society's collection on December 31 last was 2609, of which 777 were mammals, 1429 birds, and 403 reptiles. Amongst the additions made during the past year, 15 were specially commented upon as of remarkable interest, and in most cases as representing species new to the Society's collection. About 30 species of mammals, 20 of birds, and 3 of reptiles had been bred in the Society's Gardens during the summer of 1886. The report concluded with a long list of the donors and their various donations to the Menagerie during the present year.—A vote of thanks to the Council for their report was then moved by the Hon. J. S. Gathorne-Hardy, M.P., seconded by Mr. H. Berkeley James, and carried unanimously. The report having been adopted, the meeting proceeded to elect the new members of the Council and the Officers for the ensuing year. The usual ballot having been taken, it was announced that Sir Joseph Fayrer, K.C.S.I., F.R.S., Mr. John P. Gassiot, Col. James A. Grant, C.B., C.S.I., F.R.S., Prof. A. Newton, F.R.S., and Mr. Joseph Travers Smith, had been elected into the Council in place of the retiring members; and that Prof. W. H. Flower, F.R.S., had been re-elected President, Mr. Charles Drummond, Treasurer, and Dr. Philip Lutley Sclater, F.R.S., Secretary to the Society for the ensuing year. The meeting terminated with the usual vote of thanks to the Chairman, proposed by Sir Joseph Fayrer, K.C.S.I., and seconded by Mr. Herbert Druce, and carried unanimously.

Chemical Society, April 21.—Mr. William Crookes, F.R.S., President, in the chair.—The following papers were read:—The atomic weight of gold, by Prof. T. E. Thorpe, F.R.S., and Mr. A. P. Laurie.—The atomic weight of silicon, by Prof. T. E. Thorpe, F.R.S., and Mr. J. W. Young.—Note on substitution in the benzene nucleus, by Dr. H. Foster Morley.—Reply to the foregoing note, by Prof. Henry E. Armstrong.

Royal Microscopical Society, April 13.—Rev. Dr. Dallinger, President, in the chair.—Mr. T. C. White exhibited a series of photomicrographs which he had recently taken, showing the result of the method of cutting off some of the superfluous light by means of a sliding diaphragm so as to be able to admit just enough to bring out the detail and nothing more. The specimens shown were printed on Eastman's bromide paper instead of silver paper which he found brought out the character of the detail very much better.—Mr. F. R. Cheshire called attention to some specimens of bees, known as "fertile workers." It was generally well known that in the bee-hive all the eggs were usually laid by the queen, and in her absence no ovipositing occurs until they have taken some of the eggs remaining in the hive, and by a special feeding of the larvæ have been able to produce fresh queens. If, however, it should happen that in a hive which has lost its queen there are not eggs available for this purpose it was found that some of the workers under some special circumstances which could not be very clearly explained, became capable of laying eggs, but that such eggs produced drones only. These bees were known as fertile workers, and though there could be no doubt as to their frequent existence, they were very difficult to catch, owing to their being the same in appearance as the ordinary workers. He now exhibited two of these fertile workers having the ovaries drawn out of the bodies and attached to the stings and abdominal plates so as to show that they really were workers. There was a remarkable peculiarity to be observed in connexion with the ovarian tubes of these insects—every ordinary worker possessed an undeveloped ovary which it was very difficult both to detect and dissect, but when under the influence of some stimulus the worker became fertile, a number of points began to appear in the tubes which afterwards became developed, and it would seem that the eggs were

developed in alternation, an examination of the tubes showing them to contain developed eggs alternating with others in an undeveloped condition and of which some very curious instances were seen in the specimens before the meeting.—Mr. Crisp called attention to some photomicrographs of animalcules sent by Mr. J. B. Robinson; and to photographs of snow-crystals sent by Mr. Waters, from Davos Platz; also to a specimen of one of the earliest forms of the compound microscope by Campani, of Rome, made some time prior to 1665.—A new form of adjustable nose-piece, by Dr. Zeiss, was exhibited, in which the objective was made to slide in a groove in an inclined plane which insured its not scraping along the surface of the cover-glass when being changed.—A paper by Mr. P. H. Gosse, on twelve new species of Rotifera, was read.

Liverpool.

Biological Society, March 12.—Prof. Herdman, Vice-President, in the chair.—A paper was read by Mr. I. C. Thompson on some new and little known Copepoda of Liverpool Bay. The paper included the description of several new points in the anatomy of several species new to British seas.—Dr. Collins communicated some observations on anatomical abnormalities.—Mr. Harvey Gibson (Secretary) read the first of a series of notes on floral morphology, dealing with the angle of insertion of the petals on the thalamus in the *Polypetalæ* and the form of the flower as a whole in the *Gamopetalæ*, in their relation to the protection of the essential organs.

April 23.—Prof. Herdman, Vice-President, in the chair.—The Secretary (Mr. Harvey Gibson) read a preliminary paper on a research into the nature and function of the so-called "hepatic cells" of *Lumbricus terrestris*, by himself and Mr. A. J. Chalmers. The results so far tend to show that the so-called "cells" are rather digestive glands and not "vasifactive tissue" as suggested by some biologists.—Mr. G. F. Moore read a note on a new tank for the maceration of osteological specimens.—Dr. Herdman read a preliminary paper by Miss F. Palethorpe and Miss C. Wilson on a collection of Ascidians from Australian seas, sent by the Sydney Museum authorities to the Fisheries Exhibition, and containing a number of new species.—Dr. Bruce exhibited a collection of surface animals from Maltese seas, and Mr. R. McMillan exhibited a specimen of a pile from the works of the Canadian Pacific Railway, destroyed by the borings of *Teredo*.—Mr. G. H. Morton exhibited the spicules of sponges that he recently found in several places in the chert-beds of the Cefn-y-Fedw sandstone of Denbighshire and Flintshire, on the horizon of the millstone grit. Mr. Morton's observations have been confirmed by Dr. Hinde. The spicules probably belong to a genus of *Hyalonema*, and have not been recorded previously from North Wales.

Berlin.

Physiological Society, April 15.—Prof. Du Bois Reymond, President, in the chair.—Dr. Prause spoke on the degeneration of nerves resulting from sectional injuries. According to Waller, when a nerve is cut through, the peripheral parts degenerate, whereas the central remain intact. The result of a thorough investigation of the nerves in cases of amputation, which the speaker carried on some years ago in conjunction with Dr. Friedlander, has however shown that the central parts of the divided nerves had degenerated even right up to the spinal cord. Quite recently, Dr. Prause has repeatedly examined the nerves in cases where, owing to gangrene of the foot, the leg had been amputated close below the knee. Here the degeneration of the nerves extended up to, and probably beyond, the surface of amputation, having in such cases started from the gangrenous parts, and progressed centripetally. Side by side, however, with the larger number of degenerated fibres a few normal fibres were also found. From experiments on animals in which nerves of very different kinds, both sensory and mixed, were cut through, it appeared that in the peripheral parts by far the larger number of the fibres degenerate, while at the same time a not inconsiderable number remain unaltered; similarly degenerated and normal fibres were found in the central part of the nerve, only in this case the relative number of each kind is in an inverse proportion to that in which they are found in the peripheral part. It follows from the above that, starting from the point of section of a nerve, one set of fibres degenerates towards the periphery, the other towards the centre. It seemed right to assume that those fibres which degenerate towards the periphery have their trophic centre in the spinal cord or brain as the case may be, while those which degenerate centripetally are dependent for their nutrition on some centre at the periphery, such as presumably the tactile corpuscles of Meissner. Were this not so, Waller's law would again hold good, since only those parts of a nerve degenerate which are cut off from their trophic centre: only sensory nerves degenerate centripetally.—Dr. Grunmach communicated the results of some experiments on the relation between the curve of distension of elastic tubes and the rate of the pulse-wave in the same. These experiments were carried out with various gutta-percha tubes and with the aorta of horses; the internal pressure being varied from 0 to 200 mm. of mercury, the alteration of volume of the tubes and the rate of transmission of the pulse-wave were both measured. The results showed that the rate of the pulse-wave is most markedly dependent upon the distension-curve or coefficient of elasticity of the tube; this coefficient is, however, very variable with different tubes. The behaviour of a horse's aorta approximated to that of an india-rubber tube wrapped round with linen. The thickness of wall of the tubes and the size of their lumen was very slightly, if at all, altered by the varying pressure, and their influence upon the relationship of pressure and rate of pulse-wave was quite subordinate.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

La Cytodiérèse chez les Animaux: J. B. Carnoy (Peeters, Louvain).—Report on the Mining Industries of New Zealand (Wellington).—Gold Fields of Victoria; Reports of the Mining Registrars for the Quarter ended December 31, 1886 (Ferres, Melbourne).—Elements of Dynamics, part 1, book iv.: W. K. Clifford (Macmillan).—Lessons in Elementary Practical Physics, vol ii.: B. Stewart and W. W. H. Gee (Macmillan).—Pioneering in New Guinea: James Chalmers (R.T.S.)—Eastern Geography: Prof. A. H. Keane (Stanford).—Systematic Lists of the Flora, Fauna, Palæontology, and Archæology of the North of Ireland, vol. i. (Belfast Naturalists' Field Club).—Proceedings of the Linnean Society of New South Wales, 2nd series, vol. i., part iv. (Trübner).—*Challenger* Reports—Zoology, vol. xix. (Eyre and Spottiswoode).—Beobachtungen der Russischen Polarstation auf Nowaia Semlja, ii. Theil.; Meteorologische Beobachtungen: K. Andrejeff.—Beobachtungen der Russischen Polarstation an der Lenamündung, ii. Theil.; Meteorologische Beobachtungen, i. Lief.; Beobachtungen v. Jahre 1882–83: A. Eigner.—A Classification of Animals: E. T. Newton (Philip).—Botanische Jahrbucher fiir Systematik, Pflanzengeschichte und Pflanzengeographie, Achter Band, iv. Heft (Leipzig).—Journal of the Society of Telegraph-Engineers and Electricians, vol. xvi. No. 66 (Spon).—Journal of the Royal Agricultural Society of England, April (Murray).—Beiblätter zu den Annalen der Physik und Chemie, No. 4, 1887 (Leipzig).

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THURSDAY, MAY 19, 1887.

LOCAL NAMES OF BRITISH BIRDS.

Provincial Names and Folk-Lore of British Birds. By the Rev. Charles Swainson, M.A. Published for the English Dialect Society. (London, 1885 [*sic*]).

The Folk-Lore and Provincial Names of British Birds. By the Rev. Charles Swainson, M.A. Published for the Folk-Lore Society. (London, 1886.)

INEPTITUDE for the performance of a literary task has long been held by some publishers to be no bar to a man's undertaking it; but we believe that hitherto this opinion has not been shared by publishing Societies. These bodies may not always have been fortunate in the selection of editors or authors; but in a general way it may be asserted that a grave mistake is seldom made. Such a mistake, however, it is our unhappy lot now to record, and it is the more marked in that it is common to two of them—the English Dialect Society and the Folk-Lore Society. Most of the publications of the former are everywhere recognized as possessing high value—some naturally are better than others; but each of them has reflected credit upon the Committee of that Society, formed as it is of some of the best English scholars, and its work has undeniably been of great use. With the publications of the latter the present writer must avow himself inadequately acquainted, though he is willing to accord to them a reputation not inferior to that which those of the sister Society enjoy. By what perverse fate, then, these two Societies have combined to intrust a subject so exceedingly interesting, and of which it was possible to make so much, as the "Provincial Names and Folk-Lore of British Birds," to a gentleman whose knowledge of it is obviously inadequate, is beyond the reviewer's power to explain. Perhaps it may be only one of those well-known results of divided responsibility which are almost invariably exhibited in statesmanship, generalship, and editorship. A more unsatisfactory work than that of which the double title stands above has seldom appeared on the counter of a careless publisher, and of this fact the Committee of the English Dialect Society seems, when too late, to have become aware; since its thirteenth Report, read at the annual meeting on February 14 last, contains what cannot be looked upon as otherwise than an apology for the course into which it was led. Here we read—

"Mr. Swainson's 'Provincial Names of British Birds' has been published in conjunction with the Folk-Lore Society, at whose instance it was undertaken. . . . The work is interesting, and the list of local names is the best yet published; but it is only right to point out that, in the catalogue given by Mr. Swainson of the books which he has consulted for the purposes of his compilation—about one hundred in all—not a single publication of the English Dialect Society is mentioned. This means, of course, that the words used in almost fifty counties or districts have been entirely overlooked and neglected. Several recent monographs on the ornithology of English counties, most of which contain the local names of the birds, are also omitted from Mr. Swainson's list. . . . It is obvious, therefore, that the Dialect Society, whilst acknowledging their indebtedness to Mr. Swainson for the work he has done, can only regard it as a partial and temporary treatment of the subject; and they will be pleased if they could induce Mr. Swainson or some other member to attempt the compilation of an exhaustive and final list of local bird-names."

This free acknowledgement goes far to exonerate the Committee from their offence, into committing which they would seem to have been dragged by the Folk-Lore Society. Whether the Council of the latter body has expressed itself in any corresponding terms, the present writer is not aware: but that some explanation is due to its members, if they are above caring for anything more than a parcel of old wives' fables indifferently told, is very clear.

That the compiler of a successful list of provincial names of birds should be somewhat of a philologist and somewhat of an ornithologist would seem to be obvious. There is little evidence to show that Mr. Charles Swainson is either one or the other, and a good deal to make us suspect that he is neither. Moreover, we cannot free ourselves from an uncomfortable thought that he has not personally consulted some of the works he quotes, for he certainly "makes hay" with their authors' names and the titles of the books, while he is not above citing a passage at second-hand from a popular author who may or may not have correctly reproduced the original passage—a passage that may or may not occur in any very rare or recondite volume. Furthermore, besides the omissions noticed in the Report just cited, there is a considerable amount of material available which has been wholly passed by. The earlier volumes of the *Zoologist* contain several lists of the local names of birds that seem to be unknown to him, and from those lists, and others there collected, it was many years ago fondly hoped that a gentleman—the Rev. J. C. Atkinson—who, by his later labours, has proved his efficiency, would have compiled a work having the same scope as that now before us.

It does not appear to have occurred to Mr. Swainson that a name has not only a locality, but a history, and that, though information concerning the locality in which it is used is very desirable, information concerning its history is more important still. In regard to the former, what he tells us is generally little enough; and in regard to the latter, what he tells us is generally nothing at all. More than this, the source of such information on either subject as he does vouchsafe is very rarely indicated—still more rarely than is done by M. Rolland, whose "Faune Populaire de France" (a very good book in its way, but one capable of great improvement) is confessedly the model which the work before us tries to copy.

To take the first species in Mr. Swainson's list (p. 1), which species, by the way, he calls by the corruptly abbreviated name "Missel Thrush." He writes of "the fondness of this bird for the berries of the mistletoe, holly, and holm." If he had looked at the careful "Dictionary of Plant-Names" of Messrs. Britten and Holland (published by this same English Dialect Society), or almost any British Flora, he might have seen that holly and holm are synonyms, instead of being, as he would have them, the names of different trees. He also tells us that among the names which this bird has received, from the harsh note it utters when alarmed, is that of "Screech"; but he gives not a hint to connect that word with its undoubted parent form, the Anglo-Saxon *Scric*, which is rendered *turdus* in

the older vocabularies, and is, there can be little question, the early form also of "Shrike," though that was by one of Turner's friends applied to a wholly different kind of bird, which since 1544 has borne it, in books at any rate. Indeed this last species (*Lanius excubitor*) has a very doubtful claim to any English vernacular name at all, though its common congener may rejoice in that of Butcher-bird. But even under "Shrikes" we have no reference to the Anglo-Saxon *Scric*, and we may remark that here (p. 47) we find a passage, some four or five lines in length, inclosed in inverted commas, as though a quotation, and followed by "(Yarrell.)," as if the naturalist of that name were its author. Truth compels us to say that search in all the editions of Yarrell's classical work has failed to show that the so-printed quotation is anything but a paraphrase, and a very inadequate one, of the passage Yarrell wrote.

Coming to Mr. Swainson's second species, the Song-Thrush (p. 3), we find no attempt to trace the nice distinction which runs through more than one Teutonic tongue between Thrush and Throstle—the latter being the diminutive of the former, as Prof. Skeat's "Dictionary" shows, and our author is content to quote Macgillivray at second-hand from Mr. Harting, whereby an accidental error (slight, but enough to give the passage a wrong meaning) is repeated. Space fails us to criticize what else Mr. Swainson says of these two species alone, and of course it would be impossible to go through the whole of his volume in this way, even if we wished to do so. Suffice it to say that there is scarcely a page to which exception of one kind or another could not be taken, and now let us turn to the very end of the book. Here (p. 217) in what he says of the last but three of the species in his list we find the astounding statement that from the French word *Guillemot* (corresponding with the same in English) comes the Welsh *Guillem*! This is enough to make any patriotic inhabitant of the principality go off his head, for though doubtless the words have a common origin, the derivation, if such there be, must be the other way, and the modern French [1] *Guillemot* be the offspring of the Cymric and probably Breton *Gwillim*, or *Gwylym* as Pennant wrote it. On the next page, Mr. Swainson gives us a piece of information as curious and, we fear, unwarranted, telling us that the names Greenland Dove and the like (applied to what in books is called the Black—but here by accident misprinted "Lack"—Guillemot) are bestowed on account of "the great attachment shown to each other by the male and female, thus resembling the dove." Ornithologists knew that in one of its plumages the Tysty is very dove-like, but we think they did not know, and, if they believe it, will doubtless be thankful to Mr. Swainson for the news, that it is remarkable for conjugal affection! We should doubt whether the Rotch, or Little Auk, was ever called by Icelanders "*álka*," for by that name, when properly spelt, they mean the Razorbill; and, arriving at the last bird in the list, we are concerned to find that the Puffin is "so called either from its puffed-out appearance, or from its swelling beak." Setting aside the fact that no one who has ever examined the compressed "coulterneb" of the Puffin could reasonably apply thereto the epithet "swelling," we may remark that the name seems to have been first applied to the young birds in their downy clothing, which, when salted and dried, were held in some estimation as an article of food, and were described by Gesner in 1555 ("Hist. Avium," pp. 110, 768), from an account furnished to him by Caius, as wanting true feathers, and being covered only with a sort of woolly black plumage—natural "powder-puffs," in fact. It is true that Caius himself, fifteen years later ("Rarior. Animal. Libellus," fol. 21) declared that the name is derived "a naturali voce pupin"; but that assertion will not be confirmed by those who know the bird in life. Mr. Swainson would no doubt have mentioned these particulars had he known them, and he might easily have found them out by searching for the earliest record of the species; but, as before remarked, investigation is a quality in which he appears to be singularly deficient.

There may be readers who will condone such blemishes as those of which we have given some half dozen instances out of—we should be sorry to say how many that we could notice. Several far more flagrant than those we have particularized have attracted attention elsewhere,[1] and are therefore purposely passed over by us; but before we leave the subject we should like to say a few words on the distinction which exists between *real* and what we may perhaps call *book* names—a distinction in no way heeded by our author. To use the phrase of Sir Hugh Evans, these last are "affectations." They may or may not be needful, they may or may not be apposite, and they may not be adopted into our language; but they are artificial grafts, and not its natural outgrowth. Consequently, from the linguistic and philological point of view, the difference between the two classes of names should be always most carefully drawn, and the more carefully since, in some cases, the child of adoption puts on an appearance amazingly like that of the child of generation. To show this difference an investigation of the history of names is needed; but that is not attempted by Mr. Swainson. Few persons would suspect that the name "Dipper," which of late years has in common use almost wholly ousted the Water-Ousel, Water-Crow, or Water-Pyot of former days, was not of very ancient origin, and referred to that bird's habit of diving below the surface of a stream in quest of its prey, as indeed is stated by Mr. Swainson (p. 30). Yet, directly we inquire into the history of the name, we shall be unable to trace it beyond 1804, when it was apparently introduced by the writer of the work known as "Bewick," and also find that it was applied because the bird "may be seen perched on the top of a stone in the midst of the torrent, in a continual dipping motion, or short courtesy often repeated." Here the need of explanation is all the greater, because this particular sense of the word "dip" or "dipping"—though familiar enough to our forefathers, has become almost obsolete, and, indeed, is passed over by Prof. Skeat. "Dipper," therefore, is nothing but a book-name. Then, again, under "Hedge-Sparrow"—a name which must last so long as Shakespeare is read—we have, amid half a dozen genuine local synonyms, "Hedge-warbler, Hedge-accentor, Hedge-chanter" brought in, as if they were ever employed except by a few crotchety writers, who tried to confine the use of the word Sparrow in

[1] In older French, *Guillemot* was applied to a Plover, as by Belon in 1555.

[1] *Athenæum*, March 19, 1887, pp. 386-387.

a way that not many English words will brook, and certainly not a word of such wide meaning and acceptance as this. In the same way the book-names of the Stone-Curlew—Thickknee, Norfolk Plover, and the rest, to the number of half a dozen—are gravely printed as if they were "provincial"; and here we may remark that Mr. Swainson applies (p. 200) the Arabic name of this species "*Karrawan*" (as he prints it) to its namesake the Long-billed Curlew or Whaup, which must be wholly unknown to most of the descendants of Ishmael.

We very much regret that we have to express ourselves in such terms of this book. We doubt not that the author has done the best that in him lies, and we are especially sorry to find from his preface that the delay in its appearance (for it had been long looked for) is due to his ill health. It is on this last account that we are indisposed to drive home many charges of carelessness which might easily be established, and we part from him trusting that in another edition he may have the opportunity of justifying his selection by these two learned Societies for the duties that we strongly suspect he must already regret having undertaken; but to do this he should acquire some knowledge of the ways and looks of birds, and learn the rudiments of etymology.

RECENT WORKS ON THE THEORY OF DETERMINANTS.

Primeiros Principios da Theoria dos Determinantes. Por J.-A. Albuquerque. (Porto, 1884.)

Die Determinanten in genetischer Behandlung. Von Adolf Sickenberger. (München, 1885.)

Vorlesungen über Invariantentheorie. Bd. I. *Determinanten.* Von Paul Gordan. (Leipzig, 1885.)

Elemente der Theorie der Determinanten. Von Paul Mansion. 2te vermehrte Auflage. (Leipzig, 1886.)

An Elementary Treatise on the Theory of Determinants. By Paul H. Hanus. (Boston, 1886.)

Beiträge zur Theorie der Determinanten. Von Wilhelm Schrader. (Halle, 1887.)

THREE of these works are introductory text-books of from fifty to eighty pages, and may consequently be dismissed in a few lines. The first is a skilfully arranged and well-written manual, furnished with suitable exercises, and ought to be found exceedingly serviceable in the secondary schools of Portugal. That by Prof. Mansion, of Ghent, has already been referred to in NATURE; the fact that it is now in the fourth French edition and second German edition is sufficient proof of its value. The third, by Gymnasial-Professor Sickenberger, is the largest and yet the most elementary, having been intended (not very wisely, we are disposed to think) for pupils very imperfectly prepared in algebra. Twelve pages, including a collection of thirty exercises, are devoted to determinants of the second order, thirty-eight pages to those of the third order, and the remaining thirty pages to determinants in general, the whole being prepared with endless pains and much preceptorial skill. Introductory works of this kind have for a number of years been appearing in Germany at the rate of 1.3.... per annum: in England we have not had one since 1875. Our insular way of doing things, however, is so different from that of the Germans that it may be fairly questioned whether we are any the worse for the deficiency. It would certainly be very erroneous to conclude that the advance of the theory of determinants in the two countries during the period referred to has shown the same marked contrast.

Gordan's "Vorlesungen" is a book on the lines of Salmon's "Modern Higher Algebra." The theory of determinants is consequently not taken up in its entirety, the design having been to give the main propositions regarding general determinants and to include the discussion of only those special forms which are connected with the chief subject of the work—to give, in fact, such a knowledge of determinants as would enable the student to prosecute investigation in the theory of invariants. It is nevertheless a very full exposition—much fuller than Salmon's, and much more methodical. The section on Permutation and Substitution should be carefully noted: although in essence it dates from the time of Cauchy, it will be none the less fresh to many readers.

"Beitrage" is rather a misnomer for the remaining German work on our list. The book is nothing more nor less than an ordinary, or very ordinary, *text-book*, containing three chapters, the first on determinants in general, the second on the adjugate determinant, and the third on determinants of special form. The author attaches considerable importance to a new notation which he introduces and uses throughout, and to various new theorems which he enunciates and proves; indeed, the title-page bears the intimation, "Neue Sätze und eine neue Bezeichnung." The said new notation is obtained by placing the lengthy but excellent umbral notation—

$$\begin{vmatrix} 1, 2, 3, \ldots, n \\ 1, 2, 3, \ldots, n \end{vmatrix}$$

atop of another notation, which is itself none too compact, viz. $D(a_{i,k})$, the outcome being

$$D(a_{i,k})^{1, 2, \ldots, n}_{1, 2, \ldots, n}$$

It is a little hard to see that this piling of Pelion on Ossa results in "grössere Einfachheit." As for the new theorems, we are satisfied that the author will change his mind in regard to them as his range of reading widens. All the results on pp. 98–111, for example, are perfectly well known in England and America: indeed, the whole of them which concern alternants of the third order are included in a single theorem of Prof. Woolsey Johnson's. None the less credit, however, is due to the author for the work he has done; and we trust that, having examined the literature of his subject, he will continue his investigations and attain a more enduring success.

The new American text-book stands out in marked contrast with the preceding. First of all, it is a book of good outward appearance; paper, printing, and binding being unexceptionable. In the second place, the author makes no pretensions to originality: in his preface he enumerates a few manuals, English and Continental, to which he is indebted, and frankly states that he has used them all freely. Some of them, we should say, he has used more freely than others, but, on the whole, with good judgment, and in such a way as to show that he

possesses an independent grasp of the subject. The only notable instance of lack of insight is in the section on continuants, where two pages (pp. 179, 180) are unintentionally devoted to proving the theorem—

$$\frac{mA}{mB} = \frac{A}{B}$$

this very theorem itself being employed in the proof. Mr. Hanus will doubtless yet come to see that the book in which this originally appeared requires to be perused in a spirit of scepticism rather than of faith. We may note also that the identity (5) on p. 37 is exactly the same as (3) on the preceding page, that the footnote on p. 196 is misleading, and that the investigations referred to on p. 199 might with advantage have been further drawn upon. These latter, however, are small points which can be attended to in the second edition. The book, on the whole, is trustworthy, and well adapted for College use. On this account, and as being the first American text-book on the subject, it deserves a cordial welcome both in America and in Britain. THOMAS MUIR.

OUR BOOK SHELF.

The A B C of Modern Photography. 22nd Edition. (London: The London Stereoscopic and Photographic Company, 1887.)

ALTHOUGH this is called a new edition, it is really a new book, having been reconstructed and much new matter added. Those who are about to begin photography cannot do better than study and carry out the instructions which are here clearly stated. The book is divided into two parts.

In Part I. the beginner is taken through the whole process—exposing, developing, printing, &c.—and this is followed by tables of weights and measures.

Part II. contains good accounts of all the advanced parts of the art, such as re-touching, portraiture, &c., together with chapters on photo-micrography, instantaneous photography. One of the latest developments of photography is shown in the "detective book camera," which has the appearance of an octavo book of a thickness corresponding to about 200 pages. The new method of taking negatives on paper is fully described. Lastly, under the headings of "New Apparatus and Processes," Rayment's patent tripod top is mentioned, which allows the camera to be pointed in any direction, and also the patent photographic Gladstone bag, which is fitted up so as to contain a complete photographic outfit. We must not omit to say that the book is fully illustrated, the frontispiece being a photo-mezzotype taken by a pupil of the Stereoscopic Company.

Newcastle-upon-Tyne Public Libraries. Supplementary Catalogue of Books added to the Lending Department. (London: G. Norman and Son, 1887.)

IN this supplement the compiler has given nearly as much space to 10,000 volumes as was occupied by twice that number in the catalogue published in 1880 (see NATURE, vol. xxiii. p. 262). Most of the works have been published since 1880, but some earlier books have also been added. The rapid accumulation of knowledge makes it extremely difficult to provide adequate references to the subjects of pamphlets and of articles in treatises and serial publications. The compiler has, however, recognized the importance of this part of his work, and the results of the labour he has devoted to it will be of real service to students who may have occasion to consult the supplementary catalogue.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Thought without Words.

I DO not see that Prof. Max Müller's theory of the inseparability of thought from language, whether true or erroneous, has any important bearing on the origin of man, whether by evolution or otherwise. It is a question at all events to be studied by himself, and to be tested by such experiments as we can make by introspection, or by such facts as can be ascertained by outward observation.

My own opinion is strongly in favour of the conclusion urged by Mr. F. Galton. It seems to me quite certain that we can and do constantly think of things without thinking of any sound, or word, as designating them. Language seems to me to be necessary to the progress of thought, but not at all necessary to the mere act of thinking. It is a product of thought; an expression of it; a vehicle for the communication of it; a channel for the conveyance of it; and an embodiment which is essential to its growth and continuity. But it seems to me to be altogether erroneous to represent it as any inseparable part of cogitation. Monkeys and dogs are without true thought not because they are speechless; but they are speechless because they have no abstract ideas, and no true reasoning powers. In parrots the power of mere articulation exists sometimes in wonderful perfection. But parrots are no cleverer than many other birds which have no such power.

Man's vocal organs are correlated with his brain. Both are equally mysterious because they are co-operative, and yet separable, parts of one "plan." ARGYLL.

Argyll Lodge, Kensington, May 12.

HAVING much of the same experience as Mr. Galton, I nevertheless prefer dealing with a larger group of facts. I have often referred to the mutes of the seraglio at Constantinople, who cannot be charged with thinking in words. They have their own sign conversation among themselves, and which has no necessary reference to words. Even the names of individuals are suppressed among themselves, though they sometimes use lip reading to an outsider to make him understand a name. Anyone having a knowledge of sign language is aware that it is independent of words. The tenses of verbs, &c., are supplied by gestures.

The mutes are not deficient in intelligence. They take a great interest in politics, and have the earliest news. It is true this is obtained by hearing, though they are supposed to be deaf-mutes, but among themselves everything is transmitted by signs.

HYDE CLARKE.

32 St. George's Square, S.W., May 12.

I THINK that all who are engaged in mechanical work and planning will fully indorse what Mr. Francis Galton says as to thought being unaccompanied by words in the mental processes gone through. Having been all my life since school days engaged in the practice of architecture and civil engineering, I can assure Prof. Max Müller that designing and invention are done entirely by mental pictures. It is, I find, the same with original geological thought—words are only an incumbrance. For the conveyance and accumulation of knowledge some sort of symbols are required, but it appears to me that spoken language or written words are not absolutely necessary, as other means of representing ideas could be contrived. In fact, words are in many cases so cumbersome that other methods *have* been devised for imparting knowledge. In mechanics the graphic method, for instance. T. MELLARD READE.

ON reading Mr. Galton's letter, I cannot help asking how Prof. Max Müller would account for early processes of thought in a deaf-mute: does he deny them? S. F. M. Q.

Scorpion Virus.

I AM much obliged to Sir J. Fayrer for pointing out a mistake in my paper on this subject in the Proceedings of the Royal Society of January 6, 1887. In referring to his experiments I remarked, "They show conclusively that the cobra poison will not affect a cobra, and will not even affect the viperine *ptyas*." "*Ptyas*" was written by mistake for "*Daboia*."

I take the opportunity of recording an observation with regard to the slight power scorpions possess of withstanding the heat of the sun's rays. If a scorpion is placed in an open pie-dish in the sun (the experiments were tried in Madras on an averagely hot day), it will run violently round and round, lash its sting about, and then gradually become torpid; this happens in from seven to ten minutes. If then removed into the shade, it will gradually recover; but if left for longer in the sun, it dies. As the scorpion is an inhabitant of hot countries, this sensitiveness to the sun's rays is very remarkable. A. G. BOURNE.

Madras, April 13.

Weight and Mass.

I FIND it convenient to distinguish in writing between mass and weight by using the symbols *gr.* or *kgr.* or *lb.* to denote masses, and reserving capital letters *Gr.*, *Kgr.*, &c., where weights, or forces in gravitation measure, are understood; say, 50 *kgr.* of stone, or wood, or iron—1000 *Kgr.* denoting a stress in some structure or the like. Some agreement in these notations would be desirable. W.

Lemberg, May 14.

Dynamical Units.

IN reference to this subject may I remark that the proposed term "cel" is etymologically incorrect for the meaning intended to be conveyed? It might stand as a contraction for "celerity," *i.e.* velocity, but not for the rate of *increase* of velocity. The essential distinction between velocity and acceleration is wholly expressed in the prefix "ac." If we must cut all our words down to one syllable, the "ac" would really have in it more correct meaning than the "cel."

Early in 1886, Prof. D. H. Marshall, of King's University, Kingston, published a book on dynamics, in which he uses the word "tach" to mean unit velocity of one centimetre per second. He has no special name for the unit of acceleration, but the unit of momentum he calls a "gramtach," and the unit rate of doing work a "dyntach." The unit pressure-intensity of one degree per square centimetre he calls a "prem."

I would like to suggest that names for the units might be formed syste natically by the addition to the ordinary name for the quantity of the invariable affix "on," which is the root part of the word "one." Thus as unit names we would employ "velociton" or "velon"; "acceleron" or "accelon"; "momenton"; "presson"; "tenson," &c., &c. For the sake of uniformity we might change "radian" into "radion."

Birmingham, May 4. ROBERT H. SMITH.

Monkeys opening Oysters.

So many people have expressed their surprise at hearing that I constantly saw monkeys breaking open oysters with a stone on the islands off South Burmah, that it may be of interest to give a short description of their method of using such a tool.

The low-water rocks of the islands of the Mergui Archipelago are covered with oysters, large and small. A monkey, probably *Macacus cynomolgus*, which infests these islands, prowls about the shore when the tide is low, opening the rock-oysters with a stone by striking the base of the upper valve until it dislocates and breaks up. He then extracts the oyster with his finger and thumb, occasionally putting his mouth straight to the broken shell.

On disturbing them, I generally found that they had selected a stone more apparently for convenience in handling than for its value as a hammer, and it was smaller in proportion to what a human being would have selected for a proportionate amount of work. In short, it was usually a stone they could get their fingers round. As the rocks crop up through the low-water mud, the stone had to be brought from high-water mark, this distance varying from 10 to 80 yards. This monkey has chosen the easiest way to open the rock-oyster, viz. to dislocate the valves by a blow on the base of the upper one, and to break the shell over the attaching muscle. The gibbon also frequents these islands, but I never saw one of them on the beach.

ALFRED CARPENTER.

Marine Survey Office, Bombay, April 14.

Zirconia.

OUR attention has been drawn to a letter in NATURE, vol. xxxv. p. 583, written by Mr. Lewis Wright. He makes the statement that we supplied him with a sample of zirconia as "pure," which, upon examination, he found to contain silica, as well as some soda, rendering the sample quite useless for the purpose for which it was required.

We trust you will allow us to correct this statement. We sold the zirconia as "impure," and when Mr. Wright asked us to purify it further for him, declined to do so. We told him that it was an article obtained as a residue produced during the preparation of another body, and was sold, in consequence, at a price far lower than the usual price at which the article can be produced in a pure state. HOPKIN AND WILLIAMS.

16 Cross Street, Hatton Garden, London, E.C.

Sunspots.

DR. VEEDER is perfectly correct in his letter appearing in NATURE, vol. xxxv. p. 584, in his description of the tiny group of spotlets which were seen on November 15, 16, and 17. The complete record of spots for the month of November 1886 appears to have been as follows, the areas of the spots being expressed, as in the Greenwich results, in millionths of the sun's visible hemisphere.

Date.	Number of spots.	Total area.
November 12	1	7
,, 13	1	9
,, 14	2	8
,, 15	1	1
,, 16	2	5
,, 17	2	12
,, 26	1	6

The mean daily area of these seven days, the only days in the month showing spots, was only 7 millionths, and for the month as a whole, 1·6 millionths. The exceptional character of the month will be better seen when it is remembered that the Greenwich results give 24 millionths as the mean daily area for 1878, the year of minimum; whilst at maximum, as in 1883, the mean daily area was 1155.

With reference to the "six days" which Dr. Veeder quotes from the note on "Solar Activity in 1886," appearing in the Astronomical Column of NATURE, vol. xxxv. p. 445, the assertion was based on a record which was defective for three or four days. The group he describes as making its first appearance on December 8 was not seen here until December 10, and had only become important by December 12. Since the appearance of Dr. Veeder's letter, I have been privileged to inspect the series of photographs taken in India and in the Mauritius, under the auspices of the Solar Physics Committee. These show that the group had not come into view at the east limb until after the photographs on December 8 had been taken, so that, for Europe and Asia, December 9, which was cloudy here, was practically the first day of the spot.

THE WRITER OF THE NOTE.

"The Game of Logic."

IN the course of a review of Lewis Carroll's "Game of Logic" (p. 3), Mr. A. Sidgwick says incidentally that "In Mr. Venn's scheme propositions either tell us that a compartment is empty or tell us nothing about it." This is not quite correct; he should have confined his statement to *universal* propositions. It is quite true that on the schemes of Boole and Jevons nothing is recognized but 0 and 1; nothing but the excision of a combination and the letting it stand; and they both make the attempt to express particular propositions with such resources. But I have taken particular pains to show that such a scheme of dichotomy will not suffice to represent affirmatives and negatives, universals and particulars; and that for this purpose, when we are dealing with logic on the compartmental

theory, if we intend to grapple with every kind of proposition we require a threefold division. We must be able to show that a compartment is empty, that it is occupied, or that we do not know what is its state.

Speaking only of diagrammatic illustration, since it is to this that Mr. Sidgwick is referring, I may say that I have indicated in an article in *Mind* (1883, p. 599) how such a threefold scheme of alternatives could be displayed. Reference to this will be found also in Mr. Keynes's "Formal Logic."

I cannot ask for space to discuss the subject fully here. But I would remark that any scheme that confines itself to *two* alternatives seems to me to be necessarily open to one or other of two serious drawbacks. Either (1) we have to assume that the assertion of a proposition carries with it the existence of its subject. This begins plausibly enough; but when fully worked out it forces us to abandon various universally recognized rules, such as some of those for conversion, contraposition, &c. It also, in the case of complex propositions, departs even further from convention than the opposite doctrine does. And it wholly fails to express hypothetical propositions. I have pointed out these difficulties in my "Symbolic Logic," and the first of them will be found very fully treated by Mr. Keynes. Or (2) we may reject the assumption just mentioned, as Boole and Jevons practically do. We are then wholly unable (in spite of the attempts made by each of these writers) to express *particular* propositions.

JOHN VENN.

Cambridge.

THE PARIS ASTRONOMICAL CONGRESS.

IN our last article we brought down our reference to the *procès-verbaux* as follows:—General Congress meeting, April 19; Photographic Committee meetings, April 20 and 21; Astronomical Committee meetings on the 20th, 21st, and 22nd. We have since then received from Admiral Mouchez the following records:—Third and fourth meetings of the Congress on the 23rd and 25th; meeting of the Permanent Committee on the 26th; and meeting of the Permanent Bureau on the 27th. The two final meetings of the Congress were held chiefly to receive the reports of the Astronomical and Photographic Sub-Committees which have been appointed, and to whose proceedings we have referred in detail, and also to appoint a Permanent Committee, and if necessary a Bureau.

It will be convenient, then, that we should commence by referring to the third and fourth general meetings held on the 23rd and 25th. This first meeting considered the various resolutions which had been arrived at by the Sub-Committees, and the discussions upon them do not appear to call for any more remarks upon our part. With regard to the construction of the object-glass for the light near G, the eminent optician, Steinheil, communicated a note which will appear among the records of the Congress, but of which no details are given in the *procès-verbal*. With regard to the supplementary negatives which are to be obtained for purposes of a catalogue of the stars of reference, the Astronomer-Royal was evidently under the impression that to endeavour to obtain stars of the eleventh magnitude might be going a little too far, and he therefore proposed that a resolution should give authority to the Permanent Commmittee to determine down to what magnitude, not beyond the eleventh, these photographs should include. The Astronomer-Royal also was evidently under the impression that the Congress had been called together to obtain a photographic autobiography or map of the heavens in this present century chiefly, and that it should not lay so much stress as the astronomers present were inclined to do upon a mere catalogue.

Mr. Gill, Her Majesty's Astronomer at the Cape, seems to be of a different opinion, as he remarked that it is necessary to make a catalogue if the thing is possible. The number of stars to appear in the catalogue if the eleventh magnitude is adopted will be about 1,500,000 according to M. Paul Henry, and according to Dr. Schoenfeld, if the 11·5 magnitude were adopted no less than 3,500,000 stars. Subsequently the matter was put to the vote, and the resolution as it came down from the Astronomical Section was approved, Mr. Christie's amendment being lost.

The Congress next passed on to consider the distribution of work among the different Observatories. MM. Beuf and Cruls, representing the Observatories of La Plata and Brazil, were the first to reply that they were ready, it being understood that the price of a telescope similar to that employed by the Brothers Henry would be something like 40,000 francs. Admiral Mouchez stated that it had been decided that the Observatories of Algiers, Bordeaux, Paris, and Toulouse would represent the part which the French Government would be prepared to take, and he also stated that in all probability the Observatory of Santiago in Chili could undertake some portion of the work. M. Weiss stated that the participation of the Vienna Observatory might be regarded as certain. MM. Tacchini and Oom, representing the Observatories of Rome and Lisbon, had little doubt that their Governments would furnish the requisite sums. M. Dunér stated that the Senate of the University of Helsingfors would contribute a photographic refractor, and he did not anticipate any difficulty with his Government. M. Struve had no instructions; M. Auwers was in the same case; Messrs. Christie and Gill followed suit. Mr. Russell declared that in his opinion the necessary funds would be provided to enable the co-operation of the Observatories of Melbourne and Sydney to be assured. Mr. Peters said that he had no doubt that there would be ten Observatories in America anxious to help in the work, but he did not know if they would accept all the terms and conditions of the resolutions of the Congress. M. Pujazon, representing Cadiz, thought that he could promise assistance towards the map, but he could promise nothing relating to the catalogue.

M. Foli, representing Brussels, then proposed the following resolution:—

"If an astronomer takes, by means of a telescope different to that suggested by the Committee, photographs which fulfil the conditions laid down for the map, he shall be able, with the concurrence of the Permanent Committee, to join in the execution of it."

This was subsequently withdrawn.

The final meeting of the Congress was held on the 25th, and the point first discussed was that relating to the Permanent Committee. M. Knobel proposed, on behalf of some of the French astronomers, the following resolution:—

"That there should be two categories of members in the Permanent Committee—first, the Directors of Observatories where the work is carried on; (and secondly, others not necessarily taking part in the construction of the map. This Permanent Committee should name its own Bureau, consisting of a President, two Vice-Presidents, and two Secretaries."

Next followed a discussion as to the number of members of which the Committee should consist. A considerable difference of opinion was made manifest by the remarks of many members of the Committee, and Admiral Mouchez, with the apparent intention of coming to an agreement, proposed the following series of resolutions:—

(1) "Before separating, the International Congress shall delegate its powers to a Commission of eleven members, forming an Executive Commission, charged to study all the questions which have been referred to, and to hasten the preparations for the execution of the map as much as possible. The Directors of Observatories

who shall obtain from their Governments instruments constructed according to the decisions adopted by the Congress shall take part in the work and be members of the Commission."

(2) "The Executive Commission shall meet once a year in one of the cities named beforehand where one of the Observatories is situated. Those members who cannot take part in this reunion shall forward their remarks upon the principal questions to be discussed, of which the President of the Commission shall give notice one or two months beforehand."

(3) "Between these annual meetings, the President should keep himself in communication with the members, and receive or give advice on all matters touching the preparation or execution of the work and the progress already effected."

(4) "The division of the heavens between the different Observatories, and all questions not settled by the Congress, must be fully studied in advance, so that they may be decided in a definite way, at least in two years' time, at a meeting in 1889, by which period many instruments will be ready to begin work."

On the occasion of the Universal Exhibition, Paris will probably be the city most convenient for this second meeting.

(5) "While the map is in progress, each Director who takes part in the work shall send to the Permanent Committee one or two months before each meeting, stating the work done, together with any remarks which he may consider necessary."

(6) "The *procès-verbaux* of these annual meetings, and the resolution of all work done, shall be published regularly, and sent to each Observatory."

The President, M. Struve, asked if M. Knobel would withdraw his resolution in favour of that of Admiral Mouchez. Finally, after some discussion, part of M. Knobel's resolution was carried, all except that portion relating to the constitution of the Bureau.

It was next determined that the number of members of the Permanent Committee, beyond those Directors of Observatories who have declared their readiness to join at once, should be eleven. The members elected were Christie, Dunér, Gill, Paul Henry, Janssen, Lœwy, Pickering, Struve, Tacchini, Vogel, Weiss.

The following resolution was next carried, proposed by M. Auwers:—

"The Congress resolves that it is desirable to appoint a Sub-Committee occupying itself with the application of photography to astronomy, other than the construction of the map, showing the importance of all these applications and the relations which it is important to establish between these different kinds of work. This Committee should place itself in relation with the Permanent Committee. The Congress desires that MM. Common and Janssen be charged to carry out this resolution."

The thanks of the Congress to the French Government, Admiral Mouchez, and the President, M. Struve, brought the Congress to a close.

The first meeting of the Permanent Committee was held on April 26, M. Struve in the chair; M. Trépied was requested to act as Secretary. Much time was spent in discussing whether a Bureau or Sub-Committee should be appointed, although the relation of this Bureau or Sub-Committee to the Permanent Bureau appointed at the last meeting of the Congress does not come out very clearly. Admiral Mouchez stated that the Bureau to be elected at the present meeting was rather an Executive Committee than a deliberative one. This was generally agreed to. The composition of the Bureau was then fixed at one President, five Members, and three Secretaries, and the members elected were as follow:—President: Admiral Mouchez; Members: Messrs. Struve, Christie, Tacchini, Dunér, and Janssen; Secretaries: Gill, Vogel, and Lœwy. M. Vogel then suggested that his colleagues on the Permanent Committee should present to the Bureau before July 1 next any propositions they might have, concerning experiments to be undertaken, and other preparatory work. He suggested also that the Bureau should be allowed to confide directly to men of science, possessing special knowledge, some of the researches which the International Congress has left to the Permanent Committee the responsibity of undertaking and directing.

After discussion of all the documents thus received, a definite plan of preparatory work might be elaborated and distributed among the different Observatories. Admiral Mouchez then stated that the Academy of Sciences would bear all the expenses of printing connected with the work, and it was also agreed that all documents should be sent in French. The Astronomer-Royal was requested to undertake experiments with curved plates. M. Struve promised in a month's time to forward suggestions relating to the methods of proceeding to be adopted by the Bureau. It was further decided that all memoirs and communications should be addressed to the President, and distributed by him and the Secretaries residing in Paris.

The last question discussed was the probable number of Observatories. Mr. Gill remarked that the small number of Observatories in the southern hemisphere were almost all situated in the same latitude, and he suggested that if France would establish a new Observatory in the Island of Réunion or New Caledonia, probably the Government of New Zealand might establish another in that colony. The general opinion was that the Island of Réunion would be better than New Caledonia as a station, and that the Observatory in New Zealand should be built in latitude about 48° S. The following resolution was unanimously adopted:—

"The Permanent Committee of the International Astronomical Conference met together for the construction of a photographic chart of the heavens, and finding that the number of Observatories in the southern hemisphere was insufficient for the good and prompt execution of the work, expressed a desire that two new Observatories might be erected, at least as a temporary measure, one in New Zealand, the other in the Island of Réunion."

The President was charged with the duty of transmitting this resolution to the English and French Governments.

Finally, we come to the Bureau of the Permanent Committee, which held its first sitting on April 27, M. Struve being President.

Mr. Gill announced that Sir James Anderson, Director of the Eastern Telegraph Company, has provisionally authorized the exchange of free telegrams between the Cape and Paris. Thanks were unanimously voted to Sir James Anderson for this offer. All members of the Committee were requested to reply within a month to any question addressed to them, and six was made a quorum. Mr. Gill volunteered to draw up complete instructions regarding all photographic operations. The assistants appointed to conduct the photographic work in the Observatories now taking up photography for the first time are to be trained in Observatories where photographic work is already carried on.

The institution of a series of test objects was then agreed to, and Messrs. Gill, Vogel, and Henry, were requested to draw up a list. On the proposal of Admiral Mouchez, the following distribution of the experimental work was agreed to:—

(1) Systems of cross-wires.—M. Vogel.

(2) Photographic magnitudes.—Messrs. Struve and Pickering.

(3) Optical determinations of images by means of photographs supplied by the Brothers Henry.—M. Struve.

(4) The study of three or four stars nearly in a straight line embracing the total angular distance of about 1°, and photographed necessarily at the centre and at the corner of a plate.—Paris, Algiers, Pulkowa, and Leyden.

(5) Study of the deformations of films.—Algiers, Meudon, and Potsdam.

(6) Study of curved plates from the triple point of view of construction, means of covering with a film, and measures.—Mr. Christie.

(7) Study of absolute orientation—that is to say, the mounting of the plates in the photographic telescope.—The Cape and Paris.

(8) Study of the measuring-instruments to be applied for the future utilization of negatives.—This was postponed.

(9) The study of formulæ for the preparation of plates in accordance with the general rules laid down by the Conference—Messrs. Abney and Eder.

(10) Opinions of colours of stars on their photographic magnitudes.—M. Dunér.

THE TEMPERATURE OF THE CLYDE SEA-AREA.[1]

II.

FROM the curves for each station, temperature sections were constructed for every cruise, showing the position of the isotherms with relation to a profile of the bottom along certain lines. It is not easy to give an intelligible description of the distribution of temperature without reference to those diagrams; but an attempt may be made. The most important section runs from the Channel, across the Plateau, up the Kilbrennan Sound branch of the Arran Basin, through Inchmarnoch Water, to the head of Loch Fyne. It is sufficient to recollect that the Plateau is covered by about 25 fathoms of water, that the depth increases on the inside up to 107 fathoms off Skate Island, then diminishes rapidly to 15 fathoms at Otter and Minard, and increases again to nearly 80 in Upper Loch Fyne. The section is a little more than 90 miles long.

In April the whole section was filled with water between 41°·3 and 44°. The water of the Channel, the Plateau, and the surface layers (to 10 or 20 fathoms) was above 42°. The average bottom temperature was 41°·3, except in the Channel (42°), and in Upper Loch Fyne (41°·9). The June section shows marked surface heating to a depth of about 5 fathoms. Water at 47°·5 filled the Channel, covered the Plateau, and extended in a layer of about 5 fathoms thick over the inner reaches. The great mass of water was between 44°·5 and 44°. In Upper Loch Fyne the remarkable distribution of temperature, referred to when discussing the curves for Strachur, was found to extend from Minard to the head of the Loch, in the form of a lenticular mass of water of temperature under 44°, with warmer water above and below. The minimum temperature, 42°, was found off Inveraray at a depth of 30 fathoms, and the gradient of temperature was much steeper in the upper layers of the cold mass than in the lower. No satisfactory explanation of the mode of formation of this intermediate minimum of temperature has yet been arrived at, and any suggestions as to its origin would be received with interest. In August the section shows that the cold mass remained in the same position but with a rather higher temperature, and of much smaller dimensions. As in previous months, the warmest water was that nearest the Atlantic, which had a temperature of over 53°. The great Arran Basin presented a considerable range; from 54° on the surface to 50° at 20 fathoms, 48° at 30, 46° at 60, and 45°·3 on the bottom. The September cruise showed a very similar state of matters, accompanied by a general rise of temperature and an increase in thickness of the warmer layers. As in each previous month, the Channel was warmest (54°·5 throughout), and the warm surface layer became thinner and thinner until at Otter the surface temperature was under 53°. The section clearly shows, what careful experiments have proved, that the abrupt rise of the sea-bottom, from off Skate Island at 107 fathoms to Otter at 15, is characterised by a rise of colder water from beneath to the surface. The gradient at this place is 550 feet in ten sea-miles, or 1 in 100; and perhaps vertical circulation is set up as much by the sudden narrowing of the Channel, as by its shoaling. A similar effect was observed at Row Point in the Gareloch, and at the narrowest part of the Kyles of Bute. In September the bottom temperature of the Arran Basin was 47°·5, that of Upper Loch Fyne 44°·2; the intermediate minimum had disappeared from the latter. November showed the influence of surface cooling in a marked degree. The Channel and Plateau had cooled down to 50°, and for the Arran Basin the average surface temperature was 49°·5, that at the bottom 51°·5. This shows a great equalisation of temperature, and a reversal of the summer conditions, the warmer water being now below, the cooler on the surface. In Upper Loch Fyne the temperature was 44° at surface and bottom, but a maximum of a little over 50° was found at 15 fathoms. Further cooling and greater equalisation of temperature characterised December; the Channel was warmest, at 48°·5; the whole Arran Basin varied from 46°·8 on the surface to 47°·5 on the bottom; and Loch Fyne maintained its independent position by a quite new arrangement of temperature-layers. On the days of our work there (December 29 to 31) the whole upper part of the Loch was covered with a sheet of frozen fresh water, the ice being nearly half an inch thick in places. Three inches beneath the ice the temperature was 36°, and a few feet under, it was 44°. The maximum temperature of 47°·5 was met at 20 fathoms; and the warm layer of water was giving out its heat to the superficial strata, being cooled by this winter's cold, and to the lower mass which still retained the cold of last winter, although the bottom temperature had risen about half a degree since November. In February it was impossible to observe in the Channel on account of bad weather, but the water on the Plateau was slightly colder (43°·4) than that in the Arran Basin (43°·7 to 44°). There was little range of temperature, the surface being in all cases, however, slightly colder. Throughout the Arran Basin the temperature of the mass of water was the same as in June: this may be held as pointing to the end of April as the period of minimum. Loch Fyne showed a steady rise of temperature as the depth increased down to 45 fathoms, where the thermometer registered 46°·5; from that point to the bottom there was a fall to 45°·8.

Dividing the Clyde sea-area into three parts, each comprising regions of like physical configuration, the direction of the annual march of temperature may be summed up thus.

Starting from the simple case of a minimum *uniform* distribution, the Channel heats uniformly up to September, and then cools uniformly; the strong tidal currents, or some other cause, keeping the water thoroughly mixed, and equalising all heat transactions.

The deep open basins, to which the tide has free access, heat up most rapidly on the surface, and more uniformly lower down; the mass which heats uniformly decreases until at the period of maximum there is an unbroken fall of temperature from surface to bottom, and a considerable range. Then, at the autumnal equinox, the surface water begins to cool, while summer heat is still travelling downwards: this leads to the typical winter state—exactly complementary to the summer condition—of a uniform gradient of temperature rising from surface to bottom, but with a slight range. As winter goes

[1] Continued from p. 39.

on, the rate of cooling becomes more nearly equalised, and on approaching the spring minimum the whole mass of water is at one temperature, and cooling steadily throughout.

The deep inclosed basins differ from the deep open basins only in degree; but in the same direction as the deep open basins differ from the Channel. On this matter I do not care to speak with so much certainty; as, the conditions in the inclosed basins being much more complicated, there is more probability there than elsewhere of local and temporary disturbances being mistaken for the normal progress of events. It appears, however, that summer heating takes place more slowly throughout the mass, although the surface maximum is earlier; and that in the deep, comparatively still water there may be at one time the conjoint effects of more than one summer and winter.

One step further in the direction of conditioning the phenomena of temperature in water is to entirely cut off even superficial tidal communication with the ocean; to form, in fact, a deep inland lake. Observations made by Mr. Buchanan, Mr. Morrison, and myself, on Loch Lomond and Loch Katrine, show that there the annual march of temperature is very much what might be expected from the Clyde observations; but there is the great difference of the water being fresh, and having a maximum density-point varying with the depth, which prevents a rigid comparison being made.

From the temperature sections, which have been described, the average temperature of the whole mass of water for each trip was deduced, by measuring the areas occupied by each range of 2°, multiplying these by their respective mean temperatures, adding the results together, and dividing by the number representing the whole area of the section. In order to ascertain the temperature of the surface water, that of the superficial 2 fathoms was calculated in the same way. By the kindness of Mr. Buchan, of the Scottish Meteorological Society, I was supplied with the mean monthly air temperature (average of twenty-four years) of the Clyde sea-area, and the deviations from the average for each month from January 1886 to February 1887. The figures are given in the accompanying table, and are expressed graphically by curves in Fig. 4.

MEAN MONTHLY TEMPERATURES 1886-87.

	January	February	March	April	May	June	July	August	September	October	November	December	January	February
	°	°	°	°	°	°	°	°	°	°	°	°	°	°
Mean air temperature	39·5	40·0	41·5	46·0	50·5	56·0	58·0	58·0	54·5	48·5	42·5	40·0	39·5	40·0
Deviation for 1886-87	−3·5	−4·0	−2·5	−1·5	−2·5	−2·5	−1·0	−1·0	−0·5	+2·5	+2·5	−4·0	−2·5	—
Temperature of 2 surface fathoms	—	—	—	43·6	—	49·6	—	53·4	53·0	—	49·5	45·6	—	42·5
Average temperature of water	—	—	—	41·7	—	44·8	—	48·7	52·0	—	50·6	46·7	—	44·0

The temperature of water is not the monthly mean, as in the case of air, but that at the time when observations were made.

This shows that the year in which our observations have been made is rather an unfortunate one; because the low temperature of spring and summer, and the high temperature of autumn tended to retard the heating and the cooling of the water so as to produce a curve much flatter than the normal one may be expected to be. The maximum of air temperature occurred between July and August, that of the surface water between August and September, and of the whole mass of water apparently in October. The air and the whole mass of water from surface to bottom had the same mean temperature about the beginning of October; after that date the water remained warmer than the air, and the whole mass of water than the 2 superficial fathoms. It is specially noticeable that, while during heating the surface water is far above the main mass in temperature, it is only a very little below it during cooling.

Knowing the mass of water in the sea-area under consideration, it is easy to convert the temperature data into terms of heat; and, using for convenience the unit of one ton of sea-water raised 1° Fahrenheit in temperature, the following table expresses the actual changes taking place:—

QUANTITY OF HEAT.

Trip.	Commenced	Ended	Interval from last	Change of mean temp.	Average change per day	Total change of heat	Average change of heat per day
			days	°	°	millions	millions
April	13th	21st	—	—	—	—	—
June	16th	22nd	63	+3·1	+0·05	+465,000	+ 7,000
August	4th	12th	50	+3·9	+0·08	+585,000	+11,600
September	22nd	29th	49	+3·5	+0·07	+475,000	+10,000
November	11th	19th	50	−1·4	−0·03	−210,000	− 4,000
December. ...	23rd	31st	42	−3·9	−0·09	−585,000	−14,000
February	3rd	12th	42	−2·7	−0·07	−405,000	− 9,600

To summarise the above and give an account of heat transactions, it is sufficient to say that from April to September there was a gain of 1,545,000 million ton-degrees, corresponding to a rise in average temperature of 10°·3; while from September to February there was a loss of 1,200,000 million ton-degrees, corresponding to a fall in average temperature of 8°·0, thus leaving 343,000 million ton-degrees of heat to be expended by April next, supposing the water to return to the state in which it was

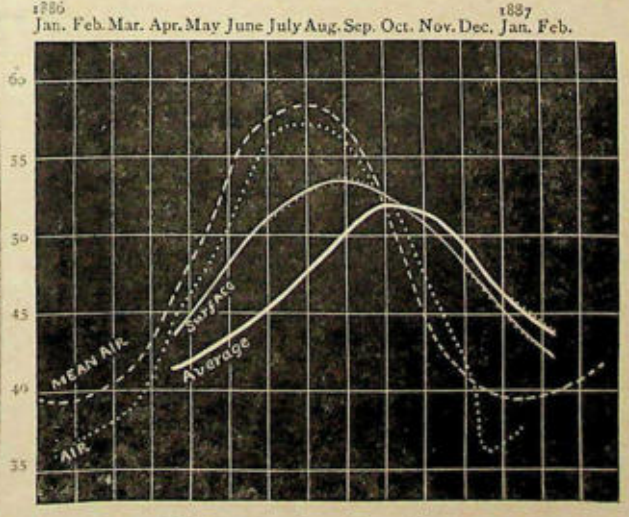


FIG. 4.—Clyde Sea-Area. Annual march of temperature.

in April last. These numbers for heat are of course based to a considerable extent on assumptions, and must only be taken as part of the preliminary discussion of the exact observations already recorded.

Observations made from March 25 to April 3, since the greater part of this paper was in type, show a general

temperature of about 43°·5 over the whole area, and confirm all the provisional conclusions stated above. The figures observed in the three typical positions are as follow :—

	Place ... Date ...	Channel. March 30.	Off Skate Island. March 28.	Strachur. March 29.
Temp. surface	...	44°·7	43°·8	44°·9
,, bottom	...	44°·2	43°·9	45°·5

From the forms of the curves the spring minimum appears to be past, and over all the temperature is about 2°·5 higher than at the same period last year. The water in Upper Loch Fyne is now cooling at the bottom and heating again on the surface, the range for the year at great depths having been only 4°. The actual change of temperature in the sea-area between the beginning of February and the end of March is very slight, but it is significant in showing by its direction that the period of minimum lay between the two.

One interesting application of the observations may be made to climatology. A great proportion of the heat gained is derived not from solar radiation, or the contact of heated air with the surface, but from the warm Atlantic water entering by the tides. Since the water on the Plateau appears to remain warmer than that inside all the year round, no heat is lost to the Atlantic in winter; but all must be radiated off from the surface or employed in evaporating water or heating air by contact, and in this way more heat is returned to the air of the Clyde sea-area in winter than was received from it in summer. Another observation may be mentioned which serves to show how important a bearing temperature observations may have on biology. On February 4, four tow-nets were used off Strachur at different depths: one at 70 fathoms, one at 50, one at 30 fathoms deep, and the fourth at the surface. There was nothing in the surface-net, and the surface temperature was 43°. The contents of the other three nets were examined by Mr. David Robertson, of Millport, who reports :—"In all three nets Copepoda were moderately abundant. The nets at 70 and 30 fathoms contained one and the same species ; but the contents of the net at the middle depth were different, confined to an abundant species of copepod loaded with ova (*Euchaeta norvegica*). With them there were two or three adult schizopods (*Nyctiphanes norvegica*)." At 70 fathoms the temperature was 45°·9, at 30 fathoms 45°·6, and at the position of the middle net 46°·3. Mr. Robertson concludes : "As the middle water of the loch at this time is shown to be warmer than either the layer above or below, we may reasonably assume that the species in ova sought the warmer layer." Similar observations repeated at many different places during the March trip showed the same result, the minute Crustacea being most abundant where the temperature was highest.

The work is being carried on meanwhile, purely as a piece of physical and meteorological research, and a considerable time must necessarily elapse before all the latent meaning of the great mass of figures now being accumulated can be brought to light. There is no doubt that when the problem of the interchanges of heat in comparatively deep water has been made out, important practical applications to other sciences, and to some arts and industries, will be discovered.

HUGH ROBERT MILL.

SCIENCE AND GUNNERY.[1]

II.

LAST week we pointed out the great advantages which accrue from retiring guns behind inconspicuous parapets, and mentioned that the energy of the discharge had been utilised to raise the guns again into the firing position without the aid of extraneous power.

[1] Continued from p. 37.

The theory of the discharge of cannon involves many interesting considerations, not only with respect to the strength and structure of the guns but also with reference to the force required to control the recoil. A gun may be considered as a heat engine of the simplest construction, performing its work in one stroke. The fuel used is gunpowder, and the energy developed is, as in other engines of this class, in proportion to the weight of fuel used and to the heat it is capable of developing. The main difference between explosives and most other fuels is that explosives are complete in themselves ; that is to say, they burn independently of the presence of extraneous bodies, and that consequently the chemical union which causes the explosion takes place simultaneously throughout the mass and in an exceedingly short time.

Fuel in large masses burns slowly because the air which forms its complement, can come into contact with only limited surfaces, but if reduced to fine powder the combustion may be made to assume almost the intensity of an explosion, as for example in the dust-fuel used in Crampton's furnace, and the dusty atmosphere of coal-mines and flour-mills.

The materials in gunpowder, intimately mixed throughout, are in a state of unstable equilibrium with respect to each other ; a very moderate increase to the thermal movement of the molecules causes them to clash together with sufficient energy to insure combination, and if such increase of motion be communicated to one portion of the explosive by the application of percussion or of a hot body, it is carried through the mass by the luminiferous ether with all the rapidity with which radiant energy travels, and the increase of motion, sufficient to cause combination, is communicated to every molecule nearly simultaneously, the consequence being a change of form and volume produced with the suddenness which marks an explosion. We believe that Mr. Anderson was the first, in his lectures on heat at the Society of Arts, to point out that it is unfair to compare the calorific value of fuels in their incomplete form ; that is to say, that such fuels as require air for combustion should have the necessary weight of air added to them, and when that was done the singular fact appeared that the quantity of heat evolved by most combustibles per unit of weight was very nearly the same ; thus in nine cases cited, which included coal, coke, wood, petroleum, illuminating gas, and gunpowder, the extreme variations from the mean calorific value did not exceed 9 per cent. In the same lectures it was shown that in guns, as in most heat-engines, a very large proportion of the thermal energy of the fuel was dissipated in a useless manner ; in the case of cannon more than half was wasted in heating up the gun, and about one-third only in producing recoil, which was the reaction to the energy communicated to the shot, to that imparted to the powder gases, and to the work of displacing the atmosphere. Of these three effects only the energy imparted to the shot was known with precision, for by means of sufficiently simple apparatus it was possible to determine with great accuracy the velocity with which the projectile left the gun, and the energy therefore was easily determined by multiplying half its mass by the square of that velocity.

The determination of the work done in expelling the powder gases was more difficult to estimate. In the first place, only about 43 per cent. of the products of the combustion of gunpowder are in the state of gas, the remaining 57 per cent. are in the form of very finely-divided solids ; next, the combustion goes on nearly all the time that the shot is travelling out of the gun, the pebbles of powder igniting in succession, a fact which is proved by the circumstance that in short guns a good deal of powder is blown out without being consumed at all, and it is doubtful even whether in the modern long guns combustion is always complete. While the shot is travelling along the chase, the centre of gravity of the powder charge is moving also

at an uncertain rate, but the moment the shot leaves the gun the whole of the products of combustion appear to spring out with a velocity equal to, if not greater than, that of the shot. The evidence of this supposition is found in the fact that in the case of disappearing guns fired with their muzzles close to a masonry parapet, and in which the recoil below it is completed in a small fraction of a second, no blackening of the masonry is noticeable. A portion of the gases follow the shot and keep up with it for a considerable distance, as is shown by the circumstance that smoke issues plentifully from the earth banks into which proof shots at short range are fired, proving that the smoke of the discharge must have followed the shot into the tunnel momentarily made and as quickly obliterated by passage of the projectile through the earth. It is evident that the velocity with which the gases issue must depend upon the pressure in the gun at the moment of the shot leaving the muzzle, and this pressure again depends upon the volume of the bore, the weight of powder consumed, and the final temperature, the latter depending partly upon the expansion and the consequent heat converted into work.

The final temperature of the gases can only be conjectured: it probably does not exceed a bright red heat, or between 1200° C. and 1400° C. absolute; and knowing that one pound of powder at 0° C. and standard barometer develops about 4·48 cubic feet of gas, it is possible to estimate what the final pressure in the gun should be. Given, however, a barrel full of gas at a definite pressure, we are not in a condition to say what energy its expulsion would generate: and the assumption that the mean velocity will be that due to a body falling from a height equal to that of a column of gas of uniform maximum density which would correspond to the observed pressure would probably be as accurate as any other. On that assumption the velocity of the gas would be 4544 times the square root of the product of the final pressure in the bore in tons per square inch into its volume in cubic feet divided by the weight of the powder in pounds, and, this velocity determined, the energy is, of course, at once arrived at.

The displacement of the atmosphere also forms a very considerable item. The expansion on leaving the gun being instantaneous, the pressures and temperatures fall approximately as in adiabatic expansion; hence it is easy to calculate what probable temperature and consequent volume the gases will assume as they stream out of the gun, and this temperature is comparatively low; otherwise powder smoke would be insupportable to those feeling its influence close to a gun. The work done in displacing the air is found by multiplying the volume pushed aside by the atmospheric pressure. A small portion of this work is performed as the shot travels along the chase, but the greater part is done after it leaves the muzzle. The energy of the reaction to the sudden liberation of gases under high pressure is but too familiar to us in the case of boiler explosions, in which it commonly happens that great masses of material are hurled with destructive force and often to great distances.

The pressure-curve inside the gun is still very ill-defined; the forms commonly given are certainly a long way from the truth, because the areas included, which form indicator diagrams representing the work done, will not account for the energy developed. The pressure probably falls in proportion to the distance travelled by the shot, and the time in which the discharge takes place may be calculated on that assumption, or even with sufficient accuracy on the supposition that the velocity of the shot is uniformly accelerated as from the action of a constant force equal to the mean pressure producing the known velocity of the shot in a known distance. The easiest way to take account of all the forces causing recoil is to ascertain the velocity of the combined powder and projectile which will possess the total energy of discharge calculated, and then to equate the momentum of the gun and moving parts of the carriage to that of the shot and powder. In the case of a carriage receding along a slide, this operation is a very easy one, but when a Moncrieff mounting has to be dealt with, the case becomes very complicated, the gun moves along a curved path, the sides and counterweights have a rolling motion, and it becomes necessary to calculate the path of the centre of gyration, and determine the virtual weight concentrated in the gun, and a similar process has to be followed in the case of the massive levers which carry the guns in hydro-pneumatic mountings.

Recoil consists of two parts: first, the period, a very brief one, in which the velocity of recoil is got up; and secondly, the period in which the energy so acquired by the parts in motion is more slowly absorbed or dissipated. The first part of recoil must necessarily occupy the same time as the discharge, that is to say, a small fraction of a second, because acceleration can only go on so long as the accelerating force is acting, but that force is the pressure of the powder gases on the base of the bore, and the pressure only lasts while the discharge is taking place. The motion of the whole system of gun and carriage does not, however, coincide with the motion of the shot. In all but very long guns the shot has left the barrel before the motion of the muzzle commences; during the time of discharge, perhaps the 1/50 part of a second, the gun is being stretched by the inertia of its forward end and of the carriage resisting the tendency to put them into motion, but the reaction to this stretching carries on the acceleration of recoil a little after the shot has left the gun. The pressure on the parts during this period is very severe, the work done being exactly the same as that performed by the shot, the powder, and the displacement of the atmosphere. The full speed of recoil is attained, not only in a very short time, but in a very restricted space, rarely more than 3 inches, and the difficulty in constructing carriages may be said to lie in providing for the violent strains which produce a velocity of some 20 feet a second in the great mass of the gun and carriage in the exceeding short time and space named. The momentum of the moving parts of the system being equal to that of the ejected charge, the velocity is readily calculated, and generally ranges between 16 and 30 feet per second, and their energy is then easily ascertained.

In the counterweight Moncrieff carriages, which have been made for short muzzle-loaders up to 9-inch calibre and twelve tons weight, the whole mass set in motion is so great compared with the energy of the discharge, that the gun sinks below the parapet with a comparatively slow and stately movement; but, with the long breech-loaders and heavy charges, with the comparatively light moving parts which characterise hydro-pneumatic mountings, the motion is very violent, and requires great strength in the parts to resist the strains. In addition, the gun describes a circular path, and by the time the maximum velocity of recoil is attained, sufficient centrifugal force is engendered to produce a sudden upward pull, which has to be met by arrangements for holding the carriage down to the masonry of the emplacements. The longer the arms which carry the gun, the less this tendency is, because the pull of centrifugal force is inversely as the length of the radius of the curve described by the trunnions. The front of the carriage has generally to be held down for another reason. The gun, when fired, is high above the base of the mounting; the mechanism, self-contained in the carriage, for absorbing recoil, offers a certain amount of resistance to the backward movement of the gun, hence a couple is established which tends to turn the carriage over on its rear wheels, and this tendency varies with the height of the gun and the length of the base.

In the hydro-pneumatic system the fall of the gun actuates a ram or piston working in a cylinder full of water, and communicating by an automatic valve, opening outwards from the cylinder, with an air-vessel about two and a half times the capacity of the ram, and filled with air compressed to a degree sufficient not only to support the weight of the gun, but also to raise it quickly into the firing position. When the gun is up, the air-vessel is nearly empty; when down, a volume of water equal to that of the ram displaces the air and increases its pressure, and the ratio of the fall of the gun to the stroke of the ram, and the relative velocities of the two, are so adjusted that the increase of air-pressure corresponds to the increasing leverage which the gun acquires as it descends.

It is possible to provide sufficient air-pressure not only to arrest the fall of the gun, but also to absorb the energy of recoil; but unless the gun is allowed to fall a very great distance this is not necessary, and any excess energy can be more conveniently absorbed by regulating the opening of the recoil-valve so as to throttle the water in its passage from the cylinder into the air-vessel. At first sight it might be assumed that, saving friction of the mechanism, the air-pressure which would suffice to check the fall of the gun would be sufficient to raise it again; but a little consideration will show that this is not the case. To allow the gun to fall in the short space of time during which recoil takes place, the pressure of the air must be less than that necessary to support the gun, because its pressure rises nearly according to the ordinates of an adiabatic curve, the temperature rising in exact proportion to the work done During the time the gun is being loaded, the heat developed in the air is dissipated, so that when the gun requires to be raised the store of heat is gone, and the air, expanding, falls in temperature by the amount of heat converted into the work of raising the gun; the pressure consequently falls.

To meet these two sources of loss, amounting to the heat corresponding to the work of the gun falling twice the height to which it rises and falls, the energy of the discharge has to be drawn upon; it compresses the air far above its isothermal line, although that line is so fixed as to yield sufficient heat for conversion into the work of raising the gun. In addition, the energy of discharge has to provide the means of overcoming the friction of the machinery which resists the falling of the gun, and again resists its rising, so that, taking all the sources of loss enumerated together, the energy of recoil of even our most powerful guns is not adequate to do more than allow them to fall some 8 or 9 feet, an amount, however, sufficient for the most ample protection.

It will be readily seen that the construction of a disappearing carriage offers a number of problems of great scientific as well as practical interest. We have only dwelt upon some of the most prominent points. There remain the strains on the elevating gear, which is arranged so as to bring the gun into the same loading position, irrespective of the angle at which it is fired, and has, therefore, to communicate a sudden rotatory motion to the gun: the resistance of the levers and elevating-bars to the cross strains caused by their own inertia when brought into sudden motion sideways: the resistance offered to the water in its passage at variable velocities from the cylinder to the air-vessel, the accelerating force to be provided to raise the gun in a given time, and many minor problems which tax to the full the application of mathematics to the design of machinery.

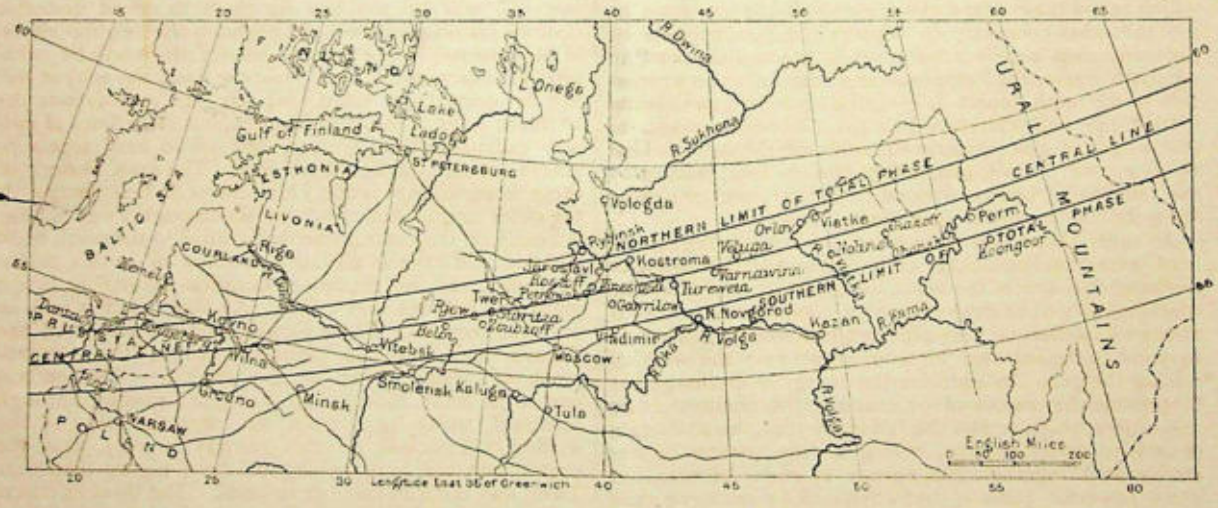
THE TOTAL SOLAR ECLIPSE OF AUGUST 19, 1887.

THE total eclipse of the sun which will occur on August 19 next, though only of average duration, will offer exceptional opportunities for observation from the circumstance that the track of the moon's shadow will be almost entirely a continental one, in striking contrast to the eclipses of the last four years, in all of which the shadow has followed a course which has been principally over the great oceans. The eclipse is technically a partial one for the principal part of Great Britain, but as it will be nearly over before sunrise, it will practically not be visible here. The middle phase will have been reached at sunrise, for places a little to the west of Berlin: and this city lying within the path of the shadow, it is just possible that it may be favoured with a sight of the phenomena of totality, though with a sun close to the horizon; for the sun will be largely obscured as it rises, and will not be quite 3° high at the end of the total phase. From Prussia the shadow track passes into Russia, and the central line does not leave the borders of the Russian Empire until it reaches East longitude 112°. It then crosses Manchuria and the Sea of Japan, and cuts the principal island of the Japanese group a little to the north of the capital. The final portion of its course lies over the North Pacific Ocean, and except for the little island of Rico de Oro, it does not touch land again. But the path of totality not only lies mainly over land, a large number of important towns are either actually included within, or lie very close to its limits. Königsberg lies just outside. Kovno, Wilna, and Vitebsk, are well within the shadow; Wilna being nearly on the central line. At these towns, however, the sun will still be too low for them to afford desirable stations for observations, and probably the neighbourhood of Moscow will be the nearest district which will be occupied by astronomers. At Moscow itself, the eclipse will not be quite total, since that city lies just outside the southern edge of the shadow-track, but three lines of railway radiating from Moscow will afford easy access to places actually on the central line. The most westerly of these three railways is that which unites St. Petersburg with the older capital, and which passes through Twer. Twer is nearly on the central line, but a little to the north of it. The sun will have an elevation of about 16° in this neighbourhood, and the maximum duration of totality is not quite two minutes and a half. At Twer itself it will be only 124 seconds. Three parties, two German, and one French, will take up positions within the Government of which Twer is the capital. The second line runs from Moscow to Vologda, passing through Jaroslavl, which lies within but near the edge of the shadow. Petrowsk on this railway is very near the central line, and here the sun will be 2° higher than near Twer, and the duration 152 seconds. The third line runs to Kineshma, which is itself very near the central line. Here the sun will be about 20° high, and the total eclipse on the central line will last 156 seconds. It will not, however, be difficult to proceed to yet more favourable positions further east. From Moscow there is a line through Nijni Novgorod to Kazan, and a service of river steamers runs thence up the River Kama to Perm. Perm lies to the south of the central line, but the totality lasts there 173 seconds, whilst the sun is 28° high at mid eclipse. If the weather should be favourable, Perm would be therefore a very suitable station for those astronomers who can spare the time to journey so far; for others the neighbourhoods of Petrowsk and Kineshma will afford readily accessible sites. Prof. Bredichin, Director of the Moscow Observatory, has his own private observatory only two kilometres from Kineshma, and very close to the central line; and he has generously offered the hospitality of his house to the Royal Astronomical Society for two English astronomers, an offer which has been gratefully accepted by the Society, on behalf of Dr. Copeland and the Rev. S. J. Perry. Prof. C. A Young also will have his station here, and a strong party of Italian and English astronomers, consisting of Profs. Tacchini and Riccò, and Messrs. Common and Turner, will be located at no great distance away, in the neighbouring Government of Vladimir.

The eclipse being visible in Europe and from places so readily accessible from England, no Government Expedition will be sent out to observe it. It is not probable, therefore, that any English astronomers will go so far east as Siberia. It may be hoped that Russian astronomers will make good this defect, especially as four of the principal towns of Siberia lie on the shadow-track—Tobolsk, Tomsk, Krasnoiarsk, and Irkutsk; the first and third being close to the central line, and the sun being eclipsed when nearly on the meridian at Irkutsk. A series of Siberian stations is the more to be desired, since, as Prof. D. P. Todd has pointed out in the *American Journal* for March, this eclipse offers an exceptionally favourable opportunity for a concerted scheme of observation. The path of totality coincides in a most remarkable manner with the lines of the Russian overland telegraph, so that it will be perfectly possible to select a series of stations in telegraphic communication with each other, and extending over a line of 100° of longitude, with an extreme difference in the absolute time of totality of more than an hour and a half. It appears, Prof. Todd learns from a letter from Dr. S. von Glasenapp, that the Russian telegraph service may be expected to give the use of its lines at the time for astronomical purposes. It is certainly to be hoped that so unique an opportunity may not be lost; for it might well happen that some discovery, either in solar research, or of a comet or intra-Mercurial planet, might receive in this manner the most satisfactory confirmation and development.

The eclipse may also be well observed in Japan. On the west coast, Niigata, one of the Treaty ports, lies well within the shadow on the north, and Takata, a large manufacturing town, on the south, the central line passing through the large fishing-village of Idzumosaki, on the high road between the two. The Island of Sado, opposite to Niigata, which is free to foreigners, is wholly within the shadow, the central line crossing Sawa Umi Bay. The totality here lasts 198 seconds, with a sun 37° high. On the east coast the important town of Mito lies almost precisely on the central line. The duration here will be 192 seconds, and the sun 35° high. Japan, indeed, offers advantages for observing stations superior to those of Perm, as the sun will be considerably higher, and the duration 20 to 25 seconds longer.

The following formulæ, computed by Woolhouse's method (*Nautical Almanac*, 1836), from the elements of the eclipse given in the *British Nautical Almanac*, will supply the means for the computation of the beginning



and ending of the total phase for any place not far from Perm, lat. 58° 8′ N., and long. 55° 12′ E.:—

$$\text{Cos } w = 52'926 - [1'89540] \sin l + [1'42842] \cos l \cos (L - 68° 25'·1);$$

$$l = 17\text{h. } 40\text{m. } 13'0\text{s.} \mp [1'94168] \sin w - [3'20536] \sin l - [3'85031] \cos l \cos (L - 19° 47'·9).$$

And for determination of the latitudes of the central line, and of the north and south limits of totality in the longitude of Perm:—

$$n \cos (N + l) = \begin{cases} - [1'73180] \text{ for N. limit;} \\ - [1'72367] \text{ for central eclipse;} \\ - [1'71538] \text{ for S. limit.} \end{cases}$$

$$n \cos N = [1'42842] \cos (L - 68° 25'·1);$$

$$n \sin N = [1'89540].$$

As in similar formulæ given in NATURE for previous eclipses l is the *geocentric* latitude, L the longitude from Greenwich counted positive towards the east, and t results in Greenwich mean solar time. Quantities within square brackets are logarithms, not simple numbers.

Similarly for places near Idzumosaki, lat. 37° 38′ N., and long. 138° 49′ E., we have:—

$$\text{Cos } w = + 53'9763 - [1'84932] \sin l + [1'53239] \cos l \cos (L - 24° 51'·1);$$

$$t = 17\text{h. } 32\text{m. } 24'9\text{s.} \mp [1'99243] \sin w - [3'45091] \sin l - [3'85537] \cos l \cos (L + 10° 4'·7).$$

And for central line and limits:—

$$n \cos (N + l) = \begin{cases} - [1'74018] \text{ for N. limit;} \\ - [1'73220] \text{ for central eclipse;} \\ - [1'72408] \text{ for S. limit.} \end{cases}$$

THE STEERING OF H.M.S. "AJAX."

WHEN H.M.S. *Ajax* was first sent to sea, her steering qualities were found to be very defective, especially at high speeds, the most objectionable and perplexing characteristic of her behaviour being a tendency to require a large angle of helm to keep her on a straight course. This helm tendency was sometimes on one side and sometimes on the other, generally remaining the one or the other for some time unchanged, but occasionally changing sides without warning or apparent cause. On such occasions, at full speed, the ship had been found to fly off her course at a right angle before she could be mastered by reversing the helm.

In a lecture on this subject, lately delivered before the Royal United Service Institution, Mr. R. E. Froude summarised as follows the causes to which such behaviour might be colourably attributed in ships of the type of the *Ajax*, namely, flat-bottomed and full-ended, particularly in the run: (1) want of "directive character" (as he phrases it)

of hull, from the flatness of bottom and fullness of ends; (2) weakness of action of rudder, from its position in the dead-water; (3) an active turning force, consisting in a one-sided pressure on the stern arising out of a one-sided system of flow in the water closing in behind the full run. It was principally to the last-mentioned cause that Mr. Froude, when called upon to investigate the case of the *Ajax*, was inclined to attribute the behaviour of the ship, such a phenomenon having been some years since incidentally observed in the course of experiments made in the experiment tank at Torquay on the resistance of a model having a full run. In this case a lateral force was found to be developed upon the stern of the model, accompanied by a trailing away of the wake to one side, and a transverse flow of the water across behind the stern, in the opposite direction to that in which the lateral force was developed. This one-sidedness of flow, and consequent force (like the helm tendency of the *Ajax*), was sometimes in one direction, and sometimes in the other, and occasionally reversed its direction during any experiment; but was generally more or less persistent in direction when initiated, although the direction in which it was initiated was apparently a matter of accident. It was Mr. Froude's belief, founded on these and many other experiments of various kinds, that this species of, so to speak, spasmodic one-sidedness of flow, and consequent one-sided force, attends the motion of all, even perfectly symmetrical, bodies through water, whenever their leaving lines are blunt enough to cause a large eddy behind them.

By way of a method of experiment suitable to test the effect of remedies designed to mitigate or remove either of the three presumable causes of the behaviour of the ship, which have been enumerated above, Mr. Froude towed a model of the *Ajax* in the experiment tank at Torquay, the model being attached to the towing carriage in such a way that, while the model was free to sheer out of the straight course, any such attempted sheering motion actuated a working rudder fitted to the model, in the proper direction for frustrating the attempt. By this contrivance the model was made to steer quite straight, and the criterion of the badness of the steering qualities of the model in the several conditions of trial subjected to experiment, was the amount and the degree of unsteadiness of the helm angle administered, this helm angle being continuously recorded throughout each experiment by an automatic apparatus. Thus tested, the model was found to exhibit conspicuously what has been referred to as the predominant characteristic of the behaviour of the ship, viz. the large helm angle, sometimes persistently on one side, sometimes on the other, and occasionally changing from one side to the other.

The principal remedies tentatively applied to the model with a view to identifying the main source of the evil, and indicating the direction in which improvement was to be sought, were these: (1) a deep keel, to supply "the directive character" in which the hull itself was presumably lacking; (2) placing the rudder altogether below the keel, so as to be quite clear of the dead-water; (3) an extensive dead-wood (or fixed rudder) behind the stern-post, (the working rudder being still below the keel), to frustrate the one-sided flow behind the stern, and do away with the consequent turning force. Of these three kinds of remedy the last-named proved much the most effective, proved indeed an almost perfect cure, thereby confirming the surmise that the one-sided flow at the stern was the chief source of the evil. A minor modification of this dead-wood, with the rudder in its proper place, such as could be practically applied in the ship, likewise proved very tolerably effective, the average helm angle required being reduced to one-third of its amount.

On the strength of the results of these experiments, the Admiralty added a structure of this kind to the stern of the ship, with a result which, while it was a remarkable corroboration of the model experiments, was also on the whole a decided success from a practical point of view, the reduction effected in angle of helm being quite sufficient to qualify the ship to steam at full speed in a squadron and keep station satisfactorily.

EDWARD T. HARDMAN

BY the unexpected death of this geologist, on the 30th ult., Irish Science has been deprived of one of her most promising followers. Mr. Hardman was born in Drogheda in 1845, and distinguished himself by the position he took at the Grammar School there, gaining a Government Exhibition and an entrance to the Royal College of Science in Dublin. He soon displayed his strong natural bent towards scientific pursuits, and when he quitted the College he had gained its diploma of Associate and taken a prominent place among its foremost students, more particularly in the departments of chemistry and geology. In 1870 he was appointed to the Geological Survey, and threw himself with characteristic ardour into the prosecution of field-work, while his knowledge of chemistry and mineralogy led to his being employed in special services where this knowledge was made available in the work of the Survey. His reports on the Tyrone and Kilkenny coal-fields are good examples of the extent of his knowledge and of his powers of literary expression. He also made his mark by the publication of papers outside the limits of official work. His interesting and suggestive memoir on the origin of Lough Neagh and his papers on anthracite and chert are well known.

In 1883 the Government of Western Australia applied to the Colonial Office for the services of a trained geologist to examine and report on the mineral resources and geological structure of the colony. Mr. Hardman was selected for the post, and obtained leave of absence from the Home Government to enable him to undertake the duties. He was absent upwards of two years, during which time he effected a preliminary survey of a wide tract of unexplored country, and made known its geological structure. In particular, he indicated the presence of gold, and pointed out the areas where gold-fields might be looked for. After enduring great hardships in the bush, he returned to this country, and resumed his duties in the Geological Survey. But the exposure in the Australian climate seems to have told upon his health. He had not been quite well during the spring, and at last he rapidly fell a victim to an attack of typhoid fever. We understand that arrangements had been nearly completed for recalling him permanently to take charge of the mineral surveys of Western Australia, when his sudden death occurred. He has left a widow and two children with no adequate provision, and his friends have already begun to take steps for collecting subscriptions for their behoof. Prof. V. Ball, of the Science and Art Museum, Dublin, and Dr. Henry Woodward, of the Natural History Department of the British Museum, Cromwell Road, S.W., have kindly undertaken to receive subscriptions.

NOTES.

THE Natural History branch of the British Museum in Cromwell Road has just received a most important donation from Lord Walsingham, consisting of a collection of Lepidoptera with their larvæ, mainly British butterflies (*Rhopalocera*) and certain families of moths (*Heterocera*), including *Sphingidæ*, *Bombyces*, *Pseudobombyces*, *Noctuæ*, *Geometridæ*, and *Pyralidæ*. There is also a fine series of Indian species, collected and preserved at Dharmsala, in the Punjab, by the Rev. John H. Hocking, and specimens of exotic silk-producing Bombyces in

various stages of their development, obtained mostly from M. Wailly. With very few exceptions, the British larvæ, which retain a most life-like appearance, and are placed upon models of the plants upon which they feed, have been prepared and mounted by Lord Walsingham himself; the process adopted having been inflation of the empty skin of the caterpillar by means of a glass tube and india-rubber spray-blower over a spirit-lamp guarded by wire gauze. This has been found a simpler and quicker process, and one admitting of more satisfactory manipulation, than the alternative system of baking by means of heated metal plates or ovens. The specimens have mostly retained their natural colour, but in the case of the bright green species it has been found necessary to introduce a little [illegible] dry pigment. The whole collection consists of 2540 [illegible]imens of larvæ, belonging to 776 species, together with a [illegible]es of the perfect insects of each species. As continued exposure to light is, unfortunately, most detrimental to the colours of insects, this collection cannot be exhibited permanently, but for the advantage of those who would like to see it without any restriction, it will be placed in the entrance hall of the Museum for a period of six weeks, including the Whitsuntide holidays and the Jubilee week in June.

THE Ladies' *Soirée* at the Royal Society will be held on June 8.

THE following men of science have been elected Foreign Members of the Linnean Society:—(Botanists) Dr. George A. Schweinfurth, Professor of Botany, Cairo, Egypt, whose travels and botanical researches in Central Africa are widely known; Count H. Solms-Laubach, Professor of Botany, University of Gottingen, whose observations on the Corallines, Gulf of Naples, and investigations in plant anatomy, especially that of flowering parasites, &c., are acknowledged biological contributions of merit; M. le Dr. Melchior Treub, Director of the Jardin Botanique, Buitenzorg, Java, whose studies among the Lycopods, Cycads, Lichens, &c., and whose labour in editing the "Annales du Jardin de Buitenzorg" are highly appreciated: (Zoologists) Dr. Franz Steindachner, Conservator of Herpetology and Ichthyology, Royal Museum, Vienna, distinguished for his very numerous and important memoirs on fish and reptiles generally; and Dr. August Weismann, Professor of Zoology, University of Freiburg, Baden, noted for his studies on the theory of descent, and embryological researches on insects and hydroids. Mr. William H. Beeby and Mr. Adolphus H. Kent, of London, and Mr. J. Medley Wood, of Durham, Natal, all three worthy workers in various departments of botany, have been elected Associates of the Society.

A LINNEAN herbarium has just been presented to the Upsala University by Prof. H. Sötherstrand, by whom it was inherited. It has been found by comparison of names to be a duplicate of that possessed by the Linnean Society of London.

THE Russian traveller, General Prjevalsky, is shortly to be presented with a gold medal by the Imperial Scientific Society of St. Petersburg, which has been specially struck, by order of the Emperor, in his honour. The medal bears on the obverse the initials of the recipient, and on the reverse the inscription "To the first student of the Natural History of Central Asia."

THE Paris Society of Civil Engineers offers a prize of 3000 francs for the best *éloge* of Henry Giffard, the well-known aeronaut and inventor of the injector. This competition is open to foreigners, but the papers must be written in French.

ON Monday evening the session of the Institution of Mechanical Engineers was opened at the Institution of Civil Engineers, Great George Street, Westminster. The President, Mr. E. H. Carbutt, delivered the inaugural address, taking as his subject, "Fifty Years' Progress in Gun-making."

THE sixtieth meeting of the German Association of Naturalists will be held at Wiesbaden on September 18–24 next. A number of new scientific instruments and preparations will be shown. All inquiries are to be directed to Herr Dreyfus, 44 Frankfurterstrasse, Wiesbaden.

THE County of Middlesex Natural History and Science Society will hold their first annual *soirée* on Monday, the 23rd inst., at 11 Chandos Street, Cavendish Square. The chair will be taken at 8 p.m. by Lord Strafford, Lord-Lieutenant of Middlesex, and President of the Society. Objects of scientific interest will be exhibited.

THE total value of the fish landed upon the coasts of Scotland during the four months ended April 1887 was £343,337, being a decrease of £10,591 upon the corresponding period last year.

A COLLECTION of Indian cocoons is about to be sent by the Indian Government to Manchester, where it will be open for inspection. Infected cocoons are to be despatched to France for examination by M. Pasteur's pupils, who, it is hoped, will be able to suggest means for checking the disease which has nearly ruined the silk industry of India.

THE largest piece of amber ever discovered was recently dug up near the Nobis Gate, at Altona. It weighed 850 grammes.

THE ravages of the May-bug in Denmark have become so serious that a Bill is now under the consideration of the Danish Parliament proposing that the cost of the destruction of these insects shall be borne half by the State and half by local authorities.

THE Dutch Government intends to construct a railway in Sumatra, the cost of which will be nearly £1,400,000 (16,000,000 florins). The object is to facilitate the working of the coal-fields near the River Umbili. The coal deposit in these fields is reckoned to consist of about two hundred millions of tons.

AN interesting paper on "An Ideal Natural History Museum," read lately by Prof. W. A. Herdman before the Literary and Philosophical Society of Liverpool, has been issued as a pamphlet. Prof. Herdman calls attention to the strange fact that the Darwinian theory of evolution has had, as yet, little or no effect upon the structure and arrangement of museums of natural history. He urges that a phylogenetic arrangement would have the following advantages over the linear arrangement now employed in our museums:—(1) A phylogenetic arrangement would give a much more accurate representation of Nature. (2) While being more intelligible and instructive to the general public, it would be more in accord with the present state of biological knowledge, and could very readily be slightly altered from time to time so as to keep abreast with the progress of science. (3) It would be a perpetual illustrated lecture, of the best kind, demonstrating to everyone with ordinary intelligence the great doctrine of organic evolution.

ON April 14 about 9.15 p.m. a large meteor was observed at Throndhjem, in Northern Norway. It went in a direction from north to north-east, and during its passage the light was so brilliant that the smallest objects in the snow were visible. It burst, as it seemed, into thousands of fragments, but there was no sound or report. Before bursting, the meteor was green, but during that process it displayed colours of red, yellow, and green, chiefly the latter.

M. E. FERRIÈRE has published a book called "La Matière et l'Energie," summarising the latest results of physical investigation concerning matter and force.

THE second number of the "Jahrbuch der Naturwissenschaften" (a volume of nearly 600 pages) has just been issued. This useful periodical is edited by Dr. Max Wildermann, and pub-

lished by Herr B. Herder, of Freiburg-im-Breisgau. The present volume contains a clear and popular account of the work done in each of the sciences in the year 1886.

We understand that the second part of the "Manual of Practical Botany," by Prof. Bower and Dr. Sydney Vines, will be published by Messrs. Macmillan and Co. in the course of a few weeks. It will include the Bryophyta and the Thallophyta; among the chief types used being *Polytrichum commune*, *Marchantia polymorpha*, *Polysiphonia fastigiata*, *Fucus serratus*, *Coleochæte scutata*, *Volvox globator*, *Agaricus campestris*, *Claviceps purpurea*, *Eurotium Aspergillus*, *Pythium de Baryanum*, and *Mucor mucedo*. Besides these a good many subsidiary types are used to illustrate special points.

"A Classification of Animals," drawn up by Mr. E. T. Newton for Mr. H. B. Woodward's "Geology of England and Wales," has now been issued separately. It is founded on the classifications proposed by Prof. Huxley, with such modifications as are, in the author's opinion, rendered necessary by recent discoveries.

The Annual Report of the Royal Alfred Observatory, Mauritius, for the year 1885, has been issued. The mean temperature for the year at the Observatory was 73°·6. The highest reading was 86°·7 in February, and the lowest 57°·4 in July. Rain fell on 200 days, and amounted to 44·61 inches; the fall was below the average in the usually wet months of January to April, but above the average in the usually dry months of May to October. The island has not been visited by a hurricane since March 1879, although several cyclones have passed not far from it. The Report contains observations made at various stations in the island and at the Seychelles, and notices of storms in the Indian Ocean, collected from ships' logs. Photographs of the sun were also taken daily, when the weather permitted. There were 354 days on which it is certain that spots were on the sun's disk, and eight days on which it is certain that there were none. The number of spots in May was unusually great.

In a recent book, "L'Enseignement actuel de l'Hygiène dans les Facultés de Médecine en Europe," Prof. Lœwenthal, of Lausanne, shows that the time allowed per year for the teaching of hygiene varies from 20 minutes per week in England to 9 hours per week in Spain. The other countries range between these two extremes. The average is from 2½ to 3 hours per week for the whole year.

In the May number of the *American Journal of Science* will be found a paper by Mr. Carey Lee, of Philadelphia, in which are described a remarkable series of salts of silver, which the author is attempting to make use of in obtaining photographs of objects in their natural colours. It is first shown, by an exhaustive series of experiments, that when light acts upon ordinary silver chloride, AgCl, in presence of hydrochloric acid, the darkening is due to the formation of a small quantity of subchloride, Ag_2Cl, which enters into combination with the unaltered silver chloride to form a reddish compound of a nature similar to that of a "lake." This red chloride of silver is termed protochloride, and is found to be, unlike subchloride, unattacked by cold strong nitric acid. After a certain amount of this substance is formed, the action of light appears to cease—a phenomenon which has been frequently noted by other observers. Successful efforts were then made to prepare protochlorides, bromides, and iodides of this nature, and a full description of the very numerous methods and analyses is given in the memoir. The startling fact was discovered that all varieties of tints from one end of the spectrum to the other could be obtained under suitable conditions. Normally, the protochloride of silver is red, even one-half per cent. giving to ordinary silver chloride a strong coloration; but on exposure to diffused sunlight it quickly changes to purple. On addition of mercuric chloride it becomes gray, potassium bromide changes it to a permanent lilac, potassium iodide to a bluish tint, while a mixture of potassium chlorate and hydrochloric acid causes it to pass through pink and flesh-colour to pure white. Heat, on the contrary, causes it to retake its red coloration, and on exposure to various parts of the spectrum it affects lovely shades of the most varied hues. The important observation was made that, in presence of small quantities of lead or zinc chloride, white light (which darkens the pure protochloride) bleaches it, thus producing white in those portions of the image which ought to be white; and it was also found that the addition of a little sodium salicylate enhances the sensitiveness threefold. The experiments are being continued and appear likely to lead to important results in chromo-photography.

The current number of the *Auk* (vol. iv. Part 2) contains some interesting papers, but none of great importance. The want of finality in the system of nomenclature now practised by the American ornithologists is as marked as ever. Thus, Dr. Stejneger, having previously settled the synonymy of the redpolls, by the confounding of all received nomenclature, and the introduction of nine new synonyms into the already overburdened literature of six species, here furnishes a tenth hitherto unrecorded title for our British redpoll; and Mr. Brewster follows suit by adding another synonym to one of the American species of the same group. It might be well for ornithologists to consider whether the best plan would not be, as Mr. Seebohm advises, to simplify matters by accepting in every case the name that happens to have been for a long time most in vogue.

In an interesting paper on the Ailsa Craig Lighthouse, read lately before the Scottish Institution of Engineers and Shipbuilders, Mr. G. M. Hunter drew attention to the admirable system of illumination and signalling in the Firth of Clyde. There are Corsewall Point light, alternating white and red, at the entrance to Loch Ryan, distant from the Craig 17 miles; Sanda Isle light, off the Mull of Kintyre, distant 18 miles; Turnberry light, off the Ayrshire coast, distant 12 miles; Pladda light and fog-signals, off the southern end of Arran, distant 12 miles; and Holy Isle green and red light, distant 18 miles—all of which are revolving lights, with the exception of the fixed lights at Pladda and Holy Isle. These lights are all under ordinary circumstances visible from Ailsa Craig.

In the *Izvestia* of the Russian Geographical Society there are some interesting remarks, by A. N. Krasnoff, on the history of the valley of the Ili River in Russian Turkestan. The Russian traveller considers that during the post-Pliocene age the valley of the Ili was nearly all occupied by water, and that the vegetation on the shores of this basin was quite different from that which exists now. It resembled, he thinks, the present vegetation of Middle Russia. There were forests of deciduous trees, among which maples, elm trees, and apple-trees prevailed, and black-earth steppes occupied wide areas. Relics of this vegetation survive only at the foot of the snow-clad mountains, where they find the necessary moisture. Several of the species have there undergone remarkable adaptations, which permit them to support the rigorous continental climate. Deprived of the moisture of the snow-clad peaks, the vegetation of the lower ridges has completely changed since the recent desiccation of those parts of Asia. These ridges are covered now with a purely Central-Asiatic flora. As to the shores of Lake Balkhash and Ala-kul, they are either stony deserts with small grassy plants, or shifting sands covered with the characteristic Aral-Caspian bushes nearly destitute of leaves. The Balkhash was formerly a much greater lake than it is now, and it is rapidly becoming smaller. The depth of the Ala-kul Gulf has so far

diminished that the Kirghizes already ford the strait which connects it with the lake. None of the rivers given on our maps as flowing into the Ala-kul Gulf and Lake Balkhash from the south-west were found by M. Krasnoff. They have all dried up.

THE additions to the Zoological Society's Gardens during the past week include an Alexandrine Parrakeet (*Palæornis alexandri*) from India, presented by Miss Ada Marshall; two Chinese Geese (*Anser cygnoides*) from China, presented by Miss Hoare; four Midwife Toads (*Alytes obstetricans*), South European, purchased; a Blue-cheeked Parrakeet (*Platycercus cyanogenys*) from North Australia; a Pied Crow Shrike (*Strepera graculina*) from Australia; a Sun Bittern (*Eurypyga helias*) from South America, received in exchange; a Blood-breasted Pigeon (*Phlogœnas cruentata*); two Dwarf Chameleons (*Chamæleon pumilus*) bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

MICROMETRIC MEASURES OF JUPITER AND SATURN.—In the recently-published "Observations," made at the Hong Kong Observatory during 1886, Dr. Doberck gives some measures of Jupiter and Saturn made with the 6-inch Lee equatorial now at Hong Kong. The measures of Jupiter, extending from August 29, 1879, to April 7, 1886, include the position-angle of the polar axis, the apparent equatorial and polar diameters, the breadth of the equatorial belts and of the red spot, and the length of the latter when on the central meridian. Dr. Doberck concludes that the equatorial and polar diameters at the mean distance of Jupiter are 38″·207 and 35″·942 respectively, and that the equatorial semi-diameter at the mean distance of the earth from the sun is 99″·39. The measures of Saturn extend from January 3, 1879, to April 5, 1886, and include the position-angle of the polar axis, the external diameter of the ring, the diameter of Cassini's division, the internal diameter of the ring, and the equatorial and polar diameters of the planet. The deduced dimensions at the mean distance of Saturn are:—External diameter of ring 40″·28, diameter of Cassini's division 34″·42, internal diameter 26″·82, equatorial diameter of Saturn 17″·22, and polar diameter 16″·53. The equatorial semi-diameter at the mean distance of the earth from the sun is 82″·11.

PRESENT APPEARANCE OF SATURN'S RING.—M. Stuyvaert, Assistant-Astronomer at the Royal Observatory, Brussels, has recently presented a couple of drawings of Saturn to the Royal Belgian Academy. These were made on February 8 and 15 in the present year, and show the Cassinian division as encroaching on the outer ring, A, in a remarkable series of shaded indentations. Ring B is nearly broken up into a series of bright white spots by a number of dusky indentations on its inner border of a similar shape, and the dusky ring, C, likewise shows two dark notches on the inner side of the following ansa. Struve's division between B and C was also seen, and appeared on February 8 to be formed by a succession of dark gray spots. These observations are largely supported by those of Dr. Terby and Mr. Elger, published in the *Observatory* for March and April. Mr. Elger observed three or four "large re-entering angles like the teeth of a saw" on the inner margin of the dusky ring. This was on the preceding ansa, and not the following, as in M. Stuyvaert's observations, but the rotation of the ring would account for the change. Mr. Elger also noticed on February 25 that the preceding ansa of the dusky ring was unequally black, certain parts of its surface appearing quite black. These black spots were also noticed and drawn by Dr. Terby, who likewise remarked the unusual distinctness and breadth of Struve's division. It would appear, therefore, from these and other recent observations that the matter composing the ring system is at present much less symmetrically and evenly distributed than usual. Irregularities in the inner borders of the various rings, such as the above observers describe, have indeed been observed before, Trouvelot, for example, having remarked notches in Ring A, and Jacob similar indentations in the dusky ring, but they are not ordinarily seen.

THE RED SPOT UPON JUPITER.—From some recent observations of this object published by Mr. Stanley Williams in the May number of the *Observatory*, it appears that the ephemeris given by Mr. Marth in the *Monthly Notices* for November 1886, is about a quarter of an hour too late. The red spot may therefore be expected to be on the central meridian at about the following times:—

	h. m.		h. m.		h. m.
May 24...21 33		June 7...23 6		June 19...23 0	
,, 26...23 11		,, 10...20 35		,, 22...20 30	
,, 29... 0 49		,, 12...22 14		,, 24...22 8	
,, 31...22 19		,, 14...23 53		,, 26...23 46	
June 2...23 57		,, 15...19 43		,, 27...19 38	
,, 5...21 27		,, 17...21 22		,, 29...21 16	

The above times are expressed in Greenwich civil time, and are reckoned from midnight to midnight.

DISCOVERY OF A NEW COMET.—A new comet was discovered on May 12, by Mr. E. E. Barnard, Nashville, Tennessee, U.S.A. Place, May 12, 16h. 57m., R.A. 15h. 10m. 58s., Decl. 31° 25′ S. The comet was only faint.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1887 MAY 22-28.

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on May 22.

Sun rises, 4h. 1m.; souths, 11h. 56m. 24·6s.; sets, 19h. 52m.; decl. on meridian, 20° 23′ N.: Sidereal Time at Sunset, 11h. 52m.

Moon (New on May 22) rises, 4h. 18m.; souths, 11h. 38m.; sets, 19h. 9m.; decl. on meridian, 14° 17′ N.

Planet.	Rises. h. m.	Souths. h. m.	Sets. h. m.	Decl. on meridian.
Mercury ...	3 47	11 31	19 15	18 38 N.
Venus ...	6 17	14 47	23 17	25 14 N.
Mars ...	3 43	11 29	19 15	18 56 N.
Jupiter...	16 26	21 43	3 0*	9 14 S.
Saturn...	7 16	15 23	23 30	22 8 N.

* Indicates that the setting is that of the following morning.

May 26	h. 8	Venus in conjunction with and 5° 18′ north of the Moon.
26	17	Saturn in conjunction with and 2° 45′ north of the Moon.
27	14	Mercury in superior conjunction with the Sun.

Variable Stars.

Star.	R.A. h. m.	Decl. ° ′		h. m.	
U Cephei	0 52·3	81 16 N.	May 24,	2 18	*m*
U Canis Minoris...	7 35·2	8 39 N.	,, 22,		*m*
δ Libræ	14 54·9	8 4 S.	,, 28,	2 44	*m*
U Ophiuchi... ...	17 10·8	1 20 N.	,, 25,	1 48	*m*
		and at intervals of		20 8	
W Sagittarii ...	17 57·8	29 35 S.	May 28,	21 0	*M*
η Aquilæ	19 46·7	0 43 N.	,, 27,	3 0	*m*
R Sagittæ	20 8·9	16 23 N.	,, 28,		*m*
R Vulpeculæ ...	20 59·4	23 22 N.	,, 22,		*m*
δ Cephei	22 25·0	57 50 N.	,, 26,	3 0	*m*

M signifies maximum; *m* minimum.

Meteor-Showers.

	R.A.	Decl.
Near o Draconis	280	54 N.
γ Cygni	301	37 N.
From Lacerta	329	48 N.

GEOGRAPHICAL NOTES.

THE new Ergänzungsheft (No. 86) of *Petermann's Mitteilungen* contains a monograph of great importance in scientific geography by Dr. Rudolf Credner, Professor of Geography at Greifswald, on "Die Reliktenseen," which he defines broadly so as to include all lakes of marine origin, whether they do or do not now contain remains of marine fauna. The author considers such lakes of so great importance in connexion with the evolution of the earth, that he thinks it the duty of physical geography to critically examine all data concerning lakes which may have a claim to be regarded as of marine origin, and

decide whether such claim is justifiable. He discusses the evidences on which lakes may be regarded as of marine origin—historical, morphological, biological, and with regard to existing names. He then devotes considerable space to the discussion of the claims of lakes in all parts of the world to be regarded as of such origin; to the relations between salt- and fresh-water fauna; and to a critical examination of the faunistic argument for the marine origin of existing inland lakes. He concludes that none of the arguments derived from the considerations referred to have a convincing importance in deciding as to the marine origin of lakes. Dr. Credner is of opinion that the question can only be satisfactorily solved on the geological evidence furnished by the various lake regions; and this argument he means to develop in a second part of this very valuable monograph.

DETAILS are to hand of the recent exploration of the Mobangi tributary of the Congo, by Capt. van Gèle, which add something to the results obtained by Mr. Grenfell. Capt. van Gèle's journey was made at the end of 1886, at the time when the river is in flood, and when the current of the rapids is most powerful. At no part was the water less than 1·80 metre in depth, and the deepest did not exceed 11 metres. Not far from the embouchure of the Mobangi, on the left bank, 8° 30" S. lat., 17° 35' E. long., there is a French station. Above this part the Mobangi measures 2500 metres in breadth, 11 metres in depth in the centre, with a current at the rate of 1 metre per second. At the 4th degree N., just below the rapids, there is a breadth of 1200 metres, a depth of 7·50 metres, and a current of 1·50 metre per second. Between these two points the breadth of the Mobangi constantly varies, never exceeding 4000 metres. Its waters are of a clear brown colour, and its general aspect much the same as that of the Congo, its channel studded with islands, and its banks wooded. The right bank is often marshy, while the left bank is frequently steep, and the neighbourhood hilly. The left bank is much more densely peopled than the right, which never has but a scanty population. On the left bank, especially above the 2nd degree of latitude, there is a rapid succession of villages, belonging to the Baati, the Monyembo, and the Montumbi. The people are well made and tall (mean height of men 1·80 metre), they are industrious, but at the same time inveterate cannibals. In all the course of the river which has been observed, Capt. van Gèle did not notice any affluent of importance; the only three worth mentioning are the Nghiri on the left bank, and the Ibenya and the Lobay on the right. The Nghiri winds through a very marshy country, which probably occupies the place of the conjectural lake of that name. About 4° N. lat., a mountain mass is met with, running in a north-east and south-west direction, through which the Mobangi must penetrate in making its way to the Congo, and here it is, as might be expected, that rapids are found. The river here is narrowed into a gorge, impassable at high water, but, Mr. Grenfell assures us, quite passable at low water for a suitable steamer.

THE Argentines have been very active recently in the exploration both of Patagonia and of their section (the eastern) of Tierra del Fuego. In a communication which appears in *Petermann's Mittheilungen*, Ramon Lista gives some details of a journey which he made through the centre of the large eastern island from Sebastian Bay to the Strait of Le Maire. He states that our notions of the surface and climate of this island have hitherto been entirely erroneous: it has been regarded as inhospitable, barren, and uninhabitable; its rocky mountains covered with everlasting snow. This may be so with the west part of the land, but M. Lista gives a different account of the region traversed by him. From Cape Espiritu Santo to Cape Peñas he found valleys of varying breadth, covered with luxuriant fodder plants, and abounding in rivers, some of which are navigable, and which come from a snow-covered region in the interior. South of this is found the region of Antarctic forests. Though not so rich in grass and water as the northern region, M. Lista states that it made a favourable impression on him. He saw a good deal of the native population, and collected considerable data as to their anthropology. Many other scientific observations were made by him on the geology, fauna, and flora of the country.

THE Carniola section of the German and Austrian Alpine Club has resolved to put up on the Old Posthouse at Wurzen, the favourite head-quarters of Sir Humphry Davy, a tablet to commemorate his services in making known the South-Eastern Alps of Austria, and in attracting visitors thither.

THE ROYAL SOCIETY CONVERSAZIONE.

LAST week we referred to the *conversazione* of the Royal Society, held on Wednesday, the 11th inst. It was the best which has been given for many years. A large number of remarkable objects were exhibited, and an account of some of the most important of them may be of interest to our readers.

Prof. A. W. Rücker exhibited lecture apparatus to illustrate the measurement of coefficients of expansion by means of Newton's rings. The rings are formed between a glass plate and the convex end of a glass cylinder. These are pressed together by a metal frame, the front and back of which are connected by tubes through which a current of water is passed. The rings are projected on a screen and expand or contract when the temperature of the water is altered. The apparatus was shown in operation.

Maps to illustrate the present state of the magnetic survey of the British Isles now in progress, with a set of instruments of the Kew pattern, which have been used in the survey, were exhibited by Profs. Thorpe and Rücker. (1) Large map showing the stations at which observations have been made, and the values of three magnetic elements, viz. the inclination, declination, and total force at all places for which the reduction of the observations has been completed. The epoch of the survey is to be January 1, 1886, but the values given are not as yet corrected for secular change, except in the case of stations in Scotland. (2) Three maps of Scotland showing the lines of equal dip and equal total force for 1837, 1858, and 1886, and the lines of equal declination for 1858 and 1886. Mr. C. V. Boys exhibited a radio-micrometer and spinning-pile, which is probably the most sensitive instrument for measuring radiant heat yet made. It consists of a movable circuit of copper, antimony, and bismuth hung by a quartz fibre in a strong magnetic field. One-hundred-millionth of a degree is not beyond the possible limit of such an instrument. Prof. D'Arsonval made an instrument essentially the same in principle last year. This radio-micrometer was devised by the exhibitor without knowledge of M. D'Arsonval's, from which, however, it differs in important details. The one exhibited is an experimental instrument only; but it is about one hundred times as sensitive as a thermopile. The spinning-pile is peculiar in that it will start itself and turn either way indifferently when a spark is held on one side, and will at once stop when the spark is held on the other. Mr. Boys also showed an apparatus for shooting threads of glass, emerald, quartz, &c. A thin rod of the material is fastened to the tail of an arrow and heated at the end by an oxy-hydrogen flame. The trigger of a cross-bow is immediately pulled, and the arrow shot, when a thread of extreme fineness is drawn out. These threads are far finer than spun glass, and many are finer than spider-lines. Threads of quartz are practically free from elastic fatigue, and are most suitable for the torsion threads of instruments of precision. Quartz can be drawn so fine that the thinnest parts are beyond the power of any possible microscope to define them. Experiments were made, showing the discharge by flame of electrically-spun threads.

Sir John Fowler and Mr. B. Baker exhibited a series of most marvellous photographs of the 1700-feet span cantilever bridge now in course of construction across the Firth of Forth. Some of these photographs will be exhibited to-morrow at the Royal Institution. Specimens of wire and other articles made from "platinoid," manufactured by Mr. F. W. Martino, were exhibited by the London Electric Wire Company. Platinoid is untarnishable under atmospheric influences, and is specially suited to be a substitute for platinum-silver, German silver, &c., for electrical purposes, as by experiments it has proved itself unchanged under variation of temperature (see Proceedings of the Royal Society, No. 237, 1885). Major H. S. Watkin exhibited a Watkin patent aneroid invented by himself, and manufactured by Mr. J. J. Hicks. It is well known that aneroids have been made of all sizes, from 3 feet to half an inch in diameter; the length of the divisions on the scale representing inches on the mercurial barometer have also been varied to suit different purposes; but inasmuch as there was only one circle of figures, either the number of inches, and therefore the extreme height at which the instrument was available, had to be restricted, or the dimensions of the scale contracted in order to obtain a longer range. Major Watkin's patent index gets over this difficulty, and an open scale can now be obtained, combined with great length of range. Thus, in the 4-inch patent aneroid 1 inch on the mercurial barometer can be made to represent from 4 to 10 inches, and yet be available for great heights.

Captain Wharton, Hydrographer of the Admiralty, exhibited a sun-signalling apparatus, designed by Mr. F. Galton, F.R.S., for the use of naval surveyors. The optical arrangements are the same as those described by him in the Journal of the British Association, 1858, but the movements are new. Its advantage is the facility it affords for accurate direction of the beam of light; an image of the sun appearing over the object to which it is desired to flash, when viewed through the telescope. Capt. Wharton also showed a set of charts illustrating the hydrographical conditions of coral reefs and islands that stand in deep water; a new chart of the south circumpolar regions, with tracks of explorers; and a chart showing sea-surface temperatures obtained off the north-west coast of Spain, June to September 1886. An improved pneumatic tide-gauge or level-indicator was exhibited by Capt. de Wolski. This enables the registering apparatus to be at any distance, horizontal or vertical, from the spot in the sea below low-water mark where the tide is measured. Specimen charts (of which we have already given some account), exhibiting the conditions of weather over the Atlantic Ocean at the four seasons of the year, were shown by the Meteorological Council. (1) Daily synchronous charts of the North Atlantic in spring, February 27 to March 4, 1883. These charts show that an anticyclone lies over Western Europe, and the neighbouring part of the Atlantic, with much calm and fog prevailing at its centre; whilst the predominant winds in these islands are northerly and easterly, typical March weather. (2) Daily synchronous weather charts of the North Atlantic in summer, August 1 to 6, 1882. These charts exhibit the prevailing area of high barometrical pressure on the eastern side of the Atlantic, which is related to a prevailing north westerly wind at the entrance of the Channel, changing to north off the coast of Portugal, and eventually merging in the north-east trade. (3) Daily synchronous weather charts of the North Atlantic, in autumn, October 9 to 14, 1882. The numerous small areas of low barometrical pressure over the sea on these charts, which appear at the time of year when the region of highest pressure is about to be transferred from the ocean to the land, seem to indicate what takes place during the change. Several small cyclonic systems are shown in the southern part of the area of high pressure which prevails over the Atlantic in about 30° N. (4) Daily synchronous weather charts of the North Atlantic in winter, February 9 to 14, 1883. The part of the Atlantic north of 40° N. is affected by a large area of low pressure, of which the centre lies somewhere to the southward of Iceland. These conditions are usual in winter. Maps of the English dialect districts, with key, by Mr. Alexander J. Ellis, to illustrate his "Existing Phonology of English Dialects," not yet published, were exhibited by the author. Mr. Frank Crisp exhibited early microscopes:—(1) Campani's microscope. No field lens, and probably the earliest microscope extant. (2) Pope Benedict's microscope. Belonged to Cardinal Lambertini, afterwards Pope Benedict XIV. Triple crown and cross keys inlaid in front of box. (3) Hooke microscope. This also belonged to the same Pope. (4) Oppelt's microscope. Instruments for measuring extensions and compressions in materials subjected to stress were exhibited by Prof. W. C. Unwin. (1) Apparatus to measure extensions to 1/10,000 of an inch. Two clips embrace the bar, so that the movement of the middle points is the mean of the extensions on both sides. The clips are set level by sensitive levels, and the distance between them is measured by a micrometer screw. (2) Apparatus to measure extensions. The bar is embraced by clips, so that a mean of the extensions on each side is taken. The extensions are measured by a roller and mirror. Measures to 1/100,000 of an inch. (3) Similarly arranged apparatus for compressions. The strain is measured by a microscope micrometer. Measures 1/50,000 of an inch. Apparatus for the drawing of automatic stress-strain curves was shown by Prof. Kennedy. In this apparatus the bar to be tested is extended "in series" with a much stronger bar of steel. This bar is used as a spring, and its elastic extensions, magnified by a light pointer, are taken as proportional to the stress in the test-bar, and recorded by the end of the pointer on a sheet of smoked glass which has a motion at right angles to that of the points, and proportional to the elongation of the test bar. There is also a special arrangement of differential levers to eliminate any errors in this motion which might arise from the extension or "give" of other parts of the instrument.

Forty-six photographs of clouds in many parts of the world were exhibited by the Hon. Ralph Abercromby, by whom they were photographed. These were mostly taken during two voyages round the world for meteorological research. The pictures illustrate very clearly the identity of cloud-forms all over the world, for similar cumulus and cumulo-nimbus forms range in latitude from London to near Cape Horn—including one actually on the equator; and the stratus from Sweden to New Zealand; while the mists in the Himalayas are indistinguishable in general character from those of Great Britain. In addition to illustrations from the countries above mentioned, clouds are represented from Teneriffe, Brazil, the Falkland Islands, the Indian Ocean, and Borneo. Model of high-speed hydraulic or steam engine for driving electric light, and other purposes, was exhibited in motion by Mr. Arthur Rigg, the inventor. Reciprocation of pistons, and other moving parts, imposes an early limit to speed in engines of ordinary construction, so it has long been an unsolved problem how to produce a satisfactory engine without this evil, no rotary engines having ever yielded results encouraging their adoption. The revolving engine possesses pistons and cylinders, which are the best mechanical contrivance for remaining steam tight or water tight, and these have reciprocations relative as between each other, but only rotation in relation to the earth, while the cylinders and pistons revolve each on their own independent centres. The static balance and the dynamic balance are identical, and this engine therefore runs in equilibrium, without vibration, and in almost perfect silence. It is governed by varying the rate of expansion in the case of steam, or by varying the length of stroke in the case of water, and produces very economical results. It has none of that rhythmical variation in speed which occurs during each revolution of an ordinary engine. It is the only engine hitherto invented which can be driven at high speed by water pressures of considerable amount, and is found to give a perfectly steady incandescent light when making 250 revolutions per minute, driving a dynamo for 100 lamps, and worked by 700 lbs. per square inch water pressure. Prof. Forbes's thermo-galvanometer, made by Messrs. Nalder Bros. and Co., was exhibited by Prof. George Forbes. This consists of a ring, half of antimony, half of bismuth, one of the soldered junctions being filed thin and blackened to receive radiations. The conductivity of the ring is increased by the addition of a block of copper. A light Thomson magnet and mirror, suspended by a silk fibre, is placed inside the ring. The present form of instrument is rendered astatic by means of a second magnet. Prof. Forbes also showed specimens of electric welding by Prof. Elihu Thomson, of Boston, U.S.A. Some of Dr. J. Puluj's remarkable vacuum tubes, made by Müller, of Bonn, were exhibited by Mr. Warren De la Rue, and Dr. Hugo Müller. (1) Electrical radiometer with phosphorescent vanes. (2) Electrical radiometer with phosphorescent rotating disk. (3) Electrical radiometer with two phosphorescent rotating disks. (4) Electrical radiometer with rotating bell-glass. (5) Phosphorescent lamp. Specimens illustrating the effect of great earth-movements upon the pebbles contained in rock-masses were exhibited by Prof. J. W. Judd. (1) Series of impressed, faulted, crushed, and polished quartzite pebbles from the old red sandstone, near the great faul', Stonehaven, N.B. (2) Impressed limestone pebbles from the Swiss nagelflue (3) Faulted, crushed, and re-cemented flints from the chalk. (4) Pebbles from Bunter conglomerate, crushed and scratched by earth-movements. Specimens and microscopic sections of carboniferous chert, filled with spicules of siliceous sponges, were exhibited by Dr. G. J. Hinde. Beds of chert are largely developed in the carboniferous rocks of Yorkshire, North Wales, and Ireland, between the horizon of the carboniferous limestone and the millstone grit. In Flintshire they attain a maximum thickness of probably not less than 350 feet. These strata are of organic origin, and built up mainly of the detached skeletal spicules of siliceous sponges, which, for generation after generation, lived and died on the sea-bottom in these areas, and by the gradual accumulation of their microscopic spicules formed the rocks. Maps and sections of the Geological Survey of the United Kingdom were exhibited by Mr. Arch. Geikie, and a MS. geological map of the British Isles, for the geological map of Europe now in preparation by the International Geological Congress, was shown by Mr. William Topley, of the Geological Survey of England. Scale, 1 : 1,500,000 (1 inch to 23½ miles). The map will be in forty-nine sheets, in all about 12 feet by 10 feet. The cost of producing the map is contributed by the various Governments of Europe. England's share of the expense is £400, instalments of which are given, as required, by the Royal Society from its Government grant. For this sum a hundred copies of the complete map will be sent to the Royal Society. A drawing of a specimen showing the assump-

tion of antenniform characters by the crustaceous ophthalmite, received from M. Alphonse Milne-Edwards, was exhibited by Prof. G. B. Howes. Mr. C. Baker showed Dr. Carl Zeiss's apochromatic objectives and eye-pieces, made of the new Abbe-Schott glass. The "Secohmmeter," a direct reading instrument for the absolute measurement of the coefficients of self and mutual induction, and for the absolute measurement of a capacity, was exhibited by Profs. Ayrton and Perry. On a future occasion we shall have something to say about this instrument. Mr. J. Norman Lockyer exhibited photographic comparison spectra of sun and metallic elements, taken at Kensington with Rowland grating. The metallic spectra were obtained in the usual way by putting metallic salts between the poles of an electric lamp. The lamp was placed at a distance of about 9 feet from the slit, and the rays of light diverging from it were rendered parallel by a lens of 9 inches focal length. An image of the sun was focused between the poles of the lamp by another lens of 10 inches focal length placed between the siderostat and the lamp. The light from the sun was thus sent through the slit under exactly the same conditions as that from the arc, so that both were brought to the same focus. The slit was covered with a piece of paper having four tongues, one of which was turned back for each exposure. The exposures varied from five to ten minutes. Mr. Lockyer also exhibited photographs of the spectra of compounds of carbon under various conditions, and a map showing the passage from flutings to lines in the spectrum of alcohol with increase of temperature, and the distribution of the various carbon flutings in the spectrum of the electric arc. The photographs, especially those of carbon dioxide, show how the spectrum of each compound depends upon the conditions of temperature and pressure to which it was subjected. A comparison of the spectra of different compounds will also show the general relations which exist between them; it will be seen that some of the flutings are special to certain compounds, while others are common to all. The accompanying map (approximately to a wave-length scale) represented the changes in the spectra of alcohol vapour produced by changes of temperature and pressure. The part of the map to the right of 4900 was mapped from eye-observations, and the remainder from the photographs. The lower half of the map shows the distribution of the carbon flutings in the spectrum of the electric arc, the spectrum of each portion of the arc being represented on the same horizon. A point of great interest is the appearance, in the flame which surrounds the negative pole, of three sets of flutings which shade off towards the red. The two most refrangible flutings shown in the alcohol spectra are apparently coincident with two of the five-membered ultra-violet group occurring in the spectra of the arc and cyanogen. Photographs of stellar spectra taken at Harvard College by Prof. Pickering (Henry Draper Memorial) were also shown by Mr. Lockyer. Spectra of α Lyræ, β Geminorum, α Cygni, α Tauri. These have already been referred to in NATURE. Twelve-inch Indian sun photographs taken at Dehra-Dun, India, March 4 and May 2, 1886, were exhibited by the Solar Physics Committee. The Rev. Dr. Pritchard showed (1) original negative of the Cluster in Perseus. Taken with the De la Rue reflector, 13 inches aperture; 120 inches focal length; exposure 30 minutes; diameter of plate-holder 6½ inches. This is one of a series of photographs taken in order to ascertain the greatest angular extent of the field, in which all the star impressions are free from deformation of circular contour. All the stars on this plate, even to the angular points, at a distance of 80′ from the centre, are sensibly free from ellipticity. Positive enlargements on glass of the above. (2) The Macromicrometer presented by Dr. W. de la Rue to the Oxford University Observatory, carrying one of the original negatives of 61 Cygni, as used for the determination of the parallax of the two components of that star. (3) Original negative showing the photographic genesis of star impressions formed during varying durations of exposure, and viewed under high magnifying power. Dr. Edgar M. Crookshank exhibited micro-organisms: — (1) Microscopical specimens, including living micro-organisms and permanent preparations. (2) Cultivations on nutrient jellies, potatoes, &c., of the following micro-organisms:—

Bacillus tuberculosis.	Bacterium of rabbit septicæmia.
Micrococcus tetragonus.	Bacillus of mouse septicæmia.
Bacillus typhosus.	Bacillus of swine-erysipelas.
Koch's comma-bacillus.	Bacterium of pneumonia (Friedländer).
Finkler's comma-bacillus.	Staphylococcus pyogenes albus.
Deneke's comma-bacillus.	Staphylococcus pyogenes aureus.
Emmerich's bacterium.	
Staphylococcus pyogenes citreus.	Red bacillus from water.
Streptococcus of erysipelas.	Red spirillum.
Bacillus of anthrax.	Black yeast.
Micrococcus prodigiosus.	Pink yeast.
Bacillus indicus.	Yellow sarcina.
Bacillus of blue milk.	Bacillus figurans.
Bacillus violaceus.	Phosphorescent bacillus.
Bacillus pyocyaneus.	

Water-cultures of the garden bean (*Vicia Faba*), the roots of which are infested with tubercular swellings, due to the parasitic action of a fungus, the extremely minute germs of which are common in the soil, were exhibited by Prof. H. Marshall Ward. Dr. E. Klein exhibited microscopic specimens and culture-tubes of the microbe of (1) foot-and-mouth disease; (2) scarlet fever; (3) several different forms of septicæmia; (4) swine plague.

THE METEOR OF MAY 8.

ON Sunday evening, May 8, at 8h. 22m., hundreds of people witnessed the flight of the brilliant slow-moving fireball, about which three letters were printed in NATURE last week. At the time of its appearance daylight was still so strong that only Venus, Jupiter, Saturn, and a few first-magnitude stars were visible in the firmament. At stations in the eastern part of England the fireball fell in the western sky; at Bristol and the west it descended in the east; while at Stafford it is described as falling in the south.

Descriptions of the apparent path and appearance of the meteor have been received from Eastbourne, Staines, Stafford, Hartfield near Tunbridge Wells, London, Clevedon, Bristol, &c. It is referred to by most observers as a strikingly brilliant object, in comparison with which the planet Venus looked small and faint.

The following are quotations from some of the reports which have reached me from various places:—

The Rev. F. B. Allison, of Eastbourne, says:—"An exceptionally bright fireball was seen to fall to-night [May 8] at 8h. 30m. There was so much light in the sky that I could only detect α and β Aurigæ. The meteor was considerably larger and brighter than Venus, of a bluish tint, with train of sparks, slow motion: 6 seconds over the path indicated." Mr. Allison sends a diagram, in which the observed part of the course is shown extending under α and β Aurigæ, at an angle of about 42°, to a length of about 24°.

Mr. Francis Gare, of Staines, writes:—"The fireball was observed about 8h. 20m. to 8h. 25m., and was about half the size of the moon; its light was pale blue in colour, and was very bright, startlingly so. It left a train of red sparks about 6° long. The first part of its track was invisible to me as I was in a room with a S.W. window; this, too, would have prevented my hearing the detonation had there been any. The motion was slow." Mr. Gare sends a sketch, in which the fireball is represented as traversing 40° at an angle of 38°, and terminating 10° east of a line joining Venus and the horizon.

The Rev. E. Allen, of Castlechurch Vicarage, near Stafford, says:—"The time was within five minutes of 8h. 20m., May 8. It was so light that to see Spica as a reference-point, and whose place I knew exactly relatively to that of Jupiter, which was plainly visible, I had to fetch a binocular. The meteor was very large, and brilliantly white. Its light seemed to rise and fall in pulsations about two-fifths of a second in period, and its general power and effect was like what an extremely brilliant Roman candle ball would appear in somewhat deeper twilight at a distance of 50 or 60 yards from the spectator. Its motion was very slow, taking, I estimate, 5 seconds in passing along its total path of about 12° of arc. Estimating proportions of distance by eye, with the space between Jupiter and Spica as a guide, the path was something as follows: It was inclined about 25° to a perpendicular, the angle lying on the west, and fell from about R.A. 12h. 35m., Decl. 13° 30′ S., in a line nearly parallel to δ and ζ Corvi, and east of those stars."

At Hartfield, near Tunbridge Wells, the fireball was observed passing a little below Venus from right to left, and inclined 30° or 40° to the horizon. Duration, 3 or 4 seconds.

At Bristol, the meteor appears to have been pretty generally observed, and a large number of reports have come to hand. These, though differing in some essential particulars, sufficiently prove that the motion was from S.E. to E. by N. at an angle of 30°, the altitude at disappearance being about 20°. One observer describes it as being as large as a tennis-ball, and having a duration of 6 seconds. Another, who mentions the time as

8h. 20m., says that at disappearance it burst into a suppressed shower or halo of red; and a third relates that it travelled from S. to E. downwards, leaving two trains of sparks, and then finally bursting into fragments. It looked like an immense fire-work bomb, and many people, at the first impression, considered it so near as to mistake it for a large rocket. One observer avers that as the meteor burst he found himself enveloped in a "wave of heat" for several seconds!

Carefully comparing the descriptions of the path and direction, it is found difficult to determine with precision over what point of the earth's surface the fireball first became visible. Probably, however, this occurred above the English Channel, about 25 miles S.E. of the Isle of Wight, when the height of the body would be about 70 statute miles. From thence it slowly pursued a direction to the N.N.W., and entered the English coast over Gosport, after skirting the eastern boundary of the Isle of Wight. The meteor was descending to the earth at an angle of 30°; at Gosport its height was 50 miles, and it afterwards passed over Winchester at an elevation of 38 miles, finally disappearing a few miles north of Swindon, when its height had further decreased to 14 miles.

This path apparently satisfies the majority of the observations, but there are, as usual, a few discordances. Thus, the Watford observation (NATURE, May 12, p. 30) gives an altitude of 30° for end-point in the W.S.W. (magnetic bearing). This seems far too great; about half, or 15°, would be consistent with the other observations. At Staines, where the altitude must have been nearly the same as at Watford, it was given as 13°, and at several places in London the altitudes are mentioned as 17° and less. Mr. Horner's observation at Montagu Street, W. (NATURE, May 12, p. 30) proves conclusively that the altitudes were very low. He saw the meteor first near γ Geminorum (alt. 23°), and it disappeared after moving slowly in the direction of Jupiter. If we adopt the end-point from this description as at 80° + 16°, we get the terminal altitude as only 12°, which is in exact conformity with the adopted height of 14 miles at disappearance. The altitude of 17° from Highgate (NATURE, May 12, p. 30) is somewhat excessive, but it is well known that in estimates of this character the figures are nearly always too great. Lieut.-Colonel Tupman states: "Most persons (as has been often before remarked) guess altitudes at double what they really are, and 'the zenith' means anything higher than 45° or so" (see his paper on the great meteors of 1875, September 3, 7, and 14, Appendix, *Astronomical Register*, vol. xiv. p. 1).

The observations at Staines, Hartfield, and Montagu Street, W., are very fairly consistent as regards the direction of the meteor, and, taken in combination with the especially valuable notice from Stafford and the average of the Bristol observations, the radiant-point is found to have been situated in the S.S.E., altitude 30°, which is about 10° N.W. of Spica Virginis, or at 191° − 5°. No definite meteor-shower is known from this point in May, though Heis gives a position at 191° + 7° for April 18 to May 18, which can hardly be the same. The great fireball of May 12, 1878, diverged from a radiant at 214° − 7°, and it can scarcely be associated with that of May 8 last, as the two radiants are 23° distant.

The recent fireball had a real path in the atmosphere of about 110 miles. Its motion was very slow, but there are great discordances in the various estimates of duration. A large proportion of the observers only saw the latter part of the flight, but it would seem that the whole duration was fully 6 seconds, probably more, in which case the velocity was certainly less than 18 miles per second. The fireball, if moving in a parabola, would have had a velocity of 13 miles per second.

As to the actual size of this brilliant visitor, nothing can be definitely concluded, because it is impossible to discriminate between the glare and flaming effect of the nucleus and what extent of it represented the material diameter. The fireball was probably a very diminutive body, and much smaller than its conspicuous aspect would lead us to suppose. Had it withstood disruption and dispersion during another 1¾ second, it would have completed the remaining 28 miles of its path, and it must have fallen to the earth near Winchcombe, in Gloucestershire.

W. F. DENNING.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—We regret to hear that Prof. Prestwich has resigned the Chair of Geology which he has held for the last thirteen years.

CAMBRIDGE.—Last week the grace authorizing the Vice-Chancellor to enter into negotiation with Downing College with a view to securing a site for the Geological Museum in the grounds of Downing College, opposite the New Museums, was carried by eighty to seventy-one votes. Prof. Hughes, in a previous discussion, had objected to the site on the New Museum grounds because it would soon become too crowded. The Downing College site would afford plenty of room. Whether the University and the College can agree on the question of the price to be paid remains to be seen.

The Botanic Garden Syndicate have issued a modified report, proposing a different site for their necessary new plant-houses, namely, palm-house, stove, warm fern-house, and orchid-house, and recommending that authority be given them to obtain a detailed plan and estimate for building these, together with a new propagating-pit, the cost not to exceed £3000. They also strongly recommend the erection, in connexion with these houses, of a small research laboratory.

The examiners for the Adams Prize—the Vice-Chancellor, Prof. Stokes, Prof. Darwin, and Lord Rayleigh—have given notice that the subject for the Adams Prize to be adjudged in 1889 is "The Criterion of the Stability and Instability of the Motion of a Viscous Fluid." It appears from experiment (see Phil. Trans. for 1883, p. 935) that the steady motion in a tube is stable or unstable according as the velocity is less or greater than a certain amount; and it is inferred from theory, confirmed by experiment, that in two geometrically similar systems the motion is stable or unstable according as $\mu/\rho cU$ is greater or less than a certain numerical quantity n; c, U being a length and a velocity which define the linear scale and the scale of velocity in the system, and ρ, μ the density and coefficient of viscosity of the fluid; but the quantity n has not hitherto been obtained even in a simple case except by experiment.

It is required either to determine generally the mathematical criterion of stability, or to find from theory the value of n in some simple case or cases. For instance, the case might be taken of steady motion in two dimensions between two fixed planes, or that of a simple shear between two planes, one at rest and one in motion.

Should the investigation not be found practicable for even a simple case of the motion of a viscous fluid, some substantial advance might be made in what has been done for a perfect fluid (see Proceedings of the Mathematical Society, vol. xi. p. 57), the title of the essay being modified accordingly.

The prize is open to all Cambridge graduates.

Each essay should be accompanied by a full and careful abstract, pointing out the parts which the author considers to be new, and indicating the parts which are to be regarded as of more importance than the rest.

The essays must be sent in to the Vice-Chancellor on or before December 16, 1888, privately. Each is to have some motto prefixed, and to be accompanied by a paper sealed up, with the same motto and the words *Adams Prize* on the outside, and the candidate's full name, with his College and degree, written within. The papers containing the names of those candidates who may not succeed will be destroyed unopened. Any candidate is at liberty to send in his essay either written (but not in his own hand) or printed or lithographed. The successful candidate receives about £170. He is required to print the essay at his own expense, and to present a copy to the University Library, to the Library of St. John's College, and to each of the four examiners.

SCIENTIFIC SERIALS.

The Quarterly Journal of Microscopical Science for March 1887, vol. xxvii. Part 4, contains:—On the termination of nerves in the liver, by A. B. Macallum (plate 36). These researches were made on the livers of man and Menobranchus (Necturus): the liver cells of the latter are from two to four times the diameter of those in man, and so were very favourable for these investigations; in man fibrils from the intercellular plexus of nerves give off excessively minute twigs, which terminate each in a delicate bead in the interior of the hepatic cells, near the nucleus; in Menobranchus the simple intracellular nerve-twigs always terminate in the neighbourhood of the nucleus, either singly or after branching, each terminal point being a delicate bead.—On the nuclei of the striated muscle-fibre in *Necturus* (*Menobranchus*) *lateralis*, by A. B. Macallum.—The development of the Cape species of Peripatus, Part 3: on the changes from Stage A to Stage F, by Adam Sedgwick, F.R.S. (plates

34-37). This elaborate memoir does not permit of being usefully summarised.—Morphological and biological observations on *Criodrilus lacuum*, by Dr. L. Orley.—Studies on earthworms, No. 3: *Criodrilus lacuum*, Hoffmeister, by W. B. Benham (plate 38). This little worm was first discovered by Fritz Müller in 1844, near Berlin, and was in the following year described by Hoffmeister; it was next found near Linz, and more recently in Italy and at Buda-Pesth by Dr. Orley, whose paper thereon has been translated from the manuscript by Mr. Benham. In the Danube this worm occurs, often in large numbers among the roots of *Sium latifolium*, the egg-cases looking like certain forms of Enteromorpha. The specimens dissected by Mr. Benham were sent to Prof. Lankester by Dr. Orley.—Notes on the chromatology of *Anthea cereus*, by Dr. C. A. MacMunn (plates 39 and 40). The pigments of Anthea are the pigments of certain marine Algæ, and are without doubt the pigments of the "yellow cells" which are now known to be unicellular Algæ.—On *Ctenodrilus parvulus*, nov. spec., by Dr. Robert Scharff (plate 41). This little Annelid was recently discovered by Mr. Bolton, of Birmingham, but its exact habitat is unknown.—On the relation of the Nemerteæ to the Vertebrata, by Prof. A. A. W. Hubrecht (plate 42); with permission from Prof. Hubrecht's Report on the *Challenger* Nemerteans.

American Journal of Mathematics, vol. ix. No. 3 (Baltimore, April 1887).—A memoir by Prof. Cayley on the transformation of elliptic functions, develops the algebraical theory established by Jacobi in the "Fundamenta Nova" (1829), and discusses other researches in this field by Jacobi, Brioschi, and the writer (see Brioschi's second appendix to his translation of Cayley's "Treatise on Elliptic Functions," and other papers cited in the present memoir).—Mr. G. P. Young contributes a long account of "Forms, necessary and sufficient, of the roots of pure uniserial Abelian equations"; and the number closes with some eighteen pages of tables under the heading "Symmetric Functions of the 14^{ic}," by W. P. Durfee,—these are arranged according to the second of the author's methods used in vol. v., where tables are given for the 12^{ic}. In vol. vi. it may be noted Capt. Macmahon does a similar work for the 13^{ic}.

In the numbers of the *Journal of Botany* for March and April, a species (or sub-species) of *Rubus* new to science is described by Mr. E. F. Linton, from Norfolk, under the name *R. lucens*, afterwards substituted by *R. latus*. The remarkable *Equisetum littorale*, differing from all other species of the genus in the absence of elaters, is recorded as British (and figured) by Mr. Beeby, on the faith of specimens from Surrey. Mr. Spruce concludes his elaborate description of his new species of Hepaticæ, *Lejeunia Holtii*, from Killarney. The remaining articles are of merely local or technical interest.

The number of the *Nuovo Giornale Botanico Italiano* for April is almost entirely occupied by articles of interest to Italian botanists. In addition to those referring to the distribution of species, Sig. L. Savastano has two short papers. The first refers to the parasitism of *Agaricus melleus*. From experiments made on a number of different trees, the author concludes that this fungus does not attack healthy trees, but only those that are weakly or diseased. In the second paper, on Gummosis, he adduces facts to show that this morbid phenomenon is to a large extent dependent on temperature, being less frequent in the northern than the southern portion of the zone of cultivation of any given species.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 5.—"The Proteids of the Seeds of *Abrus precatorius* (Jequirity)." By Sidney Martin, M.D. Lond., Pathologist to the Victoria Park Hospital. Communicated by Prof. E. A. Schäfer, F.R.S.

Two proteids were found in the saline extract of the crushed seeds; one a *globulin*, identical with that occurring in papaw-juice, and belonging to the group of vegetable paraglobulins; the other an *albumose*, identical with what the author has described as α-phytalbumose in the papaw-juice. Attention was called to the differences between the class of vegetable paraglobulins and the vegetable myosins, which differ in the fact that the latter become readily changed into an albuminate when the sodium chloride holding them in solution is dialyzed away.

The investigation of the proteids is preliminary to that of their physiological action

"Note on the Microscopic Structure of Rock Specimens from Three Peaks in the Caucasus." By Prof. T. G. Bonney, D.Sc., LL.D., F.R.S.

These specimens are from three localities in the Caucasus, all difficult of access, viz. the peaks of Tau Tetnuld, Guluku, and Elbruz. The first and second are peaks near together in the central part of the Caucasus; the specimens were collected in 1886 by Mr. W. F. Donkin. (1) Tau Tetnuld: one specimen from near the summit, representative of the rock forming all the upper part of the mountain. It is a mica-schist, which has been much crushed subsequent to its first crystallization. (2) Guluku: a series of rocks representing the upper part of the mountain—granitoid and gneissoid rocks and strong schists. These afford indications of more or less mechanical disturbance. In one, the garnets have been flattened out into elongated ovals, and ultimately cracked. The specimens indicate a succession of different rocks, possibly resulting from original stratification, though true granite probably forms part of the mountain. (3) From the western crater-peak of Elbruz, collected, in 1874, by by Mr. H. Walker (from the highest rocks, more than 17,500 feet above the sea). It is a hornblende-andesite, not containing quartz, and thus is different from those on the lower part of the mountain.

Linnean Society, May 5.—Mr. W. Carruthers, F.R.S., President, in the chair.—Mr. E. W. Forrest, and Mr. G. Perrin were elected Fellows; Mr. W. H. Beeby, Mr. A. D. Kent, and Mr. J. M. Wood were elected Associates; Prof. G. A. Schweinfurth, Prof. H. Solms-Laubach, Dr. Franz Steindachner, Dr. M. Treub, and Prof. A. Weismann were elected Foreign Members of the Society.—The auditors chosen to examine the Treasurer's accounts were Mr. F. V. Dickins and Mr. G. Maw, to represent the Fellows, and Mr. J. E. Harting and Mr. A. D. Michael for the Council.—Mr. J. W. Willis-Bund exhibited specimens of the rainbow trout (*Salmo iridæus*) reared in the fish-culture establishment, Delaford Park. Though from eggs of the same batch, the fish were very unequal in size. From the evidence of its being a migratory fish and other facts, Mr. Bund doubts the value of its introduction into this country as a stream trout.—Photos were shown and a letter read from Mr. J. G. Otto Tepper regarding a gall formation on *Scævola spinescens* observed by him at Yorke's Peninsula, South Australia.—On behalf of Mr. W. Brockbank, there was exhibited photographs of a series of forms of *Narcissus reflexus* of Brotero, from Ancora, North Portugal, and grown in his garden at Didsbury. *N. reflexus* is ranked as a species by Nyman; but the variation in the Portuguese plant is so great in the size and shape of the corona, that it is evident no definite line of demarcation can be drawn between the Spanish *N. triandrus* and the Brittany *N. calathinus*. It would seem, therefore, that all the varietal forms of the section Ganymedes constitute a single species.—Mr. J. Harris Stone exhibited the flowers of *Nicotiana glauca* from Fuerteventura and Sanzarote, Canaries. The plant is a native of Buenos Ayres, where it grows 10 feet high. It seems to have been introduced into the Canary Islands about 1867-69, since which date it has run wild, and is now to be met with flourishing as a weed on the path sides and in the villages, attaining a height of 3 or 4 feet. The natives call it "mismo" (same), as spreading everywhere the same over the islands.—Photographs of the mud volcanoes of Trinidad, and of the Peak of Rakata, volcano of Krakatão, after the eruption, were exhibited respectively by Mr. R. V. Sherring and for M. Verbeek.—Mr. F. J. Hanbury called attention to specimens of hybrid Primulas.—A paper was read, viz. experimental observations on certain heterœcious Uredines, by Mr. Chas. B. Plowright. Among these, *Puccinia phalaridis*, *P. arenariicola*, *Gymnosporangium clavariæforme*, *G. juniperinum*, and *G. sabinæ* more particularly engaged the author's attention; full details of the cultures and analyses of the experiments being given.—There followed a paper on *Vaccinium intermedium* as a new British plant, by Mr. N. E. Brown. It was discovered by Prof. Bonney at Cannock Chase, August 1886, growing plentifully in certain spots; *V. myrtillus* and *V. Vitis-Idæa* being also abundant. Mr. Brown regards the plant in question as a hybrid between the two latter species, and to have originated independently at Cannock Chase, and not been introduced from the Continent.—A paper was read by Mr. R. A. Rolfe, on bigeneric orchid hybrids, the subject being treated chiefly with reference to its bearing upon classification. After pointing out that these hybrids, as in the case of those between species of the same genus, were more or less intermediate between the two

parents, the practice was recommended of compounding a name from those of the two parent genera, so as to avoid all confusion with existing genera. With regard to orchid hybrids generally, the following are the author's conclusions:—(1) Hybridization may take place not only between distinct species, but also between distinct genera, or between plants so structurally different as to be usually regarded as such. (2) These hybrids are generally of artificial origin, or accidentally produced, and cannot be treated in the scheme of classification either as varieties, species, or genera. (3) The possibility of hybridization taking place between species hitherto considered as distinct does not necessarily prove them to be merely forms of the same species. (4) The occurrence of a hybrid between two structurally different genera does not prove the necessity of uniting them in one; nor can such hybrids be arbitrarily referred to either of the parent genera. (5) Species and genera will always have to be dealt with in the scheme of classification according to their structural peculiarities and differences, without reference to the possibility of hybridization taking place between them.—A report was read, on the Alcyonaria of the Mergui Archipelago, by Mr. Stuart O. Ridley, in which a considerable number of new forms were described; the Burmese coast being rich in species bearing an Indian facies.

Zoological Society, May 3.—Dr. E. Hamilton, Vice-President, in the chair.—The Secretary read a report on the additions that had been made to the Society's menagerie during the month of April 1887, and called attention to two young Polar bears (*Ursus maritimus*) presented by Mr. Joseph Monteith; and to two crested ducks (*Anas cristata*) from the Falkland Islands, presented by Mr. F. E. Cobb.—Extracts were read from a letter addressed to the Secretary by Mr. Roland Trimen, respecting the obtaining of a second example of *Laniarius atrococcus* in South Africa.—Mr. J. Jenner Weir exhibited and made remarks on a skull of a boar from New Zealand.—A communication was read from Mr. G. A. Boulenger, containing the description of a new snake of the genus *Lamprophis*, based on a specimen living in the Society's Gardens, which had been presented to the collection by the Rev. G. H. R. Fisk.—A communication was read from Mr. J. H. Leech, containing an account of the diurnal Lepidoptera of Japan and Corea, based on a collection recently made by the author during a recent entomological expedition to those countries. The total number of species in Mr. Leech's list was 155. In Japan, Mr. Leech had discovered one new species (*Papilio mikado*), and in Corea four others.—Mr. R. Bowdler Sharpe, gave an account of a second collection of birds formed by Mr. L. Wray in the mountains of Perak, Malay Peninsula. This collection contained samples of about fifty species, of which ten were described as new to science.—Mr. H. J. Elwes pointed out the characters of some new species of diurnal Lepidoptera, specimens of which had been obtained by him during his recent visit to Sikkim.—A communication was read from Mr. Lionel de Nicéville, containing an account of some new or little-known Indian butterflies.

Entomological Society, May 4.—Dr. D. Sharp, President, in the chair.—The Rev. C. Ellis-Stevens, Mr. F. Merrifield, Mr. H. Rowland-Brown, and Mr. C. Matthews were elected Fellows.—Mr. Warren exhibited specimens of *Stigmonota pallifrontana*, *S. internana*, *Asthenia pygmæana*, and *A. abiegana* (*subsequana*, Haw.).—Mr. Stainton remarked that it was formerly thought that Haworth's *subsequana* was identical with the species previously figured by Hübner as *pygmæana*; but now that the two allied species were critically examined, it appeared that the species described by Haworth as *subsequana* was not *pygmæana*, but another species known as the *abiegana* of Duponchel, dating only from 1842, so that Haworth's name—*subsequana*—had priority by thirty years.—Mr. F. Pascoe exhibited a specimen of *Diaxines taylori*, taken out of the stem of an orchid—*Saccolabium celeste*—received from Moulmein.—Mr. McLachlan exhibited nearly 200 specimens of Neuroptera, collected by Mr. E. Meyrick in Australia and Tasmania, comprising about seventy species. There were between forty and fifty species of Trichoptera, including forms from Western Australia, allied to *Plectrotarsus*, and other species belonging to a group represented by *Hydropsyche edwardsii*. Among the Planipennia, the most remarkable insect was a species of the singular genus *Psychopsis*, from Mount Kosciusko, where it was common. Of Pseudo-Neuroptera there was a species of *Embiidæ* from Western Australia, and certain *Psocidæ* and *Perlidæ*. Mr. Meyrick made some remarks on the localities in which he had collected the species.—Mr. M. Jacoby exhibited a new species of *Xenarthra*, collected by Mr. G. Lewis in Ceylon.—Mr. C. O. Waterhouse exhibited a living example of an ichneumon—*Ophion macrurum*—bred from a larva of *Callosamia promethea*, a North American species. He also exhibited a number of wings of Lepidoptera denuded of the scales, in order to show the neuration, and explained the method he had adopted for removing them. The wings were first dipped in spirit and then placed in *eau de javelle* (potassium hyperchlorite). Mr. Waterhouse said he had sometimes substituted peroxide of hydrogen for *eau de javelle*, but the action was much less rapid, although the results were satisfactory. Mr. Poulton remarked that the discovery of some chemical for softening chitine had long been wanted to prepare specimens for the microscope.—Mr. Slater read a note, extracted from the *Medical Press*, on the subject of the poison used by certain African Bushmen in the preparation of their arrows. It was stated that the poison was prepared from a caterpillar which they called "N'gwa."—The Rev. W. W. Fowler read a note received from Mr. J. Gardner, in which it was stated that *Dytiscus marginalis* possessed the power of making a loud buzzing noise like that of a humble-bee. Dr. Sharp said he was familiar with the humming of *Dytiscus marginalis* previous to flight, and thought it might perhaps be connected with an inflation of the body for the purpose of diminishing the specific gravity of the insect; he had noticed also that it was occasionally accompanied by the discharge of fluid from the body.—Mr. Wm. White read a paper on the occurrence of anomalous spots on Lepidopterous larvæ.—Mr. Waterhouse read descriptions of new genera and species of *Buprestidæ*.

Geological Society, April 27.—Prof. J. W. Judd, F.R.S., President, in the chair.—The following communications were read:—On the London Clay and Bagshot beds of Aldershot, by Lieut. H. G. Lyons, R.E. The author first described the section from Thorn Hill on the north to Redan Hill on the south, plotted from the 6-inch Ordnance Survey on a scale of 6 inches to 1 mile horizontal, and 12 inches to 1 mile vertical. This section comprises beds from the Woolwich and Reading series to the Upper Bagshot inclusive. The second section described runs from Gravel-Pit Hill on the north to Ash Green on the south. It was drawn to the same scale, and showed the beds from the Chalk to the Middle Bagshots inclusive. The third section was drawn, also on the same scale, through Aldershot town, showing the beds from the Woolwich and Reading series to the Middle Bagshots inclusive. It was inferred from various calculations, as also from direct observations, that the thickness of the London Clay shows no diminution throughout the section, being nearly the same also at Ash and at Aldershot Place. In "Cæsar's Camp" the pebble-bed occurs at altitudes ranging from 500 to 550 feet. The author concluded that wherever we can fix the top or base of the London Clay we get a northerly dip of 2½° to 3°, showing a fairly constant thickness of from 330 to 340 feet. The same thing occurs from Odiham on the west to Ash on the east, whilst at Brookwood the London Clay is thicker. He also assumed the existence of a passage from the London Clay up into the Bagshot beds in the deep wells or borings at Wellington College, at Brookwood, and at South Camp. Hence at these points there can have been no great erosion or unconformity. The overlying Bagshots lie conformably on the London Clay and on each other. The President congratulated the Society on the acquisition of a recruit whose carefully plotted sections did credit to his training as an officer of the Royal Engineers. The author's conclusions were discussed by Messrs. Irving, Whitaker, Monckton, Hudleston, and Herries.—Supplementary note on the Walton Common section, by Mr. W. H. Hudleston, F.R.S. The principal object of this paper was to point out the occurrence of certain beds of clay or loam in what are usually known as the "Lower Bagshot Sands" of West Surrey. The author maintained (1) that the more we study the Bagshot beds of this area the less likely are we to see a passage between the curiously diversified Lower Bagshots and the much more uniform and homogeneous London Clay; (2) that, until we realize the considerable though sporadic development of clays in the Lower Bagshots, we shall be in danger of referring beds to the Middle Bagshots which do not belong to them, and thereby give encouragement to a speculative stratigraphy which can only mislead. The reading of the paper was followed by a discussion, in which the President, Mr. Whitaker, Mr. Irving, and Mr. Herries took part.

Anthropological Institute, April 26.—Mr. Francis Galton, F.R.S., President, in the chair.—Mr. R. A. Cunningham exhibited some aboriginal Australians from North Queensland. The party consisted of a man, a woman, and a boy. They sang a corroborree song, and successfully showed the manner of throwing the boomerang.—Mr. C. H. Read read a paper on the ethnological bearings of the stone spinning-top of New Guinea, in which he gave a description of some spinning-tops recently presented to the British Museum.—Lieut. F. Elton, R.N., read some extracts from notes on natives of the Solomon Islands, obtained by him in reply to questions addressed to the solitary European resident on one of the islands.

PARIS.

Academy of Sciences, May 9.—M. Janssen in the chair.—A general method for determining the constant of aberration, by M. M. Lœwy. A demonstration is given of the remarkable geometrical property that the action exercised by aberration on the great arc connecting two stars is in proportion to the cosine of the angle formed between the median and the direction of the motion. It is then shown that, by effecting two conjugated observations, the constant of aberration may be determined independently of any physical corrections.—On Admiral Cloué's second memoir regarding the cyclone which swept over the Gulf of Aden last year, by M. H. Faye. Some exceptional features of this destructive cyclone are described and accounted for, and it is suggested that a regular signal service should be established in Socotra, or at some other favourable point, for the protection of shipping in these much-frequented waters.—Researches on the liberation of ammonia by vegetable soils, by MM. Berthelot and André. The experiments here described have reference mainly to the argillaceous soil on the higher plateaux in the neighbourhood of Paris. They tend to show that vegetable humus possesses the property of spontaneously liberating ammonia in proportion to the slow but certain decomposition of the starchy and ammoniacal compounds contained in it. The decomposition is effected under the influence of the purely chemical actions due to the water and the earthy carbonates, and doubtless also to the physiological actions attributable to the fermentations, microbes, and vegetation properly so-called; causes continually at work in Nature.—On a method of recording the calorific intensity of the solar rays, by M. A. Crova. A study of the curves obtained with his registering actinometer has enabled the author to estimate more accurately the value of the methods employed for determining this quantity, and to study the causes of the diurnal and annual variations of atmospheric absorption. He promises soon to communicate the method adopted by him for the study of the actinometric curves and its application to the determination of the law of atmospheric absorption.—The earthquake of February 23, 1887, by M. Albert Offret. In supplement to his previous communication, the author here gives in tabulated form the exact time when the shocks were felt in various places lying beyond the line of general movement. Appended is a corresponding table for the magnetic disturbances recorded at different observatories lying mostly beyond the seismic area, but evidently produced under the influence of the earthquake. A comparative study of these tables gives the unexpected result that the velocity of the seismic waves increases with the distance from the central area of disturbance.—Study of the effects of an electric shock felt during the earthquake of February 23, by M. Onimus. A detailed account is given of the severe shock felt by a person at Nice while working the telegraph at the moment the third seismic wave occurred. The incident seems to place beyond all doubt the fact that earthquake movements are normally accompanied by strong electric currents.—On the two species of Phylloxera of the vine, by M. A. L. Donnadieu. The two species of this organism, hitherto confused under one form, are here carefully distinguished and described under the names of *P. vastatrix* and *P. pemphigoides*.—On the direct photography of the barometric state of the solar atmosphere, by M. G. M. Stanoiéwitch. The author has made a comprehensive study of the solar photographs taken at the Meudon Observatory during the last eleven years, for the purpose of elucidating as far as possible the question of the origin of the solar photospheric network viewed in its relation with the solar pores, spots, and faculæ. The general result is that this phenomenon is nothing but the direct photograph of the barometric maxima and minima of the solar atmosphere.—On synthetic acetic acid and its derived forms, by M. Louis Henry. The author's researches show that monochlorureted acetic acid and malonic acid are essentially one, always identical with themselves, forming only a single variety whatever be the nature of the acetic acid from which they are derived.—On anemonine, by M. Hanriot. A full description is given of the properties of this neutral, non-nitrous substance, extracted by Heyer from different anemones, some forty years ago, but since then entirely neglected by chemists.—On the creatines and creatinines, by M. E. Duvillier. This note deals mainly with the formation of α-amidocaprocyamine and α-amidocaprocyamidine.—Variations of the phosphoric acid in cows' milk, by M. A. Andouard. The object of this paper is to complete our knowledge of the modification which the composition of milk undergoes during lactation, and especially the variations occurring in the quantity of the phosphoric acid present during that period.

BOOKS, PAMPHLETS, and SERIALS RECEIVED

Anatomy of Movement: Dr. F. Warner (Paul).—Atlantic Weather Charts, part 2 (Eyre and Spottiswoode).—Die natürlichen Pflanzenfamilien, 3 and 4 Lief.: A. Engler and K. Prantl (Engelmann, Leipzig).—A Treatise on Geometrical Optics: R. S. Heath (Cambridge Press).—Saddle and Moccassin: F. Francis (Chapman and Hall).—Jahrbuch der Naturwissenschaften: Dr. Max Wildermann (Herder, Freiburg).—Proceedings of the Royal Society of Edinburgh, No. 122.—Naturæ Veritas: G. M. Minchin (Macmillan).—Schriften der Physikalisch Ökonomischen Gesellschaft zu Königsberg i. Pr. 1886 (Königsberg).—The Species of Ficus of the Indo-Malayan and Chinese Countries, part 1, Palæomorphe and Urostigma: Dr. G. King (Reeve).—Notes from the Leyden Museum, vol. ix., No. 2 (Brill, Leyden).—Journal of the Chemical Society, May (Gurney and Jackson).

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THURSDAY, MAY 26, 1887.

TREATMENT AND UTILISATION OF SEWAGE.

Treatment and Utilisation of Sewage. By W. H. Corfield, M.A., M.D. (Oxon.). Third Edition, Revised and Enlarged by the Author and Louis C. Parkes, M.D., Cert. Public Health (Lond.). (London: Macmillan and Co., 1887.)

OF late years, discussions about sewage have occupied a large share of the proceedings of many of the Societies concerned with the practical application of science, and recent scientific discoveries have as yet done little to modify the conclusions of the last ten or fifteen years. Dr. Farr's Report on Vital Statistics proves that increased density of population (if sanitary conditions remain constant) is itself a cause of increased ill-health and death, which can only be counteracted by increased precaution. And the prominent position occupied by England in sanitation must be ascribed to the constant efforts which have been made to cope with the increasing density of the population. A danger to health arises from density of population mainly because of the retention in our midst of the impurities which are the necessary accompaniments of the act of living, that is to say, the retention of those substances which putrefy, and from the products of the putrefaction of which various matters, or, it may be, organisms, inimical to life, become disseminated through the air.

The new, a third, edition of Dr. Corfield's record of the treatment and utilisation of sewage is a valuable contribution to the history of the development of the methods by which some of these evils have been counteracted. The first edition was the practical outcome of researches and experiments made by a Committee of the British Association, which was appointed to consider the evils arising from the unsystematic arrangements which prevailed at the inception of the water-carriage system for sewage. Before the introduction of the water-carriage system, refuse polluted the soil under and around the houses, the wells, and the air: when water-carriage was resorted to, it was thought sufficient to allow the dirtied water to flow to the nearest outfall, and the result was the pollution of our ditches, streams, rivers, and seashores. Our experience of the way in which these evils can be overcome has been gained slowly and tentatively; and Dr. Corfield's record of the various processes which have been tried and abandoned is not only useful as a means of preventing those methods that have been found unsuccessful from being brought forward again, but the account he gives of the causes of failure teaches important lessons to the sanitarian—lessons that may enable him to combat the insanitary conditions which a dense population is continually developing under new and unforeseen aspects.

Much as the subject of sewage disposal has been discussed, the varying conditions under which towns have to dispose of their sewage make it impossible that there should be any uniform method of disposal. It is abundantly certain that sewage contains elements of value. Dr. Tidy values the sewage at 8*s.* or 9*s.* per annum per head of the population, of which the solid part is worth 1*s.* 2*d.* Dr. Corfield estimates the sewage of London alone at between £1,000,000 and £1,500,000. Dr. Liebig estimated it at £4,000,000. But Dr. Hoffman, in 1857, summed up this question in the statement that the value in London sewage was like the gold in the sands of the Rhine—it amounted to millions, but it would not repay the cost of recovering it. Some of our first authorities on the subject, indeed, having most strongly advocated the commercial value of sewage, have ended, after years of labour, by saying, "Get rid of it in the cheapest manner; throw it into the sea if you can." The assumption that, because sewage has within it manurial value, therefore its removal ought to produce a profit, has had a most unfortunate effect on the treatment of this question. The search after the philosopher's stone of profit in sewage-disposal retarded the sanitary movement for years.

But, whilst it is easy to say, "Throw your sewage into the sea," it is rarely that we can so deal with it without injuring foreshores or tidal estuaries, and many seaside resorts are suffering from such a method of disposal. A tidal river can only be safely resorted to under exceptional conditions. The discharge of crude sewage into a river, or, for the matter of that, on to land, is not satisfactory. For instance, the metropolitan sewage is poured into the tidal estuary of the Thames, where there is an enormous volume of water. Notwithstanding the purifying power of water, the sewage has seriously polluted the river beyond its capacity for purification in dry weather. On the other hand, it has been shown that the Barking and Halfway Reaches of the Thames, where the sewage is poured in, are really now better for navigation than they were before the metropolitan drainage outfalls were opened.

Independently, however, of the evils of the pollution of the tidal estuary of the Thames by the metropolitan sewage, we cannot conceal from ourselves that if some method of utilisation were feasible, even though it cost as much as we now pay for disposing of the sewage without utilisation, the resulting agricultural produce would be a gain to the nation. But there is not at present any generally-accepted plan for converting the metropolitan sewage into food, nor does it seem very probable that any method of treating the London sewage as a combined whole will enable us to do so usefully. The Metropolitan Board of Works, indeed, appear to consider it more prudent to submit to the known cost of loss than to embark on the more speculative course of endeavouring to rescue the valuable contents.

The most important question for the nation at the present time relates to other towns in the kingdom—that is to say, the question how, in the case especially of inland towns, can the sewage be purified so as to prevent it from damaging neighbouring properties, and make it fit to be passed into rivers. The best authorities are agreed on one point, viz. that it must not be sent crude into the rivers; and the preliminary straining off of the suspended matters is only a little less objectionable. Precipitation alone will not render the effluent water sufficiently pure; but if you let that effluent, after precipitation, flow over a small area of land, you will give the effluent the finishing touches towards

purification. Precipitation by chemicals implies certain conditions. First, if you want to treat sewage properly by a precipitation process, you must treat it fresh, before active putrefaction sets in. Secondly, before you mix your chemicals with it, you should strain the sewage in some way or other. Thirdly, you should add sufficient chemicals to effect complete purification. Fourthly, there should be efficient stirring after the addition of the chemicals. Fifthly, it is essential that you should have sufficient tank accommodation, for two reasons: first, that the precipitate may subside perfectly; secondly, that the sludge may be frequently removed. If you allow the old sludge to remain in the tanks, it is perfectly certain that it will contaminate the fresh sewage when it comes in. When the sludge is taken out of the tank, the tank itself must be washed. By combining precipitation, which will produce a good effluent, with land treatment or prepared filters, you may produce the best effluent that is known.

Intermittent downward filtration through land will adequately purify sewage so as to allow the effluent to pass into a stream; but by this plan the manure which is so much wanted is almost entirely lost, the greater part escaping in solution in the effluent water in the form of nitrates and nitrites. On the other hand, if the effluent is used for irrigation farming, under necessary conditions of soil and methods of application, the sewage is purified, a certain agricultural return is obtained, and, provided the irrigated land is placed at a sufficient distance (say 500 yards) from houses, the health and comfort of the neighbourhood are not endangered.

Dr. Corfield thus sums up his conclusions:—

"Wherever it is possible, irrigation should be carried out, the sewage having been previously freed, by one or other of the methods described, from the offensive suspended matters, which must be deodorised to prevent the production of a serious nuisance. Wherever, on the other hand, irrigation is practically impossible, intermittent downward filtration through soil affords the means of satisfactorily purifying the sewage."

Drs. Corfield and Parkes say that these were the conclusions at which they arrived seventeen years ago, and that they see no reason to alter them now; but we much doubt whether finality on this question of sewage-disposal has been arrived at. The cremation of refuse on a systematic plan is of only a few years' standing, and at present of somewhat limited application. Moreover, we stand on the threshold of discoveries as to the more occult causes of infection: we are learning daily much of the history and habits of those lower forms of life which play so large a part in putrefactive changes, and which are in some cases proved to be baneful to us under the conditions in which they now occur, but whose action we might possibly learn to modify under enlarged knowledge. We have recently seen how the extraction of oxygen from the atmosphere has risen from being a toy to the position of a practical art. These discoveries may eventually have some bearing on the safe disposal of the refuse matter which is continually being formed in the midst of dense populations. During the last twenty years we have made rapid strides in the methods of removal and disposal of refuse, which have been the result of the free development of the intelligence of the community in sanitary matters: each of those years has marked some step of progress, and we continue daily to advance. It is therefore to be hoped that Parliament will not accept the views of those persons who seem now to be endeavouring to stereotype by Act of Parliament our present position in sanitation, as if it were perfection. Such a step might seriously check future progress.

THE POLYZOA OF THE "CHALLENGER" EXPEDITION.

The Zoology of the Voyage of H.M.S. "Challenger." Part XXX. "Report on the Polyzoa—Part II. The Cyclostomata, Ctenostomata, and Pedicellinea." By George Busk, F.R.S., &c. (Published by Order of Her Majesty's Government, 1886.)

THE first and second memoirs contained in Vol. XVII. of the Zoological Reports of the Voyage of the *Challenger* were reviewed in NATURE two weeks ago (p. 26). The third memoir, the subject of the present notice, formed the last piece of scientific work of the distinguished naturalist to whom the preparation of the Report on the Polyzoa had been intrusted. During a period of illness and suffering under which the energies of most men would have broken down, Mr. Busk still laboured to accomplish the task which he had undertaken, and it was only a few days before his death that he was enabled to bring it to a conclusion.

The author deemed it advisable to divide the Report on the Polyzoa collected during the great exploratory voyage into two parts. The first of these has already been reviewed in NATURE (vol. xxxi. p. 146). It is confined to the Cheilostomatous species, and includes by far the greater number of all the Polyzoa collected. There still remained for consideration such species as are referable to the three remaining sections, namely, the Cyclostomata, the Ctenostomata, and the Pedicellinea. Each of these three groups has its representatives in the present Part, but the number of these is small in comparison with those referable to the Cheilostomata, and there does not occur among them any generic form which can be regarded as new. The account of them here given, while it completes the Report on the Polyzoa collected during the expedition, is characterized by all that careful and exact work which invariably marked the scientific labours of its author.

The entire number of species included in the present Part is forty-six, of which thirteen are now described for the first time. Of these forty-six species the most interesting are probably the two referable to the section Pedicellinea, and placed by the author in his genus Ascopodaria. The Pedicellinea form a very aberrant group of Polyzoa, presenting characters which differ widely from those met with in typical Polyzoal structure. They are represented in our own seas by two or three species of the curious genus Pedicellina, with its naked pedunculated polypides destitute of the "cells" into which the polypides of other Polyzoa admit of being retracted. The genus Ascopodaria is rendered further remarkable by the flask-like dilatation with muscular walls which exists at the origin of each peduncle. The

structure of this form is worked out in the Report with great care, and is illustrated by excellent figures depicting for the first time the anatomy of the genus as far as spirit specimens would admit of its demonstration.

The Report enters fully into the geographical and bathymetrical distribution of the species included in it. Of these the Cyclostomata attain the greatest depth, though only two of them extend to depths greater than 1000 fathoms; namely, *Crisia elongata*, which was obtained in the Australian region from a depth of 1450 fathoms, and *Idmonea marionensis*, which was brought up from a depth of 1600 fathoms in the region of Kerguelen Land. It is a fact, however, by no means without significance, as showing how little certain marine organisms of even complex structure are dependent on depth, that in the case of the last-mentioned species specimens have been obtained from depths varying from 50 fathoms downwards. The Ctenostomata and Pedicellinea are all from comparatively shallow water, none having been obtained from a depth greater than 150 fathoms.

No one could have been found better qualified than Mr. Busk to institute a comparison between recent and fossil Polyzoa. His work on the Polyzoa of the Crag is among the most important contributions we possess to the palæontology of this group, and gives a special value to his determination of the fossil relations of the species collected by the *Challenger*.

To the sub-order Cyclostomata belong the oldest fossil Polyzoa as yet known, and out of the thirty-three species of Cyclostomata obtained by the *Challenger* Mr. Busk has been able to identify fourteen as occurring also in a fossil state, thus proving the wide distribution in time of even specific forms of this group. No fossil species has as yet been identified with either the Ctenostomata or the Pedicellinea. The negative evidence, however, which is all that this statement expresses, proves but little, as these groups are destitute of structures which might be expected to continue recognizable in a fossil state. Barrois, indeed, contends that the larval stage of the Entoprocta (Pedicellinea) represents the primitive form from which the whole of the Polyzoa have descended. Of the Cheilostomata—the sub-order to which the former part of the Report is confined—no species has as yet been proved to belong to Palæozoic times, though this group is largely represented in Mesozoic and Tertiary strata.

The ten beautiful plates which illustrate this part of the Report contain figures of all the newly-described species of Cyclostomatous, Ctenostomatous, and Pedicellinean Polyzoa, and bear ample evidence to the conscientiousness and accuracy with which all the details of form are delineated.

The purely descriptive part of the Report is marked by all that judicious selection of characters, and succinctness yet definiteness of diagnosis, which add so much to the facility of comparison and to the practical value of any work having for its object the determination and description of specific forms. The number and variety of the species and generic types described and figured in this and the former part of the Report give to the whole a special value, not only as a record of the species collected, but as a faithful and comprehensive picture of the external morphology of the important and interesting group of organisms to which it is devoted. G. J. A.

OUR BOOK SHELF.

Dynamics for Beginners. By the Rev. J. B. Lock, M.A. Pp. 178. (London: Macmillan and Co., 1887.)

THIS book is an attempt to explain the elementary principles of dynamics in a manner suitable for school-work with boys of ordinary mathematical attainments. Accordingly it contains a great number of easy *numerical* examples, some worked out in illustration of the text, the others arranged in groups at frequent intervals. There is considerable freshness in these exercises, and they form altogether a very useful series.

The work is divided into four sections. The first treats exclusively of rectilinear dynamics, thus avoiding at the beginning of the subject all purely geometrical difficulties.

The second section introduces the notion of directed or vector quantities, and deals with the application of the parallelogram law to displacements, velocities, accelerations, and forces in succession.

Next we have a section on applications of the preceding to projectiles, oblique impact, circular motion, and relative motion, concluding with a short chapter on the hodograph.

The final section deals with energy, work, and power. These last three or four chapters read in connexion with the first section would form a suitable first course in many cases, involving no mathematics beyond a knowledge of simple equations in algebra.

The exposition throughout is remarkable for clearness and precision of statement. The definitions of terms seem particularly well worded. The names *velo* and *celo* have been adopted for the units of velocity and acceleration, and are used systematically in both text and examples; we hope these terms may win their way to general acceptance, for the language of the subject gains both in simplicity and directness by their introduction.

The debt of gratitude which many teachers and students already owe to Mr. Lock will be considerably increased by this new class-book on a difficult subject, wherein it appears to us that the skill and experience of the author are displayed with great advantage.

Journals kept in Hyderabad, Kashmir, Sikkim, and Nepal. By Sir Richard Temple, Bart., M.P. Edited, with Introductions, by his son, Richard Carnac Temple. With Maps and Illustrations. Two Vols. (London: W. H. Allen and Co., 1887.)

THE first journal contained in these volumes was written at Hyderabad during the year 1867, when the author was Political Resident at the Court of the Nizám. It is entirely political, and will interest only those who study somewhat minutely the course of recent Anglo-Indian history. The journals kept during visits to Kashmir, Sikkim, and Nepal appeal to a larger class of readers. They deal with the physical features of these countries, and to some extent with social customs and institutions. Most of the author's notes are too slight to be of much scientific importance; but all of them have the merit of being written in a clear and unpretending style, and the information contained in them is, so far as it goes, thoroughly trustworthy. The introductions which the editor has contributed to the book add very considerably to its value. They are careful essays, in which Capt. Temple has brought together a great many interesting and suggestive facts that are not readily accessible to ordinary readers.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Sunlight Colours.

WILL you permit me to say, in relation to the very interesting lecture on Sunlight Colours, reported in NATURE, vol. xxxv. p. 498, that Capt. Abney does not seem to have quite apprehended my meaning, when he represents me as stating in a previous lecture at the Royal Institution, that the sun was "really blue outside our atmosphere," for I nowhere in the lecture used those words, nor intended to convey the idea which, without qualification, they must give the reader.

I recognize, however, that if my actual words conveyed it to so fair-minded a critic as Capt. Abney, they must have been open to misconstruction, and I therefore ask permission to recall in explanation an important fact referred to in the lecture, to which he does not allude. It is that the sun is surrounded by an atmosphere of its own, and that the prime modification of its actual colour at the photosphere takes place *there*. Only the secondary change of colour takes place in the earth's atmosphere. "Outside our atmosphere," accordingly, we see, not the absolute colour of the photosphere, but one already greatly modified toward white. I meant, then, when formally defining the colour of the sun outside our atmosphere, to use such qualified phrases as "tends toward blue," or "bluish," and it was for the colour of the sun itself, *i.e.* at the photosphere, and before any absorption, that I meant to reserve the word "blue." Let me hasten to add that I also tried—even to iteration—to insist that "blue" here does not and cannot mean a monochromatic blue, but a combination of all the spectral colours, in which those of the blue end appear in such immense predominance that this is the dominant effect.

Capt. Abney also says: "he" (I) "surmised the result from experiments made with rotating disks of coloured paper. He did not, I think, try the method of using pure colours."

Capt. Abney will, I think, agree on consideration that these words may be liable to convey to most readers a wrong impression of labours which began nearly fifteen years ago, with studies on the absorption of the sun's atmosphere, resting on direct and elaborate photometric comparisons of the light of its centre and edge. These have been followed by confirmatory measures with the bolometer, giving the relative proportions of the pure colours in the normal spectrum, and the tint has not been surmised, but experimentally shown by the actual combination of pure spectral colours.

The solar studies were supplemented in the four years preceding my lecture by almost unintermittent investigations on the absorption of the earth's atmosphere, in which (though considerably over 20,000 galvanometer readings were recorded) I do not recall ever making any observation by the aid of "rotating disks of coloured paper." The paper disks have been often employed in explanation of my method, to roughly show the principles involved, and to *illustrate* results, but certainly not as means by which these results were surmised or discovered.

In a communication to the British Association, published in NATURE, vol. xxvi. p. 586, after alluding to the antecedent researches of Mr. Lockyer and others, which show that certain rays of short wave-length are more absorbed than those of long, I exhibited charts showing how much each ray had grown. One of these, which suffered some curtailment at the hands of the engraver to fit it to the height of the page, was reproduced in the report of the lecture (NATURE, vol. xxxii. p. 42), and it is possibly from this that Capt. Abney derives his impression as to my results in other respects. I can only conjecture that it may be so, since in my professional memoirs there are, not only more accurate charts, but with them warnings that the figures representing the relation of the blue and red end in such drawings, or even in the tables whence they are taken, necessarily give minimum values of the blue.

The fact that this blueness was first predicated from a long and careful study of the absorption of the sun's atmosphere is a distinct one, and I am entirely disposed to admit that this point was not explained at sufficient length in my lecture, in which I had but an hour to describe the work of twelve years. Being forced to confine myself to an account of some limited portion of this long research, I chose that part of it which dealt with the absorption of the earth's atmosphere, as illustrated by the expedition to Mount Whitney, but I thought the facts just stated about the influence of the sun's atmosphere too important to go without explanation altogether, and rehearsed them substantially in other words before entering at length on the subject of the telluric absorption.

As the observations on the sun's atmosphere are still unpublished, it may be of interest if I give here, in anticipation of the final reductions, the approximate results of some made at Allegheny in 1882, and which were supplemented by others which I was enabled to make at South Kensington in the same year by the kindness of Mr. Lockyer.

This table gives the reduction to the normal spectrum at the points indicated in the first line, where λ designates the wave-length and μ = one micron = 1/1000 of one millimetre. The second line gives the approximate transmission by the solar atmosphere (not alluded to in Capt. Abney's lecture). The third line gives the approximate transmission by the earth's atmosphere alone (numbers nearly concordant with those he seems to employ for this secondary effect); and the fourth, the combined effect of the two. It is from such numbers as those in this fourth line that we have deduced the true colour of the sun at Allegheny, by methods to be presently alluded to, and which authorize us to state that its dominant tint before any absorption is not so much "bluish" as "blue."

	μ 0·40	μ 0·45	μ 0·50	μ 0·55	μ 0·60	μ 0·65	μ 0·70	μ 0·75
Transmission by solar atmosphere	·16	·24	·30	·35	·38	·41	·43	·45
Transmission by terrestrial	·31	·44	·53	·61	·68	·74	·79	·83
Resultant transmission by both atmospheres	·05	·11	·16	·21	·26	·30	·34	·37
Reciprocal of last, showing approximate brightness before any absorption.....	20·2	9·5	6·3	4·7	3·9	3·3	2·9	2·7

Thus we see that of the extreme blue or violet light, whose wave-length is 0·4 μ, 16 per cent. (*i.e.* less than $\frac{1}{6}$) only is transmitted by the solar atmosphere, and of this 16 per cent. 31 per cent. only is transmitted by the earth's atmosphere. It is of this latter alone that Capt. Abney here takes account, but in consequence of the absorption by both atmospheres, only about 5 per cent. of the original violet light reaches us; or in other words, before the double absorption there was over twenty times as much of this sort of blue in the sun as what we now see. On the other hand, of the deep red light whose wave-length is 0·75 μ as much as 45 per cent. is transmitted by the solar atmosphere, and of this again 83 per cent. by the earth's; so that after the action of both atmospheres on this ray 37 per cent. is transmitted as against 5 per cent. of the violet. If we take the reciprocal of the numbers in this fourth line we have those of the fifth, which evidently show the relative intensity of the colours at the photosphere (*i.e.* before any absorption), as compared with that of common daylight. I employed in 1882 an optical arrangement, suggested by Mr. Very of the Allegheny Observatory, by which we passed from these figures to the production of the actual resultant tint of the solar photosphere; not by using pigments or revolving disks, but by the direct combination of pure spectral colours in the above proportions. The resultant colour cannot, I repeat, be exactly defined by any one spectral one, as it was not monochromatic; but the tint was, to my eye and that of others, best technically defined as that of Herschel's lavender, with perhaps a suggestion of purple; and certainly I think now, as I thought then, that "blue" is the nearest familiar word to describe it.

It was with all these facts, and many more, in my possession, that I used the language in question.

I hope after this statement that I may conclude that Capt. Abney and I have really no serious ground of difference as to the propriety of the term "bluish," or as to what it here means. I would only say that by no latitude of interpretation do I take it as meaning *white*.

S. P. LANGLEY.

Smithsonian Institution, Washington, D.C., May 2.

The Eclipse of August 19, 1887.

THIS eclipse will be seen over such an extent of territory that it is desirable to make the best use of the opportunity offered. The astronomical observations I do not mention, but besides them the following would be very important, and could be made by travellers alone, and those who do not take with them heavy and troublesome instruments :—

Observations every ten minutes on the *pressure* and *temperature* of the air from the beginning of the eclipse to about half an hour after its end; and, some days before and later, every hour, at the hours of the eclipse.

The *barometer* might as well be an aneroid, but with large divisions; a pocket instrument would be too small. Relative and not absolute measures are intended, and it is especially necessary that the instrument be not sluggish.

The *thermometer* preferable for the observations should be a sling-thermometer (Frowde), as one in a thermometer-stand and not swung could not follow rapidly enough the changes of temperature. It would be best to swing it at the height of the shoulder.

Observations on *cloud*, *direction* and *force of wind*, every half hour the day of the eclipse and every hour before and later.

Some observations on the colour of the sky, &c., and on the influence of the eclipse on animals, domestic and wild, would be useful.

The eclipse will be visible in Eastern Germany, but at so early an hour in the morning that there will be comparatively little interest in meteorological observations. Russia (especially Eastern) and Western and Central Siberia give much better opportunities of observation. I give below some notices on the amount of cloud; the stations are disposed from west to east, the mean is that of three observations, 7 a.m., 1 p.m., and 9 p.m. The conditions as to cloudiness will be better than those indicated here, in Eastern Russia and Siberia to nearly Lake Baikal, as the eclipse will be seen in the later morning hours, which have a smaller amount of cloud than 7 a.m. and 1 p.m.

Amount of Cloud.

	Mean	7 a.m.
Rjev, Government of Tver	57	49
Moscow	57	50
Academy of Petrovsky, near Moscow..	51	
Rojdestwenskoye, Government of Kostroma	60	61
Kasan	58	55
Viatka	53	51
Ekaterinburg	68	67
Nijnetaguilsk	64	
Bogoslovsk	57	
Irbit	53	
		1 p.m.
Irbit		69
Yeniseisk	53	
Irkutsk	49	48
Foundry of Nertschinsk	53	59
Niigata, west coast of Nippon... ...	55	

I give a list of some places where tolerably good accommodation is to be found, with the time of travel from the nearest railway-station :—

Tver, Torjok, Moscow,[1] Yaroslav,[2] Kostroma (three hours' steamer from latter point), Schuja, Ivanovo-Wosnessensk, Kineschma, Vladimir, Viatka (steamer on Volga, Kama, and Viatka, from Nijni-Novgorod, in three days), Perm (steamer from Nijni-Novgorod in eighty-five hours.

Nijnetaguilsk, with important foundries, malachite mines, &c., reached by railroad from Perm in fifteen hours.

Tobolsk, by rail from Perm to Tjumen in about thirty hours, thence by steamer in two days, twice a week. It is well to telegraph beforehand to retain a cabin.

Tomsk by steamer from Tjumen in about eight days, by the Tura, Tobol, Irtysch, and Ob.

The places eastward, the most favourable for observation, can be reached by road only from Tomsk. Post-horses everywhere available, rapid travelling in good weather, but bad carriages.

To astronomers bringing with them bulky instruments, the water-ways are to be recommended. St. Petersburg is in easy steamer communication with British harbours, and thence luggage can be sent by water to all parts of the Volga basin. So far as known at present, it is intended that there shall be observations of the eclipse at five points: (1) the observatory of General Maiewsky, Government of Tver; (2) the estate of Count Olsuffiew, district Dmitrov, Government of Moscow; (3) the estate of Prof. Bredichin, district Kineschma, Government of Kostroma,—two English astronomers are expected; (4) Glasov, Government of Viatka; (5) Krasnoiarsk, on the Yenisei.

A. WOEIKOF.

[1] Just at the southern limit, it would be better to observe somewhat to the north.

[2] See Mackenzie-Wallace's "Russia."

Iridescent Clouds.

THE clouds seen by Prof. Stone, as described in NATURE, vol. xxxv. p. 581, may have been of the same character (though I cannot judge positively from the description) as those so extensively observed in the Decembers of 1884 and 1885; if so, it is the only account I have read of their being seen last winter. Those described by Mr. McConnel, writing from St. Moritz, Switzerland (p. 533), are evidently of a totally different character, and I suppose simply the ordinary iridescent clouds which are common everywhere.

T. W. BACKHOUSE.

Sunderland.

Remarkable Hailstones.

MAY I ask for space to make a suggestion as to the possible cause of the banded structure of hailstones recently observed and recorded in NATURE, vol. xxxv. p. 438? It seems to me that the phenomenon may perhaps be explained by *devitrification of the ice*. We are familiar with a considerable number of bodies which assume the vitreous state by rapid solidification from the liquid state; and it seems reasonable to suppose that in the conditions under which hail is formed the ice may assume at first the vitreous state, the higher molecular structure of perfectly crystalline ice requiring more time for its full development (see paper by the writer read before Section C of the British Association last year at Birmingham). If such were the case (and the hypothesis is supported by the statement of Mr. C. S. Middlemiss in NATURE, vol. xxxv. p. 413), the observed structure (which can be actually seen to develop itself in some vitreous substances under the microscope, as a preliminary to the assumption of the full crystalline and opaque condition) would simply mark an early stage of the devitrification of the ice-glass. To bring this theory to the test of experiment it would only be necessary to observe closely the effect of keeping such hailstones for some time at a temperature rather below 0° C.

A. IRVING.

Wellington College, Berks, May 14.

The Orbit of the Minor Planet Eucharis.

ON reading your note (p. 16) on the determination of the orbit of the planet *Eucharis*, by Dr. de Ball, and the discordances between his observations and those obtained with the Washington meridian instrument, I am reminded of an earlier case which seems to me to be analogous.

Hansen drew attention to the very material difference between the observations of *Egeria* in 1864 at Bonn and Leyden. This discrepancy between observations which otherwise harmonized well amounted to 10" in R.A., and occasioned a protracted inquiry by Argelander (*Astron. Nachr.*, No. 1769), in which he came to the conclusion that the reason probably lay in the personal error of the Leyden observer in the observation of bright and faint stars. As I am not acquainted with Dr. de Ball's treatise, I cannot judge whether respect was paid to such differences in isolated cases.

W. VALENTINER.

Karlsruhe Observatory, May 8.

A Question for Chemists.

YOUR correspondent, Mr. West, will find reference to the fact that a mixture of glycerine and potassium permanganate is liable to spontaneous combustion in the "Extra Pharmacopœia" of Martindale and Westcott, fourth edition, p. 292.

Dublin. HARRY NAPIER DRAPER.

"A Junior Course of Practical Zoology."

IN a recent notice of "A Junior Course of Practical Zoology" (NATURE, vol. xxxv. p. 506) the reviewer expresses surprise

that anyone should, in a text-book for students, "discard the ophthalmic somite of their seniors, and press the telson into the service," a procedure on which he comments thus:—"The introduction of so sweeping a change into a book for juniors, without due comment is, under these circumstances, a false step, especially when it is considered that the precise converse is stated in all other books current."

Now Claus in his text-book says (I quote from the English edition):—"The facetted eyes are borne on two movably separated stalks. These were for a long time considered as the anterior pair of appendages, while in fact they are merely lateral portions of the head which have become jointed"; and elsewhere: "The last abdominal segment, which is transformed into a telson."

Gegenbauer in his text-book says:—"The projecting character of the eye, owing to its curvature, may lead to a stage in which the eye is stalked. When still more developed, this stalk may become movable"; and nowhere speaks of the stalk as the homologue of an appendage.

Prof. Lankester's pupils are all taught to regard the telson as a somite and the "ophthalmic somite" as an erroneous interpretation of parts.

I fail to see, therefore, that Prof. Marshall need offer any excuse for his method of counting the segments, nor, in an elementary text-book, discuss a question on both sides of which there is avowedly much to be said.

I may note with regard to one other criticism that, although there is nothing "irrelevant or absolutely fantastic" about the term commissure, it is convenient to distinguish between "commissures connecting two ganglia of the same pair" and "connectives connecting ganglia of dissimilar pairs" ("Encycl. Brit.," ed. ix. Art. "Mollusca"). The "word-mongerers" are here marking "a turning-point in advance."

Madras, April 20. A. G. BOURNE.

"On the Establishment of the Roman Dominion in South-East Britain."

IN my article on the above subject printed in NATURE, vol. xxxv. p. 562, I have briefly alluded to the ridiculous mutiny of the Roman soldiers. I ought to have added (from Dio) the relation of the following incident, which terminated the mutiny:—

"Taking courage, because a brilliant meteor rising in the east passed across to the west, to the part to which they were making their course, they descended on the island."

That is, the Romans descended from an easterly part of Europe upon Britain.

This agrees with the course which in my former letter I assigned as most probable; namely, that the Romans sailed from the mouth of the Scheldt to Southend. G. B. AIRY.

The White House, Greenwich, May 18.

FLORA OF CHRISTMAS ISLAND.

THE Hydrographer of the Admiralty has kindly forwarded to Kew, as he has stated in his note in NATURE for May 5, p. 12, the botanical specimens collected during the visit of H.M.S. *Flying-Fish* to Christmas Island. They were unfortunately, as explained by Capt. Maclear, a mere residue of the collection which was obtained. The examination of a better preserved and more extensive one would be interesting, as the flora is evidently of a less common-place kind than that generally met with in coral islands.

In all, twenty-four species admitted of approximate determination. Of these five were ferns, all widely-spread species. Of the remaining nineteen flowering plants five are also probably identical with widely-distributed species, and they occur in the Cocos or Keeling Islands between which and Java Christmas Island lies. The much more limited flora of these islands is only known from the collections of the late Mr. Darwin, and of Mr. H. O. Forbes. Of the remaining fourteen species at least six must be set aside, the specimens being too imperfect to be more than approximately determinable. Of the rest, two, a *Vitis* near *V. pedata*, Vahl, and an *Ehretia*, may, in Prof. Oliver's opinion, possibly be new; the teak (*Tectona grandis*, L. f.) occurs generally in the Malayan Archipelago; *Euphorbia Chamissonis* is interesting as a Polynesian type; fruits of *Barringtonia* are thrown up universally on shores in the Malayan waters; *Terminalia Catappa*, L., is found pretty well everywhere in the tropics; the remaining two suggest no special remark.

The collection unfortunately throws little light on the composition of the dense arborescent vegetation with which Capt. Maclear found it to be covered. Teak probably forms large trees. *Cordia subcordata*, Lam., which occurs also in the Cocos-Keeling Islands, and, according to Mr. H. O. Forbes, originally covered them abundantly,[1] is known there as "iron-wood," and is no doubt one of the iron-wood trees recognized by Capt. Maclear in Christmas Island. It is widely distributed throughout the Malayan Archipelago, and extends to the Philippines and some of the Pacific islands.[2]

On the whole, it can hardly be doubted that Christmas Island has been stocked with its flora by the agencies described by Dr. Guppy, and worked out by Mr. W. B. Hemsley in the "Botany Report of the Voyage of H.M.S. *Challenger*" (vol. i. part 3, p. 310): "Winds and currents drift to their shores the fruits and seeds of the littoral trees which ultimately form a belt, whilst the fruit-pigeons disgorge the seeds or fruits of those often colossal trees which occupy the interior."

The former agencies brought no doubt *Barringtonia*, *Hibiscus tiliaceus*, *Terminalia*, *Cordia subcordata*, *Ochrosia parviflora*, and *Pandanus*. Carpophagous birds are elsewhere known to bring a profusion of fruits of palms, nutmegs, *Euphorbiaceæ* and *Laurineæ*, and other arborescent species. Upon this element in the flora of Christmas Island the collection, as already remarked, throws insufficient light. The flora of Java is still but imperfectly known, and though there is no reason to believe that that of Christmas Island contains any absolutely endemic species, it would not be surprising if a careful examination yielded many plants new to science which have yet to be ascertained from the larger contiguous island, from which they have been derived.

W. T. THISELTON DYER.

THE JOURNAL OF THE ROYAL MICROSCOPICAL SOCIETY—RETROSPECTIVE AND PROSPECTIVE.

THE month of March 1878 will ever remain memorable in the annals of microscopy in this country, for it marked the regeneration of the Journal of the Royal Microscopical Society, the most conspicuous feature of which was the introduction, for the first time, of a systematic record of current researches under the title of "Notes and Memoranda." Now that the period of editorship which worked the change is fast approaching its decade, we would wish to review the position, in anticipation of the introduction of still further modifications which, it is to be assumed, the editors will adopt on entering upon a second period.

We read in the preface to the first volume that the "Notes and Memoranda" are intended to present a summary of what is doing throughout the world in all branches of microscopical research. Whilst extracts from English publications will not be excluded, preference will be given to those of foreign countries, as being less easily accessible. Amongst these will be included the Transactions and Proceedings of the Academies of the United

[1] "Naturalist's Wanderings in the Eastern Archipelago," pp. 28, 29.

[2] Mr. H. O. Forbes (*l.c.* pp. 26, 27) gives a curious account of the way in which the labours of a crab turn the white calcareous fore-shore of coral islands into "a dark vegetable mould." They do this by burying systematically particles of vegetable *débris*; by scooping away the soil beneath them they lower down even large branches of trees. The ground thus enriched is fitted for occupation by plants; and as Mr. Forbes particularly noticed that they carry "down also the newly-fallen seeds of the iron-wood" these industrious factors in the economy of a bare coral island not merely prepare the soil but also plant it.

States, France, Belgium, Germany, Austria, Italy, and Russia, together with the microscopical, botanical, and zoological journals of those countries. It will be obvious to anyone who will compare the last few numbers of the Journal with the first volume, from which we have just quoted, that the former are no less superior to it in general excellence than it was to its immediate predecessors. The editors have elaborated their scheme with the growth of the Journal, and have, in their desire to satisfy the public, gone beyond the prescribed limits, and incorporated abstracts of all the more important papers in certain branches of the science, whether microscopical or not.

In no period of the history of biological science has advance been so rapid as within the last decade, and it is no exaggeration to say that the Journal before us is a faithful historical record of the work done during that period, in those branches with which it professes to deal. To him who would labour in earnest at a given subject the original monographs are indispensable; but even the narrowest of specialists must obtain some knowledge of the advance made in cognate branches of his science, and a ready means of acquiring this, as it applies to microscopy, has been provided by the Journal named during the period of which we write.

It might naturally be supposed that the increase in native workers, whose labours have so far extended the literature of the science and consequently swelled the pages of the Journal in which that literature has been abstracted, must have resulted in a corresponding increase in the circulation of the Journal itself. This, we are informed, has not been the case. In reflecting upon this fact we must remember that during the past decade many changes have been wrought in the literature of biological science. Anzeigers and Records have been established and augmented. But withal the "Notes and Memoranda" of the Society's Journal have made a place for themselves in the library of the working biologist; the abstracts are up to date, and frequently fairly detailed, and they are invaluable to workers who, though not actual specialists, are so placed as to be beyond reach of a good reference library.

The Journal is primarily a microscopical one, and such it must continue to be under the Charter of the Society whose organ it is. Supplemental matters are added by courtesy; but we believe the editors would do well to restrict themselves to purely microscopical matters. In these days of profuse literature showered upon us from all parts of the globe, it is highly desirable that the aims and scope of all journals should be clearly defined and adhered to, if only by way of enabling the worker to know approximately where to turn in search of information upon a given subject. Much has been done of late in this direction by other Societies, and we submit the suggestion to the executive of the one whose Journal we are considering, in full assurance that in restricting their labours as indicated they will be still further contributing to the utility and success of their venture. We would also suggest that pains might occasionally be taken to set forth more fully than hitherto the precise vantage gained by authors quoted, to the exclusion of purely historical *résumés* and details of minor importance. The vital points of a paper are occasionally sacrificed to the reproducing of descriptions of insignificant structural details; and attention to this point would, we believe, enhance the value of the abstracts without in any way lengthening them. Further, work in the native tongue has not always received that attention which it merits.

The editorship of the Journal could not be in better hands than at present. Officers of the Society and all engaged have laboured indefatigably, and they deserve unstinted praise in the execution of their somewhat thankless task. Under the present editorship the Journal has attained a definite and responsible position, beyond that which it occupies as the organ of a chartered Society; its pages are quoted as authoritative records, and we would fain see it more widely disseminated than at present. It is pre-eminently a microscopical journal for workers; it stands unique in its combined features, and is second to none extant in its dealing with the *technique* and optics of the subject. If it is deemed worthy of the formulæ of Abbé, and of orginal articles by the President of the Royal Society, it is deserving of maintenance at the hands of English-speaking people.

BRIDGING THE FIRTH OF FORTH.[1]

DURING the past four years many thousands of visitors from all parts of the United Kingdom, and, indeed, I may say from all parts of the world, have more or less carefully inspected the works now in progress under the superintendence of Sir John Fowler, the engineer-in-chief, and myself, for bridging the Firth of Forth. All classes of visitors, whether possessed of technical knowledge or not, have found at least something to interest them amongst the multifarious operations incidental to carrying out so gigantic an undertaking; and I should have little fear of interesting my present audience if I could change the scene from Albemarle Street to the shores of the Forth. That is impossible, so I must rest content with an imperfect attempt to convey to you, by description and illustration, some notion of the magnitude of the proportions and difficulties of construction of what is generally admitted to be one of the most important engineering works yet undertaken. A "personally conducted" tour over the work would be far more congenial to me than giving a lecture, and infinitely more effective. Photographs, and even the highest efforts of pictorial art, are a poor substitute for the reality. The smallest street accident witnessed by ourselves affects us more than a description or picture of the greatest battle, and for similar reasons I well know that when I speak of men working with precarious foothold at dizzy heights in stormy weather my words will sound very different in this room to what they would were my listeners standing beside me in an open cage hanging by a single wire rope, in appearance like a packthread, and swinging more or less in the wind at a height of between three and four hundred feet above the ground; or were they following me up a ladder as high as the golden cross on the top of St. Paul's Cathedral, with the additional excitement of the rungs of the ladder being festooned with icicles a foot long. You will lose a great deal in vividness of impression necessarily by the substitution of a lecture for a personal visit to the works, but there are some compensating advantages, as you will be saved between eight and nine hundred miles of railway travelling, and a good deal of clambering of the kind shadowed forth.

I should not have thought it necessary to preface my remarks by the statement that the Forth Bridge has nothing to do with the Tay Bridge, had not my four years' experience informed me that about one-half of my fellow-countrymen labour under that singular hallucination. Even at this date I fully expect every second Britisher (of course Americans and foreigners are better informed) to say: "How are you getting on with the Tay Bridge?" I suggest "Forth Bridge," and the correction is generally accepted as a mere refinement of accuracy on my part. As a matter of fact, however, the Tay Bridge which was blown down in 1879, and has since been rebuilt, is at Dundee, whilst the Forth Bridge is near Edinburgh; and as regards type of construction there is nothing in common between the two. If my lecture serves no better purpose, it will at least help, therefore, to disseminate a little useful geographical knowledge respecting the Firths of Forth and Tay.

[1] Lecture delivered at the Royal Institution, on Friday, May 20, by B. Baker, M. Inst. C.E.

And yet the Forth which "bridled the wild Highlander," and especially that part of it where the bridge crosses, should be well enough known to every reader of fiction, for it has been made the scene of many adventures. Mr. Louis Stevenson's thrilling story, "Kidnapped," will have been read by most of you; the hero of that story was kidnapped at the very spot where the bridge crosses, so I can describe the point of crossing in David Balfour's own words:—

"The Firth of Forth (as is very well known) narrows at this point, which makes a convenient ferry going north, and turns the upper reach into a land-locked haven for all manner of ships. Right in the midst of the narrows lies an island with some ruins; on the south shore they have built a pier for the service of the ferry, and at the end of the pier, on the other side of the road, and backed against a pretty garden of holly-trees and hawthorns, I could see the building which they call the Hawes Inn."

Such was the appearance of the spot 150 years ago. The middle pier of our bridge now rests on the island referred to, and the Hawes Inn flourishes too well, for being in the middle of our works its attractions prove irresistible to a large proportion of our 3500 workmen. The accident ward adjoins the pretty garden with hawthorns, and many dead and injured men have been carried there, who would have escaped had it not been for the whisky of the Hawes Inn.

I would wish if possible now to convey to my hearers some clear impressions of the exceptional size of the Forth Bridge, for even those who have visited the works and noted the enormous gaps to be spanned on each side of Inch Garvie, may yet have gone away without realizing the magnitude of the Forth Bridge as compared with the largest railway bridges hitherto built. For the same reason that architects introduce human figures in their drawings to give a scale to the buildings, do we require something at Queensferry to enable visitors to appreciate the size of the Forth Bridge. If we could transport one of the tubes of the great Britannia Bridge from the Menai Straits to the Forth, we should find it would span little more than one-fourth of the space to be spanned by each of the great Forth Bridge girders. And yet it was of this Britannia Bridge that Stephenson, its engineer, thirty years ago said:—"Often at night I would lie tossing about, seeking sleep in vain. The tubes filled my head. I went to bed with them, and got up with them. In the gray of the morning, when I looked across Gloucester Square, it seemed an immense distance across to the houses on the opposite side. It was nearly the same length as the span of my tubular bridge!"

Our spans, as I have said, are each nearly four times as great as Stephenson's. To get an idea of their magnitude, stand in Piccadilly and look towards Buckingham Palace, and then consider that we have to span the entire distance across the Green Park, with a complicated steel structure weighing 15,000 tons, and to erect the same without the possibility of any intermediate pier or support. Consider also that our rail level will be as high above the sea as the top of the dome of the Albert Hall is above street level, and that the structure of our bridge will soar 200 feet yet above that level, or as high as the top of St. Paul's. The bridge would be a startling object indeed in a London landscape.

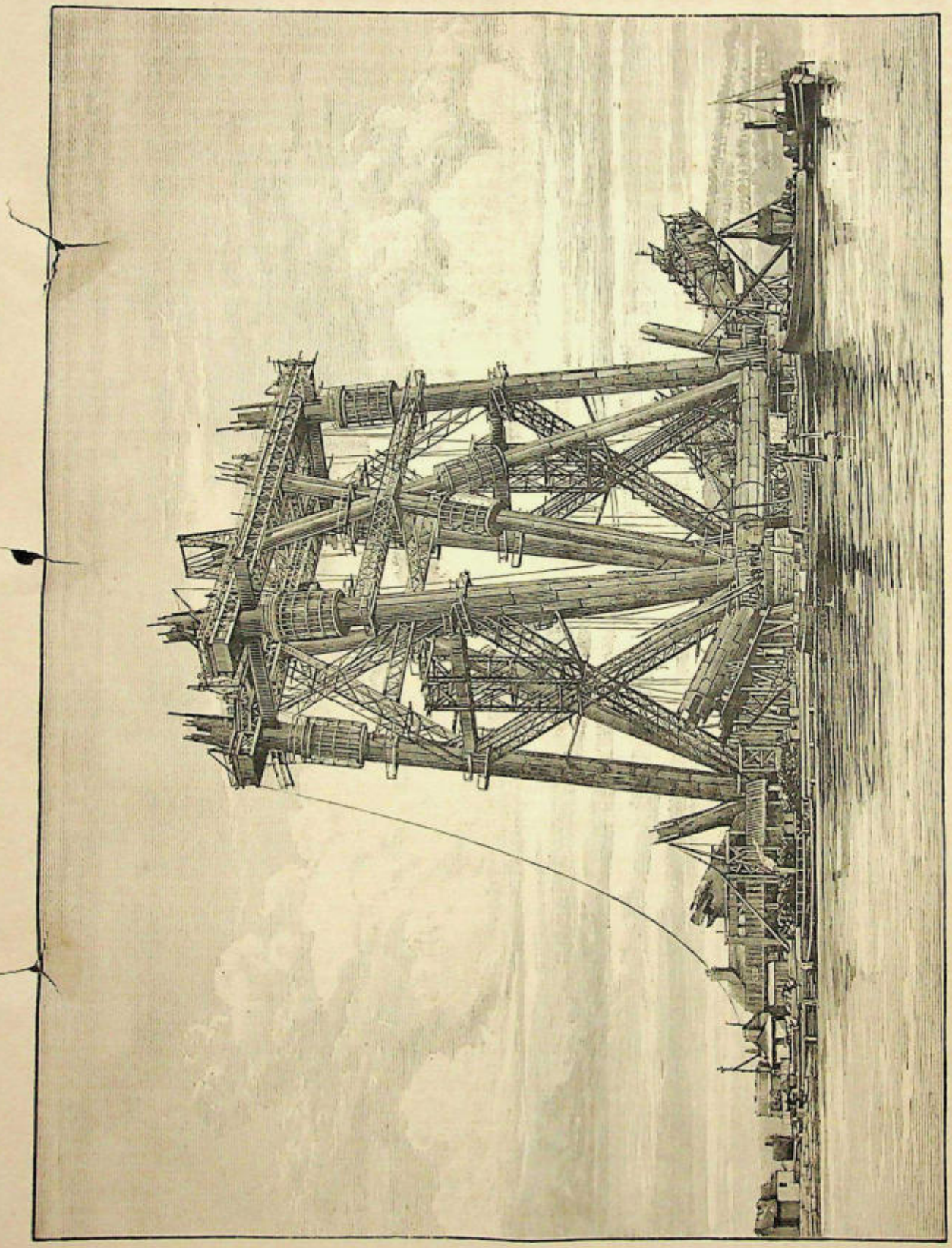
It is not on account of size only that the Forth Bridge has excited so much general interest, but also because it is of a previously little-known type. I will not say novel, for there is nothing new under the sun. It is a cantilever bridge. One of the first questions asked by the generality of visitors at the Forth is, Why do you call it a cantilever bridge? I admit that it is not a satisfactory name and that it only expresses half the truth, but it is not easy to find a short and satisfactory name for the type. A cantilever is simply another name for a bracket. The 1700-feet openings of the Forth are spanned by a compound structure consisting of two brackets or cantilevers and one central girder. Owing to the arched form of the under-side of the bridge, many persons hold the mistaken notion that the principle of construction is analogous to that of an arch. In preparing for this lecture the other day, I had to consider how best to make a general audience appreciate the true nature and direction of the stresses on the Forth Bridge, and after consultation with some of our engineers on the spot a living model of the structure was arranged as follows:—Two men sitting on chairs extended their arms and supported the same by grasping sticks butting against the chairs. This represented the two double cantilevers. The central girder was represented by a short stick slung from one arm of each man, and the anchorages by ropes extending from the other arms to a couple of piles of brick. When stresses are brought on this system by a load on the central girder, the men's arms and the anchorage ropes come into tension and the sticks and chair legs into compression. In the Forth Bridge you have to imagine the chairs placed a third of a mile apart and the men's heads to be 360 feet above the ground. Their arms are represented by huge steel lattice members, and the sticks or props by steel tubes 12 feet in diameter and 1¼ inch thick.

I have remarked that the principle of the Forth Bridge is not novel. When Lord Napier of Magdala accompanied me over the works one day he said: "I suppose you touch your hat to the Chinese?" and I replied "Certainly," as I knew that a number of bridges on the same principle had existed in China for ages past. Indeed, I have evidence that even savages when bridging in primitive style a stream of more than ordinary width, have been driven to the adoption of the cantilever and central girder system as we were driven to it at the Forth. They would find the two cantilevers in the projecting branches of a couple of trees on opposite sides of the river, and they would lash by grass ropes a central piece to the ends of their cantilevers and so form a bridge. This is no imagination, as I have actual sketches of such bridges taken by exploring parties of engineers on the Canadian Pacific and other railways, and in an old book in the British Museum I found an engraving of a most interesting bridge in Tibet upwards of 100 feet in span, built between two and three centuries ago, and in every respect identical in principle with the Forth Bridge. When I published my first article on the proposed Forth Bridge some four years ago I protested against its being stigmatized as a new and untried type of construction, and claimed that it probably had a longer and more respectable ancestry even than the arch.

The best evidence of approval is imitation, and I am pleased to be able to tell you that since the first publication of the design for the Forth Bridge, practically every big bridge throughout the world has been built on the principle of that design and many others are in progress.

PIERS.—Having referred thus briefly to the general principle of the Forth Bridge, I will now describe more particularly the details of the structure, commencing with the piers.

There are three main piers, known respectively as the Fife pier, the Inch Garvie pier, and the Queensferry pier, and upon each of these there are built huge cantilevers stretching both ways. The Fife pier stands between high and low water mark, and is separated by a span of 1700 feet from the Inch Garvie pier, which is partly founded upon a rocky island in mid-stream. Another span of 1700 feet carries the bridge to the Queensferry pier, which is at the edge of the deep channel. The total length of the viaduct is about 1½ mile, and this includes two spans of 1700 feet, two of 675 feet, being the shoreward ends of the cantilevers, and fifteen of 168 feet. Including piers, there is thus almost exactly one mile covered by the great cantilever-spans, and another half-mile of via-



FORTH BRIDGE.—BUILDING THE GREAT STEEL CANTILEVERS.

duct-approach. The clear headway under the centre of the bridge is 152 feet at high water, and the highest point of the bridge is 360 feet above the same datum.

Each of the main piers includes four columns of masonry founded on the rock or boulder-clay. Above low water the cylindrical piers are of the strongest flat bedded Arbroath stone set in cement and faced with Aberdeen granite. The height of these monoliths is 36 feet, and the diameter 55 feet at bottom and 49 feet at top, and they each contain forty-eight steel bolts 2½ inches in diameter and 24 feet long to hold down the superstructure.

Below low water the piers differ somewhat in character, according to the local conditions. On the Fife side, one of the piers was built with the aid of a half-tide dam, and the other with a full-tide dam. The rock was blasted into steps, diamond drills and other rock-drills being used. Even this comparatively simple work was not executed without considerable trouble, as the sloping rock bottom was covered with a closely-compacted mass of boulders and rubbish, through which the water flowed into the dam in almost unmanageable quantity. After many months' work the water was sufficiently excluded by the use of cement-bags, and liquid grout poured in by divers under water, and other expedients, and the concrete foundation and masonry were proceeded with.

At Inch Garvie, the two northernmost piers were founded like the preceding, but the two others presented greater difficulties, owing to the depth of water, and had to be dealt with in a different way. Several designs were prepared for these foundations, but it was finally decided, and, as experience proved, wisely, to put them in by what is known as the pneumatic or compressed air process. The conditions of the problem were a sloping, very irregular, and fissured rock bottom, in an exposed seaway, and with a depth at high water of 72 feet. Anything of the nature of a water-tight cofferdam, such as was used at the shallow piers, was out of question, and the plan adopted was as follows:—

Two wrought-iron caissons, which might be likened to large tubs or buckets, 70 feet in diameter and 50 to 60 feet high, were built on launching-ways on the sloping southern foreshore of the Forth. The bottom of each caisson was set up 7 feet above the cutting edge, and so constituted a chamber 70 feet in diameter and 7 feet high, capable of being filled at the proper time with compressed air to enable men to work as in a diving-bell below the water of the Forth. The caisson, weighing about 470 tons, was launched, and then taken to a berth alongside the Queensferry jetty, where a certain amount of concrete, brickwork, and staging was added, bringing the weight up to 2640 tons. At Inch Garvie a very strong and costly iron staging had previously been erected, alongside which the caisson was finally moored in correct position for sinking. Whilst the work described was proceeding, divers and labourers were engaged in making a level bed for the caisson to sit on. The 16-feet slope in the rock bottom was levelled up by bags filled with sand or concrete. As soon as the weight of caisson and filling reached 3270 tons, the caisson rested on the sand-bags and floated no more. The high ledge of rock upon which the northern edge of the caisson rested was blasted away, holes being driven, by rock-drills and otherwise, under the cutting edge, and about 6 inches beyond for the charges. After the men had gained a little experience in this work, no difficulty was found in under-cutting the hard whinstone rock to allow the edge of the caisson to sink, and, of course, there was still less difficulty in removing the sand-bags temporarily used to form a level bed. The interior rock was excavated as easily as on dry land, the whole of the 70-feet diameter by 7-feet high chamber being thoroughly lighted by electricity. Access was obtained through a vertical tube with an air-lock at the top, and many visitors ventured to pass through this lock into the lighted chamber below, where the pressure at times was as high as 35 lbs. per square inch. Probably the most astonished visitors were some salmon, who, attracted by the commotion in the water caused by the escape of compressed air under the edge of the caisson, found themselves in the electric lighted chamber. When in the chamber the only notice of this escape of large volumes of air was the sudden pervadence of a dense fog, but outside a huge wave of aërated water would rise above the level of the sea, and a general effect prevail of something terrible going on below. No doubt the salmon thought they had come to a cascade turned upside down, and, following their instinct of heading up it, met their fate.

Another astonished visitor was a gentleman who took a flat-sided spirit-flask with him into the caisson, and emptied it when down below. Of course the bottle was filled with compressed air, which exploded when passing through the air-lock into the normal atmospheric pressure, the pressure in the bottle being 33 lbs. per square inch. The Garvie piers, notwithstanding the novelties involved in sinking through whinstone rock, at a depth of 72 feet below the waves of the Forth, were completed without misadventure, in less than the contract time. The first of the deep Garvie caissons was launched on March 30, 1885, and both piers were finished to sea-level or above by the end of the year.

At Queensferry all four piers were founded on caissons identical in principle with those used for the deep Garvie piers. The deepest was 89 feet below high water, and weighed 20,000 tons; the shallowest of the four was 71 feet high, the diameter in all cases, as at Garvie, being 70 feet at the base. Some differences in detail occurred in these caissons as compared with Garvie, owing to the differences of the conditions. Thus, instead of a sloping surface of rock the bed of the Forth was of soft mud to a considerable depth, through which the caissons had to be sunk into the hard boulder-clay. Double skins were provided for the caissons, between which concrete could be filled in to varying heights if necessary, so that greater weight might be applied to the cutting edge where the mud was hard than soft. This annular wall of concrete also gave great strength to resist the hydrostatic pressure outside the caisson, for it must be understood that the water was excluded both below and above the working chamber.

The process of sinking was as follows:—The caisson being seated on the soft mud, which, of course, practically filled the working chamber, air was blown in, and a few men descended the shaft or tube of access to the working chamber in order to clear away the mud. This was done by diluting it to the necessary extent by water brought down a pipe under pressure, and by blowing it out in this liquid state through another pipe by means of the pressure of air in the chamber. It was found that the mud sealed the caisson so that a pressure of air considerably in excess of that of the water outside could be kept up, and it was unnecessary to vary the pressure according to the height of the tide. In working through this soft mud both intelligence and courage were called for on the part of the men, and it is a pleasure and duty for me to say that the Italians and Belgians engaged on the work were never found wanting in those qualifications. There was always a chance of the caisson sinking suddenly or irregularly, and imprisoning some of the men; and, indeed, on one occasion a few men were buried up to their chins in the mud, and on another the caisson gave a sudden drop of 7 feet. Happily no serious accident happened, although I confess that I felt a little apprehensive myself, as I was familiar with the details of an accident with a similar caisson sunk in the bed of the Neva, at St. Petersburg, in 1876. In that case the wet mud rose rapidly in the working chamber when the caisson sank suddenly 18 inches one day, and of the twenty-eight men in the

chamber nine remained imprisoned. Of these, two managed to get their heads into the shaft of access, and were taken out alive after twenty-eight hours, and the remaining seven were smothered in the mud. It was nearly a year before sinking was renewed. Again, in 1877, one of the air-locks suddenly gave way, and of the men then in the chamber, three escaped uninjured, nine were blown out by the rush of air, and, falling into the water and on craft, were mortally injured, whilst twenty were smothered in the caisson. It was thirteen months before the chamber was accessible, and then the vitiated atmosphere in the charnel-house below rendered it very difficult to work. Happily we had no such experiences at the Forth.

With one of our caissons we unfortunately had an accident and loss of life, which, although it had nothing to do with the sinking of the caisson, as in the Neva Bridge, was indirectly due to the same cause, viz. the softness of the mud bottom. On New Year's Day, 1885, the south-west Queensferry caisson, which had been towed into position, and weighted with about 4000 tons of concrete, stuck in the mud, and, instead of rising with the tide, remained fixed so that the water flowing over the edge filled the interior. The 4000 tons of water caused the caisson to sink further in the mud, especially at the outer edge, and to slide forward and tilt. The contractors determined to raise the skin of the caisson until it came above water-level, and then pump out and float the caisson back into position. About three months were occupied in doing this, but when pumping had proceeded a certain extent the caisson collapsed, owing to the heavy external pressure of the water, and two men were killed. It was necessary then to consider very carefully what had better be done, as the torn caisson was difficult to deal with. Finally it was determined to case it in "tubbing" of whole balks of timber strutted with ring girders and rakers. This was a very tedious work, as every balk had to be fitted water-tight to its neighbours by divers. Finally, on October 19, 1885, or between nine and ten months after the first accident, the caisson, to the relief of everyone, was floated into position and the sinking proceeded without further difficulty, this, the last of the main piers, being completed in March 1886, or almost exactly two years after the first caisson was floated out. No doubt some of my hearers have passed through air-locks and experienced the physiological effects of compressed air, one of the first of which is a painful pressure on the drums of the ears. It is necessary to restrict the hours of work, and even then most men suffer more or less inconvenience. Pains in the limbs are generally relieved by galvanism; a long continuance often leads to paralysis if the depth is great. At the St. Louis Bridge in America, for example, out of 600 workmen who worked in the compressed air, 119 were attacked, 16 died, and 2 were crippled. We had no deaths directly attributable to the air-pressure. Personally I felt no inconvenience whatever. Photographs were taken in the caisson, a total lighting power of 6000 candles and an exposure of as much as 15 minutes in some cases being given. Owing to the fog formed when the air blew under the edge the results were not so good as could be wished, the eyes especially coming out in glaring spectral fashion.

SUPERSTRUCTURE.—I must now say a few words respecting the design, manufacture, and erection of the superstructure.

Design.—I have already illustrated the principle of the cantilever bridge, and need only deal with the details. At the Forth, owing to the unprecedented span and the weight of the structure itself, the dead load is far in excess of any number of railway trains which could be brought upon it. Thus the weight of one of the 1700-feet spans is about 16,000 tons, and the heaviest rolling load would not be more than a couple of coal trains weighing say 800 tons together, or only 5 per cent. of the dead weight. It is hardly necessary therefore to say that the bridge will be as stiff as a rock under the passage of a train. Wind, even, is a more important element than train weight, as with the assumed pressure of 56 lbs. per square foot the estimated lateral pressure on each 1700-feet span is 2000 tons, or two and a half times as much as the rolling load. To resist wind the structure is "straddle-legged," that is, the lofty columns over the piers are 120 feet apart at the base and 33 feet at the top. Similarly, the cantilever bottom members widen out at the piers. All of the main compression members are tubes, because that is the form which with the least weight gives the greatest strength. The tube of the cantilever is, at the piers, 12 feet in diameter and 1¼ inch thick, and it is subject to an end pressure of 2282 tons from the dead load, 1022 tons from the trains, and 2920 tons from the wind; total, 6224 tons, which is the weight of one of the largest Transatlantic steamers with all her cargo on board. The vertical tube is 343 feet high, 12 feet in diameter, and about ⅞ inch thick, and is liable to a load of 3279 tons. The tension members are of lattice construction, and the heaviest-stressed one is subject to a pull of 3794 tons. All of the structure is thoroughly braced together by "wind bracing" of lattice girders, so that a hurricane or cyclone storm may blow in any direction up or down the Forth without affecting the stability of the bridge. Indeed, even if a hurricane were blowing up one side of the Forth and down the other, tending to rotate the cantilevers on the piers, the bridge has the strength to resist such a contingency. We have had wind-gauges on Inch Garvie since the commencement of the works, and know, therefore, the character of the storms the bridge will encounter. The two heaviest gales were on December 12, 1883, and January 26, 1884. On the latter occasion much damage was done throughout the country. At Inch Garvie the small fixed gauge was reported to have registered 65 lbs. per square foot, but I found on inspection that the pointer could not travel further, or it might have indicated even higher. I did not believe this result, and attributed it to the joint action of the momentum of the instrument, and a high local pressure of wind too instantaneous in duration to take effect upon a structure of any size or weight. The great board of 300 square feet area on the same occasion indicated only 35 lbs. per square foot, and I doubt much if the pressure would have averaged more than 20 lbs. on so large a surface as the bridge.

Manufacture.—The bent plates required for the tubes of the Forth Bridge would, if placed end to end, stretch 42 miles. Special plant had to be devised for preparing these plates. Long furnaces, heated in some instances by gas-producers, and in others by coal, first heated the plates, which were then hauled between the dies of an 800-ton hydraulic press, and bent to the proper radius. When cool, the edges were planed all round, and the plates built up into the form of a tube in the drilling-yard. Here they were dealt with by eight great travelling machines, having ten traversing drills radiating to the centre of the tube, and drilling through as much as 4 inches of solid steel in places. A length of 8 feet was drilled in a day of twenty-four hours. When complete, the tubes were taken down, the plates cleaned and oiled, and stacked ready for erection.

The tension members and lattice girders generally are of angle bars, sawn to length when cold, and of plates planed all round. Multiple drills tear through immense thickness of steel at an astonishing rate. The larger machines have ten drills, which, going as they do, day and night, at 180 revolutions per minute, perform work equivalent to boring an inch hole through 280 feet thickness of solid steel every twenty-four hours. About 4 per cent. of the whole weight of steel delivered at the works leaves it again in the form of shavings from planing-machines and drills. The material used throughout is Siemens's steel of the finest quality, made at the Steel

Company's Works in Glasgow, and at Landore in South Wales. Although one and a half times stronger than wrought iron, it is not in any sense of the word brittle, as steel is often popularly supposed to be, but it is tough and ductile as copper. You can fold half-inch plates like newspapers, and tie rivet-bars like twine into knots. The steel shavings planed off form such long, true, and flexible spirals, that they are largely used for ladies' bracelets when fitted with clasps and electro-plated.

Erection.—Facility of erection is one of the most important desiderata in the case of the Forth Bridge. Owing to the 200 feet depth of water, scaffolding is impossible, and the bridge has to constitute its own scaffolding. The principle of erection adopted was, therefore, to build first the portion of the superstructure over the main piers, the great steel towers, as they may be called, although really parts of the cantilever, and to add successive bays of the cantilever right and left of these towers, and therefore balancing each other, until the whole is complete. This being the general principle, a great deal yet remained to be done in settling the details. What was finally settled, and is now in progress, is as follows:—

After the skewbacks, horizontal tubes, and a certain length of the verticals as high as steam-cranes could conveniently reach were built, a lifting-stage was erected. This consisted of two platforms, one on either side of the bridge, and four hydraulic lifting-rams, one in each 12-feet tube. To carry these rams cross-girders were fitted in the tubes capable of being raised so as to support the rams and platform as erection proceeded, and steel pins were slipped in to hold the cross-girders. Travelling cranes are placed on the platforms, and these cranes, with the men working aloft, are of course raised with the platforms when hydraulic pressure is let into the rams. The mode of procedure is to raise the platform 1 foot, and slip in the steel pins to carry the load whilst the rams are getting ready to make another stroke of 1 foot. When a 16-feet lift has been so made, which is a matter of a few hours, a pause of some two or three days occurs to allow the riveting to be completed. The advance at times has been at the rate of three lifts, or 48 feet in height, in a week.

The riveting appliances designed by Mr. Arrol are of a very special and even formidable character, each machine weighing about 16 tons. It consists essentially of an inside and outside hydraulic ram mounted on longitudinal and annular girders in such a manner as to command every rivet in the tubes, and to close the same by hydraulic pressure. Pipes from the hydraulic pumps are carried up inside the tubes to the riveters, and oil furnaces for heating the rivets are placed in convenient spots, also inside the tubes. By practice, and the stimulus of premiums, the men have succeeded in putting in 800 rivets per day with one of the machines, at a height of 300 feet above the sea, which, in fact, is more than they accomplished when working at ground level. Indeed, by the system of erection adopted, the element of height is practically annihilated, and with ordinary caution the men are safer aloft than below, as in the former case they are not liable to have things dropped on their heads.

The cantilever will be erected and riveted in precisely the same manner as the great towers, but owing to the overhang temporary ties will occasionally be required. The centre girder itself will be similarly erected, one half being temporarily added on to the extremity of each cantilever, and when the two ends meet at the centre of a 1700-feet span they will be connected, and the temporary joints, with the cantilevers, released. Roller joints are provided at the cantilever ends for expansion, and at the main piers the whole superstructure rests on lubricated sliding bed-plates.

The system of erection by overhanging offers great advantages as regards safety, as each successive part of the superstructure is riveted up and completed before a further portion is added. In the case of an ordinary bridge the whole superstructure must first be temporarily bolted up on scaffolding, and in that condition is liable to be swept away by flood or hurricane at any moment.

There is nothing new under the sun, and therefore you will not be surprised to hear that in 1810, a certain Mr. Pope proposed to construct a cantilever bridge, of 1800 feet span, across the East River, in New York, and, indeed, exhibited a 50-feet model of the same.

I have described the process of erecting the Forth Bridge in sober prose; if I had thought of doing it in verse I should have appropriated bodily Mr. Pope's lyrical version of his intended operations at the East River, of which the following is a sample:—

> "Each semi-arc is built from off the top,
> Without the aid of scaffold, pier, or prop;
> By skids and cranes each part is lowered down,
> And on the timber's end grain rests so sound.
> Sure all the bridges that were ever built,
> Reposed their weight on centre, pier, or stilt;
> Not so the bridge the author has to boast,
> His plan is sure to save such needless cost;
> A ladder on each side is lowered down,
> And shifted from the fulcrum to the crown."

To carry out the work at the Forth Bridge there is an army of 3500 workmen, officered by a proportionate number of engineers. Everything, except the rolling of the steel plates, is done on the spot, and consequently there are literally hundreds of steam and hydraulic engines and other machines and appliances too numerous to mention, many of them being of an entirely original character.

It is, of course, impossible to carry out a gigantic work of the kind I have had the honour of bringing before the Institution without paying for it, not merely in money, but in men's lives. I shall have failed in my task if you do not, to some extent, realize the risks to which zealous and plucky workmen will be sure to expose themselves in pushing on with the work of erecting the Forth Bridge. Speaking on behalf of the engineers, I may say that we never ask a workman to do a thing which we are not prepared to do ourselves, but of course men will, on their own initiative, occasionally do rash things. Thus, not long ago a man trusted himself at a great height to the simple grasp of a rope, and his hand getting numbed with cold he unconsciously relaxed his hold and fell backwards, a descent of 120 feet, happily into the water, from which he was fished out little the worse after sinking twice. Another man going up in a hoist the other day, having that familiarity with danger which breeds contempt, did not trouble to close the rail, and, stumbling backward, fell a distance of 180 feet, carrying away a dozen rungs of a ladder with which he came in contact, as if they had been straws. These are instances of rashness, but the best men run risks from their fellow-workmen. Thus a splendid fellow, active as a cat, who would run hand over hand along a rope at any height, was knocked over by a man dropping a wedge on him from above, and killed by a fall of between one and two hundred feet. There are about 500 men at work at each main pier, and something is always dropping from aloft. I saw a hole 1 inch in diameter made through the 4-inch timber of the staging by a spanner which fell about 300 feet, and took off a man's cap in its course. On another occasion a dropped spanner entered a man's waistcoat and came out at his ankle, tearing open the whole of his clothes, but not injuring the man himself in any way.

Happily, there is no lack of pluck amongst British workmen; if one man falls another steps into his place. Difficulties and accidents necessarily occur, but like a disciplined regiment in action we close up the ranks, push on, and step by step we intend to carry on the work to a victorious conclusion.

UPPER WIND-CURRENTS NEAR THE EQUATOR, AND THE DIFFUSION OF KRAKATAO DUST.

THE crude idea that the trade-winds on either side of the equator met in the doldrums, and that then the air rising upwards flowed backwards as a return south-west current in the northern hemisphere, and as a north-west current in the southern hemisphere, has been modified by the more modern discoveries that the atmosphere is not composed of horizontal layers of air moving in different directions, but that, as a rule, there is a regular continuous successive veering of the wind as we ascend. It is not usual to find a southerly wind on the surface, and for some height above, and then abruptly a westerly current also of a certain thickness; for cloud-observations show that over a surface south wind the upper currents may be from south-by-west at quite a low level, from south-south-west a little higher up, then successively from south-west and west-south-west as we ascend, and perhaps from west at the altitude of the highest cirrus. We must, in fact, look upon the atmosphere as circulating in the form of a continuous complex screw.

Innumerable observations show that, as a rule, there is a very definite law of the vertical succession of the upper currents. Stand with your back to the surface wind, and the upper currents will come successively more and more from your left hand the higher they are. The rule is reversed in the southern hemisphere, for there the upper currents come successively more and more from the right. For instance, with a southerly wind in London, the clouds will come more and more from the west the higher they are, while in Australia they would come more and more from the east.

But during my two meteorological voyages round the world I have discovered some very remarkable exceptions to this law in that interesting part of the world, meteorologically, that lies between the equator and the doldrums. These have so important a bearing, not only on the whole problem of the circulation of the atmosphere from the equator to the Pole, but also on the remarkable diffusion of dust from the volcano of Krakatao, that I propose to give a short account of these researches in this article.

In the Atlantic, the doldrums lie north of the equator at all seasons of the year. Between 20° and 30° W. longitude they range from about 3° N.; in winter, to 11° N. in summer time. In the Gulf of Guinea, the position of the doldrums cannot be accurately defined, but they probably range from about 5° to 10° N. of the equator. There is, however, a striking difference in the direction of the winds between the equator and the doldrums in the eastern and western portions of the Atlantic. In the Gulf of Guinea, the south-east trade turns to south-west and forms a south-west monsoon; while west of about 15° W. longitude the south-east trade remains from nearly in the same direction as before it crossed the line.

In the Indian Ocean, the position of the doldrums varies enormously at different seasons. From about November to March the doldrums are 5° to 10° S. of the line, and the north-east monsoon draws into the well-known north-west monsoon as it crosses the equator. From April till September the doldrums must be somewhere to the north of the line; but, contrary to the opinion of Dove and others, the Indian meteorologists now believe that the south-west monsoon is not linked up regularly with the south-east trade. As the evidence for this belief is not yet published, we can say nothing about it, though we shall have to refer to the point later on.

The words rotation, circulation, and veering of wind are unfortunately used so vaguely by different writers that it may be well to define them more precisely before we discuss the general circulation of the equator.

"Rotation" should be confined exclusively to the manner in which the surface wind blows round areas of high or low pressure. For instance, we may say that the wind rotates counter-clockwise round a cyclone in the northern hemisphere.

"Circulation" should be applied to the general movement of a whole mass of air extending over a certain breadth and height. For instance, the air in a cyclone rotates round and in below, round and out at high levels; and the whole system makes up the general circulation of a cyclone. Or, again, the whole motion of the atmosphere into the doldrums, then upwards and more or less polewards, should be called the general circulation in the vicinity of the equator.

"Sequence" of wind should be applied to the changes in the direction of the wind which take place during any interval of time as a cyclone passes over a station. This veering or backing of the wind has unfortunately been too often called the rotation of the wind. The confusion here, as often, arises from sometimes talking of the motions of a mass of air extending over a large area at a given moment, and sometimes of the successive motions of the air at a single station during a certain interval of time. Some writers make matters worse by not only drawing the plan of a cyclone on a chart, but also by putting in small circles at different stations to show how the wind would go round as the cyclone drifted past. The confusion is direful.

"Vertical succession" should be used to denote the gradual successive directions of the upper currents, as has been already explained.

The two sections of weather across the Atlantic which I made were taken, the one in July, between Rio Janeiro and Teneriffe; the other in December, between Teneriffe and Capetown. A short account of the observations were published in NATURE, vol. xxxiii. p. 294, so that the general results only need be stated here.

Between Rio and Teneriffe, while south of the line, the low or middle clouds over the south-east trade invariably came from some point to the right of the surface when you stood with your back to the wind; *i.e.* if the surface wind was south-east the low clouds would drive from about east-south-east. This is the usual vertical succession of the southern hemisphere

But north of the line, when, for reasons which cannot be discussed here, the south-east trade did not turn into south-west, as might have been expected, the upper currents continued to follow the succession of the southern hemisphere, instead of conforming to the law of the northern hemisphere. In the doldrums, which extended from about 8° to 13° N., the same rule obtained, and the middle layer of cloud over some "cats' paws" of south-east wind drove from the east. To show how difficult it is to get cirrus observations in the tropics, I may mention that this was the highest layer I was able to record during this part of the voyage.

In the north-east trade I only got one unsatisfactory observation in 22° N., 19° W., which gave a middle layer of north-north-east wind over an east-north-east surface trade. This is the contrary of what might have been expected.

In the second section, between Teneriffe and Capetown, the lower layers of cloud in the north-east trade—from 30° N. to the doldrums in 5° N.—invariably came from some point to the left of the surface wind, generally from south or south-by-west. This is the usual vertical succession of the northern hemisphere.

But as we entered the doldrums, in 5° N., a totally different wind-system became apparent. Over the oily calm of that district I could just detect, through the universal haze and gloom, a middle current from the east; and when a few hours later we picked up the south-west monsoon of the Gulf of Guinea—here coming from south-by-west—the low clouds came from south-east. This con-

tinued till we reached the line, and the single observation that I got of high cirrus in 1° N. lat. showed an easterly current at that level. The above results are very curious, for the usual idea is that the south-east trade on crossing the equator becomes a south-west wind under the influence of the earth's rotation; but here, though the surface wind appears to conform to the usual rotation of the air round a low pressure, the upper currents maintain the vertical succession of the southern hemisphere.

After crossing the equator ourselves, the wind turned to south-by-east, or south-south-east; and as far as 18° S., beyond which we need not follow them, the lower currents were either identical in direction with the surface winds, or else a very little more easterly—that is, they followed the normal vertical succession of the southern hemisphere.

I have endeavoured to show all this in a diagrammatic form in Fig. 1, where the full arrows denote the surface wind; the broken-lined arrows the direction of the low or middle-level clouds; the dotted arrows that of the highest cirrus. A couple of arrows to denote the typical succession over an extra-tropical south-west wind are inserted on the upper left-hand corner of the figure.

The observations in the Indian Ocean have also been published in NATURE, vol xxxii. p. 624, and vol. xxxiii. p. 460. They were taken during two trips—one from Aden to Cape Lewin, in February, the other from Cape Lewin to Colombo, in the same month of the following year.

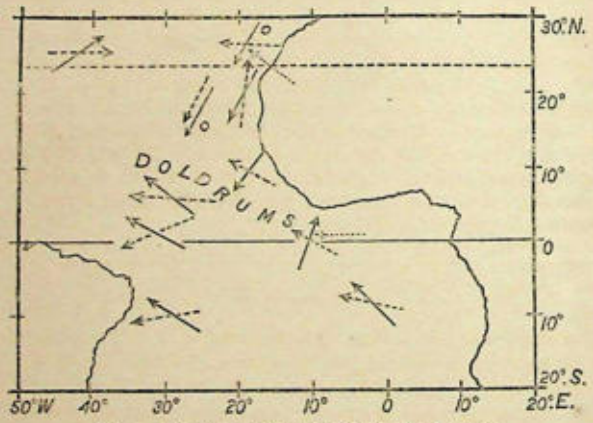


FIG. 1.—Surface and upper currents in the Atlantic.

This is the season of the north-west monsoon. The results were very accordant, and showed conclusively that in vertical succession the upper currents over the north-east monsoon were always more from the east than the surface wind, as is usual in the northern hemisphere. No high cirrus was ever observed in this part of the ocean.

In the north-west monsoon, between the equator and the doldrums, low and middle currents came from north or north-east, and the only two observations on the highest cirrus showed an easterly current at that level.

In the south-east trade, the low or middle currents were generally about from the same direction as the surface wind, or else a little more from the east. This is the normal succession of the hemisphere. Thus we see an extraordinary analogy to what occurs in the Atlantic. When the north-east monsoon is drawn across the equator, towards the low pressure of the doldrums, the surface wind seems to pick up the westerly component of the earth's rotation in the usual manner; but the upper currents retain the vertical succession of the northern hemisphere.

The results of all the observations are given in a diagrammatic form in Fig. 2. It will be remarked how few observations there are of cirrus; this is because it is so rarely seen in those latitudes. It is certain that, on the southern and western edges of the great anticyclone which controls the south-east trade, the highest currents would have come more or less from the north-west, as is marked at Mauritius.

I have unfortunately got no equatorial observations from the Pacific, but they would most likely be very similar to those in the Atlantic.

However, the upshot of all those which we have just described is to show that when the trades or monsoons meet they do not interlace, as has been suggested by Maury, but that the upper winds combine in a generally easterly current, and probably diverge only slightly polewards on either side. I am unable to form any opinion as to the velocity of this current.

I have often been asked how far all this bears on the remarkable distribution of dust from Krakatão, and the answer is very simple. The great explosion of Krakatão took place on August 26; that is to say, during the south-west moonsoon of the Indian Ocean. The distribution of the surface and upper currents is then very different from that in our last diagram. The south-east trade, with its upper easterly currents, extends all over the Indian Ocean, and Malaysia south of the line, including Krakatão, marked K in the figure. North of the equator the surface wind turns to the south-west, but we know nothing of the motion of the upper currents.

Now, assuming that the blue sun and unusual twilight

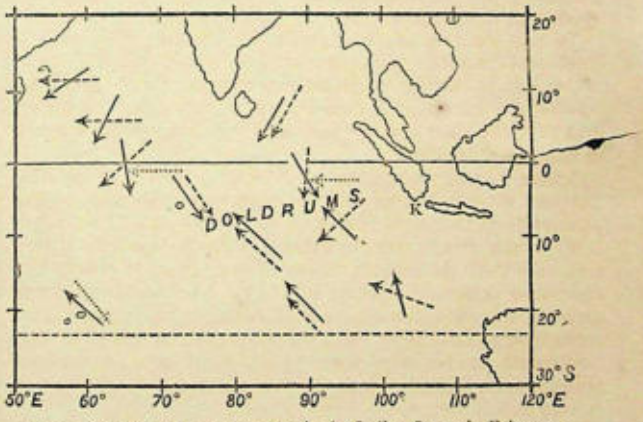


FIG. 2.—Surface and upper currents in the Indian Ocean in February.

glows were equally the product of volcanic dust as the fall of actual ashes, the sequence of the first appearance of these phenomena in different parts of the world, dating from August 26, was as follows:—

On August 26, the day of the eruption, ashes, lofty haze, or red twilights are reported south of the equator, nearly 20° of longitude west of Java, from one station in Sumatra, just north of the line, and from near Formosa.

Next day, the 27th, similar phenomena were reported from many stations in the Indian Ocean, south of the equator, as far west as Mauritius and the Seychelles; while north of the line, strange appearances were reported for the first time in Borneo and Ceylon.

On the 28th, the haze and abnormal glows had extended to Natal on one side and Japan on the other.

No important extension of the area is reported on August 29; but by the 30th unusual coloration of the sky is reported from various parts of the South Atlantic, and Guiana, and, what is specially noticeable, from about the Cape Verd Islands, north of the equator.

On the 31st, another station in Brazil, and also a West Indian island, report a strange look about the sun or sky; while on September 1 the same was noted at Guayaquil, on the west coast of South America; and in a quite unexpected locality, far away from there,—New Ireland.

September 2 was characterized by an outburst of

coloured suns all over the northern provinces of South America; while between the 3rd and 4th of the same month the glows extended across the Pacific both north and south as far as the Society and Gilbert Islands, and were reported from two stations in New Britain.

By September 5 the Sandwich Islands were reached; while the outburst of glows in Southern India did not commence till about the 6th to 8th of the same month.

The northward extension of the dust all this time was very small, and not widespread. Isolated phenomena are reported from Formosa on August 26, and from Japan on the 28th, but I am unable to say whether the glows which appeared in the Sandwich Islands on September 5, had come *viâ* Japan, or across South America. Thus the general system of the dust-flow appears to [illegible]e been very simple. The great dust-stream was [illegible]ried for the first twenty-four hours by the normal [illegible]sterly upper currents over the south-east trade, at the [illegible]traordinary rate of more than 120 miles an hour, but hardly extended north of the line. Three days after the eruption we find the products of Krakatáo in Guiana, the South Atlantic and also north of the line in the Cape Verd Islands. Just to the south of the latter we know that the south-east trade with its attendant upper currents crosses the equator. Then all the north of South America was invaded; and six or seven days after the first outburst, the Pacific Islands—south of, or on the line—were also overshadowed.

In fact we may say that the great stream of Krakatáo dust was carried nearly round the world by the usual upper winds of the south-east trade, in which the dust was first ejected, at a rate of about 120 miles an hour, and that the dust spread very slowly either north or south of the main current.

There is one inference from this which is very important in any theory of the general circulation of the atmosphere from the equator to the Poles. The main body of the equatorial circulation is in an easterly direction, so that the whole mass of air going towards the doldrums does not rise up and flow backwards on itself directly towards the Pole; and though the highest currents over the Polar limit of both the south-east and north-east trades are from north-west and south-east respectively, still the poleward motion near the equator is very small.

The high velocity of 120 miles an hour is certainly more than would have been expected; but we have very few observations on the rate of motion of the highest clouds. Hildebrandsson has, however, reported from Upsala one velocity of about 112 miles per hour for a cirrus at 28,000 feet (50 metres per second at 8559 metres); and several velocities ranging between that figure and 90 miles per hour.

There would be nothing, then, outrageous in the assumption of a velocity of 120 miles an hour for the easterly current over the equator to account for the high speed of the diffusion of Krakatáo dust; and it is also satisfactory to know that the general direction of the flow is in accordance with the most recent researches on the vertical succession of the upper currents near the equator.

RALPH ABERCROMBY.

BERNARD STUDER.

AMONG the magnates of Swiss geology, no name has held a more honoured place than that of Bernard Studer, who now at the ripe age of ninety-three years has passed away. Upwards of sixty years ago he began his scientific career by the study of some of the geological problems presented by the rocks of his native country. From the molasse of the lower grounds he soon climbed into the higher Alps, and distinguished himself as one of the foremost pioneers who grappled with the intricate problems in stratigraphy which these mountains present. With patient toil he extended year by year his acquaintance with the various portions of the chain, publishing from time to time notices of his labours, and preparing materials for a geological map of the whole region. In association with A. Escher von der Linth he pursued these labours until the two fellow-workers were enabled to give to the world their great map of Switzerland, which, though only an outline of the geology of the Alps, will remain as an enduring monument of the geological prowess of its authors. No one who has not climbed the mountains with that map in hand can form any adequate conception of the physical labour, mental exertion, and happy geological intuition which its preparation required.

Studer's contributions to the glacial geology of the Alps brought him into intimate personal relations with many English geologists. All who passed through Berne tried to see the venerable Professor, who retained, in spite of his weight of years, his keen interest in the progress of his favourite science. His papers, published in various scientific journals, make a long list. But he was also the author of some separate works. Besides the great map of Switzerland, he published several volumes on Swiss geology, the most important of which was his "Geologie der Schweiz," which appeared in two volumes in 1851-53. Less known perhaps, but full of suggestive matter, is his "Lehrbuch der physikalischen Geographie und Geologie," which was issued as far back as 1844. This work was one of the earliest in which the processes of physical geography were discussed from the geological side, and showed how wide and thoughtful had been the observations of the author, especially among the phenomena to be witnessed in Switzerland. Another of the old lights of geology has been extinguished by the death of Bernard Studer, whose kindly presence and helpful courtesy will be affectionately remembered by everyone who has been fortunate enough to come in contact with him.

NOTES.

AN important Bill dealing with the question of technical education has been introduced into the House of Commons by Sir Henry Roscoe. The Bill empowers any School Board, local authority, or managers of a public elementary school, to provide day technical and commercial schools and classes for the purpose of giving instruction in any of certain subjects. These include the several science subjects which are specified in the Directory of the Science and Art Department, and in which that Department undertakes to examine. The following subjects are also included: the use of ordinary tools, commercial arithmetic, commercial geography, book-keeping, French, German, and other foreign languages, and freehand and machine drawing. The addition of other subjects may be sanctioned from time to time by the Committee of Council on Education or by the Science and Art Department. For the purpose of carrying on these schools and classes, the power of School Boards, other local authorities, and school managers is to be in every respect the same as for providing ordinary elementary schools. They are to have power to provide, or contribute to the maintenance of, laboratories and workshops in endowed schools for the purpose of carrying on classes or instruction under the Bill. All these schools and classes are to be subject to the inspection of the officers of the Committee of Education or of the Science and Art Department. Before a scholar is admitted he must have passed the Sixth Standard or some equivalent examination. The Education Committee and the Science and Art Department are authorized to give grants on such conditions as they may lay down for any of the subjects taught. For the purpose of obtaining grants a technical school or class must be one carried on under minutes to be made by the

Science and Art Department, and laid on the table of the House of Commons in the same way as the minutes that regulate the grants of the Education Department.

ON Tuesday afternoon the new Science and Art Schools which have been erected (at a cost of £17,000) in connexion with Sir Andrew Judde's School, Tunbridge, were formally opened by the Lord Mayor of London. Among those who addressed the company present at the ceremony was Prof. Judd, who referred to Mr. John Morley's idea that science is likely to retaliate on literature for the subservient position it has been so long compelled to occupy. All who had any authority to speak on behalf of science, said Prof. Judd, fully recognized the value of a true literary training, which taught men how best to express the thoughts arising from the trained mind, and the store of facts which science supplied. People must recognize, however, that the time had come when science must take her proper place in the education of the country; for if they did not, other nations would, to the destruction of all our pre-eminence.

ANOTHER serious loss has been inflicted on the cause of geology in this country by the death of Mr. Champernowne, of Dartington Hall, Totnes. Representative of an old Devonshire family, and living in the ancestral home, he was a country gentleman of the best type. At the same time, he devoted himself with singular ardour to geology and especially to the study of the complicated structure of the Devonian rocks of his own district. He had with his own hand mapped the subdivisions of these rocks in far ampler detail than had ever before been attempted, and with a skill and success worthy of the best-trained professional geologist. He lately generously presented his maps to the Geological Survey, with a view to the projected publication of a new edition of the Survey maps of the district. It was while engaged in revising some of his lines for this purpose that he aggravated a previous cold, and brought on congestion of the lungs, which carried him off after an illness of only a few days. His geological ardour was fully equalled by his courtesy and kindness, which endeared him to a wide circle of friends who mourn his early death.

PROF. VULPIAN, the eminent French physiologist, died of pneumonia on the 18th inst. He was sixty-one years of age. For some time he was Assistant Professor in the Museum of Natural History in Paris, but afterwards he was made Professor of Pathological Anatomy in the Paris Medical School. He was appointed Member of the Academy of Sciences in 1876, and Perpetual Secretary in 1886. His principal works relate to the vasomotor system, the diseases of the nervous system, the digestive process, and the physiological action of curare, strychnine, and some other drugs. Before the short illness of which he died, he was giving lectures on the respiratory function; and he was about to publish an important book on the cerebral functions. He was a most conscientious investigator, and his death is greatly regretted by French men of science. The funeral took place on Saturday last, and was attended by a large crowd of friends and students.

THE anniversary meeting of the Royal Geographical Society was held on Monday, when General R. Strachey, who has been elected President, delivered the annual address. After paying a high tribute to his predecessor, Lord Aberdare, and noticing the losses of the Society by death during the past year, General Strachey went on to speak on the subject of geographical education. He then reviewed the chief geographical events of the year, and traced the progress that has been made in geographical knowledge since the beginning of the Queen's reign.

AT the last meeting of the Council of University College, Liverpool, Mr. R. J. Harvey Gibson was appointed to the Lectureship of Botany, vacant by the resignation of Dr. Shearer.

MR. EDGAR M. CROOKSHANK, M.B. (Lond.), has been appointed Lecturer on Bacteriology by the Council of King's College, London.

RATHER more than a year ago (vol. xxxiii. p. 361) we reviewed a "Manual of Bacteriology," by Mr. Edgar M. Crookshank. A new edition has now been issued, and the author has increased the value of the work not only by revising it throughout and bringing it up to date, but by recasting the systematic part. He has written new chapters on the general morphology and physiology of Bacteria, on antiseptics and disinfectants, and on immunity; and seventy-three illustrations have been added. He also gives a useful list of references to works on bacteriology.

IN the Annual Report of the Belfast Naturalists' Field C for the year ended March 31, 1870, it was stated that the Co mittee considered it advisable that the Club should prepa complete lists of the fauna, flora, geology; and archæology o Ulster. This purpose has been kept steadily in view, and twenty-one separate papers have been issued, illustrated by twenty-seven plates. These papers have now been brought together in what is intended to be the first of a series of volumes. The volume is entitled "Systematic Lists illustrative of the Flora, Fauna, Palæontology, and Archæology of the North of Ireland," and contains the results of much careful and conscientious work. Among the papers is a very useful one by Mr. William Gray on the cromlechs of Antrim and Down. The list is complete, and each of the monuments has been examined by the author, and, as far as possible, measured and sketched. Mr. Charles Elcock contributes notes on the prehistoric monuments at Carrowmore, near Sligo. Both of these papers are accompanied by good illustrations.

A GEOGRAPHY of the Malay Peninsula, Indo-China, the Eastern Archipelago, the Philippines, and New Guinea, by Prof. A. H. Keane, has just been published by Mr. Edward Stanford. The author's primary aim has been to produce a work which may meet the requirements of teacher and pupil in the Straits Settlements, and in the other colonies directly interested in the regions dealt with. The book ought, however, to be of considerable service to students at home. Prof. Keane knows his subject thoroughly, and his treatment of it is in accordance with the methods of the highest authorities on geographical science.

THE Deutsche Seewarte and the Danish Meteorological Institute have just issued the first quarter of a fresh series of daily synoptic charts, commencing with December 1883. The charts show the conditions of weather over the North Atlantic and a part of the adjacent continents, on each morning, from the data collected by both institutions. The period now embraced by the charts is from September 1873 to September 1876, and from December 1880 to February 1884—excepting from Septembe 1882 to August 1883—being part of the thirteen months selected by the Meteorological Council for their synchronous charts; and the whole work forms a valuable contribution to our knowledge of the causes of the weather changes which generally affect this country. A work of a similar nature is being carried out for the Indian Ocean by Dr. Meldrum, of the Mauritius, for the year 1861, but only the charts for the first three months have yet appeared.

THE *Annalen der Hydrographie und maritimen Meteorologie* of Berlin for April last contains the results of observations taken on board the German warship *Habicht* during her stay at Cameroon from April 1885 to September 1886. The maximum temperature in the harbour was 88°·0 in May 1885, and the minimum 71°·2 in June 1885. The amount of rainfall is not stated, but the number of wet days was most frequent between

April and October; the wet season began in June and ended in October. Lightning was observed almost daily, accompanied at times by heavy thunderstorms. Tornadoes were most frequent in June, October, and November. They lasted about fifteen to twenty minutes, and were generally preceded by a threatening bank of clouds rising over the land, accompanied by a heavy downpour lasting for several hours. The tides were irregular; for instance, there was scarcely any tidal current in the harbour in the beginning of October 1886, but only a slight rise of the water, so that often the ship did not swing.

ON the night of March 15, at about 8 p.m., a most remarkable display of aurora borealis was observed at Throndhjem, in Norway. It first appeared in the east in the form of a streamer, which suddenly flashed upwards to the zenith, and joined another shooting up from the west; a perfect and symmetrical arc was thus formed right across the sky, one of the bases of which rested on the horizon at the ridge Stenobjerget, and the other at the fortress of Christiansten. The arc emitted a steady white brilliant light, in the centre of which a nucleus of light appeared, more brilliant still. After remaining perfectly stationary and without any undulating motion along it for about a quarter of an hour, the arc moved slowly a little to the northwards, parallel with its former position. The light then began to be diffused, but the aurora remained in the sky till nearly 10 o'clock, although with less intensity.

DR. M. A. VEEDER writes to us from Lyons, New York, that an aurora was seen there on Saturday evening, April 23. Streamers were numerous and active from 10 to 10.30 p.m. There were magnetic perturbations of marked extent at intervals on Saturday and on Sunday. These perturbations became very decided during the evening of Sunday, when there was again an appearance of the aurora, which was, however, very faint.

Science says that the U.S. Geological Survey proposes to collect all attainable information regarding the recent earthquakes in Arizona. Circular letters of inquiry will be sent to residents on the area affected. The disturbed area seems to be a circle of some 400 miles radius, fully one-quarter as large as the Charleston earthquake, and nearly one-third of the area of the Riviera earthquake of last February.

A PAPER by Prof. Milne, containing an interesting account of a series of observations made upon earthquakes in Tokio between March 1884 and March 1885, has lately been printed. Prof. Milne arrives at the practical conclusion that there are at least three ways in which an ordinary building may be to a considerable extent protected from earthquake motion. The first method in a given district is, he says, to make a seismic survey of that area, and then select the locality where the least motion is experienced. A second method is to rest the building at each of its piers upon layers of cast-iron shot. A third method, which is applicable to heavy structures of stone or brick, is to allow them to rest upon foundations on hard ground rising from a deep pit or series of trenches.

AT a meeting of the Council of the National Fish-Culture Association, on Thursday last, a resolution approving of the proposed North Sea Fisheries Institute was unanimously carried. At the same meeting the Secretary reported that a large quantity of trout fry had been presented to various public waters in London and the provinces by the Association. The rest of the fish hatched out this season had been deposited in ponds at the Delaford Park establishment, the aim of the Association being to raise fish entirely from the ova taken from stock bred therein, not from eggs obtained from outside sources. He further stated that the rainbow-trout of California, bred by the Association, had all been maliciously poisoned by arsenic. A severe loss had thus been sustained, the fish being very valuable.

ANOTHER establishment for fish-culture has just been formed at Dulverton, in Somersetshire, by Mr. Frank Langdon. A series of ponds has been made near a tributary of the Exe, which affords an ample supply of pure water. Trout culture will constitute the chief business of the establishment, and a hatchery is being erected to receive the ova, which will be laid down for incubation at the end of the present year.

A *soirée* will be given at University College by the University College Biological Society on Monday, June 6, when Prof. Moseley, F.R.S., will lecture on "Life on the Ocean Surface." Cards of invitation will be sent on application to the Secretary, Mr. Bruce G. Seton.

M. E. QUINQUAUD has been investigating the influence of baths on the chemical phenomena of respiration and nutrition. He finds, by experiments on dogs, that cold baths increase the consumption of oxygen, the consumption being on the average ten times more abundant after the bath than before. Very hot baths exert a like influence, but in a less marked manner. Cold baths (and hot as well, but in a less degree) increase pulmonary ventilation: the quantity of air passed through the lungs is double or treble after the bath. At the same time a greater quantity of carbonic acid is expelled. By the analysis of arterial and venous blood it is shown that the respiratory combustions are very much increased under the influence of cold or hot baths, and it is also shown that the production of blood sugar is greater.

DR. T. MITCHELL PRUDDEN, of New York, has been making some important experiments with a view to determining the effect of freezing on Bacteria. In the case of the *Bacillus prodigiosus*, there were 6300 Bacteria in a cubic centimetre of water before freezing; after being frozen 4 days, 2970; after 37 days, 22; and none after 51 days. Of the *Staphylococcus pyogenes aureus*, there were a countless number before freezing; after 18 days of freezing, 224,598; after 54 days, 34,320; and after 66 days, 49,280. Of the typhoid-fever Bacillus, innumerable before freezing; 1,019,403 after being frozen 11 days; 336,457 after 27 days; 89,796 after 42 days; and 7348 after 103 days. These facts show that certain Bacteria have a remarkable power of resisting the temperature at which ice forms. Dr. Prudden, therefore, recommends that the New York State Board of Health, or other authority, should have power to determine which, if any, of the sources of ice-supply are so situated as to imperil the health of consumers of ice.

AN important new reaction is described in the current issue of the *Comptes rendus* by MM. Varet and Vienne. A current of acetylene was passed through 200 grammes of benzene containing 50 grammes of aluminium chloride during 30 hours, and the oily liquid remaining after removal by washing of the unaltered aluminium chloride was found to yield, on fractional distillation, three distinct products. The first, which came over between 143° and 145°, and which amounted to 80 per cent. of the whole, consisted of pure cinnamene or styrolene, $C_6H_5—CH = CH_2$, a substance occurring in liquid storax (*Liquidambar orientale*), and which was synthetized by M. Berthelot by passing acetylene together with benzene vapour through a tube heated to redness. The second fraction, coming over at 265°-270°, consisted of diphenyl ethane $(C_6H_5)_2 = CH—CH_3$, and the third fraction, boiling at 280°-286°, was found to consist entirely of dibenzyl, $C_6H_5—CH_2—CH_2—C_6H_5$, a solid substance isomeric with diphenyl ethane. These syntheses are extremely interesting, and afford another instance of the singular action of aluminium chloride in enabling us to attack the benzene nucleus.

A curious series of experiments has just been completed by Drs. Emil Fischer and Penzoldt (*Liebig's Annalen*, B. 239, i. 131) upon the sensitiveness of the sense of smell. These chemists used mercaptan and chlorphenol as their odoriferous substances, and experimented in a room of 230 cubic metres capacity. A gramme of the substance was dissolved in a litre of alcohol; 5 c.c. of the solution were again diluted to a known volume, and 1-3 c.c. of the latter solution measured out into a flask from which a fine jet could be directed by the experimenter to all parts of the room, the air of which was subsequently agitated by the waving of a flag. At a given signal a second experimenter stepped into the room, and took his olfactory observation, which was checked by the independent observation of a third person. The astonishing result was arrived at that our olfactory nerves are capable of detecting the 1/4,600,000 part of a milligramme of chlorphenol and the 1/460,000,000 part of a milligramme of mercaptan. The quantity of mercaptan present in the air of the room was 250 times less than the amount of sodium present in the air of the room in which Bunsen and Kirchhoff made their experiments upon the sensitiveness of the spectroscope, when the sodium lines were just perceptible.

In our note last week (p. 64) on Mr. Carey Lee's paper in the *American Journal of Science*, for "protochloride" read "photochloride."

The additions to the Zoological Society's Gardens during the past week include a Brown Capuchin (*Cebus fatuellus*) from Guiana, presented by Mr. George Doddrell; a Rhesus Monkey (*Macacus rhesus*) from India, presented by Mrs. Livingstone; a Common Marmoset (*Hapale jacchus*) from South America, presented by Mr. J. H. Hallett; a Ring-tailed Coati (*Nasua rufa*) from South America, presented by Mr. Robert R. MacIver; a Brown Bear (*Ursus arctos*) from Russia, presented by Mr. John Rhind; a Grey Ichneumon (*Herpestes griseus*) from India, presented by Mr. J. W. Deacon; a Bare-eyed Cockatoo (*Cacatua gymnopis*) from South Australia, presented by Sir Nathaniel Barnaby; two Daubenton's Curassows (*Crax daubentoni* ♂ ♀) from Venezuela, presented by Mr. F. G. Thompson; two Madagascar Porphyrios (*Porphyrio madagascariensis*) from Mozambique, presented by Capt. J. C. Robinson, s.s. *Roslin Castle*; a Western Slender billed Cockatoo (*Licmetis pastinator*) from West Australia, presented by Miss Streeter; a Horse-shoe Snake (*Zamenis hippocrepis*); an Ocellated Sand Skink (*Seps ocellatus*) from Tripoli, North Africa, presented by Mr. George Russell; two Hawk's-billed Turtles (*Chelone imbricata*) from the East Indies, presented by Mr. J. A. Wilson; a Collared Fruit Bat (*Cynonycteris collaris*) born in the Gardens.

OUR ASTRONOMICAL COLUMN.

Photography the Servant of Astronomy.—As an instance of the ease with which relative motions of stars can be detected by the aid of photography may be cited the case to which attention is drawn by M. de Gothard in *Astronomische Nachrichten*, No. 2777. On examining a photograph of the cluster G. C. 4440, taken at the Hérény Observatory in 1886, M. de Gothard found that a small star of the eleventh magnitude had changed its position relatively to the other stars in its neighbourhood by a considerable amount since the date of Herr Vogel's measurements of the relative positions of several of the components of this cluster executed with the Leipzig equatorial in 1867-69. The star in question is No. 48 of Herr Vogel's list, and it appears to have a proper motion of 2"·3 per annum. No. 46 of the same list appears also to have changed its position.

A New Minor Planet.—No. 266, if, as it would appear, Dr. Luther's discovery of April 11 be really Hesperia, was discovered by Herr Palisa, at Vienna, at midnight on May 17; magnitude 12.

Comet 1887 *e* (Barnard, 1887 May 12).—Dr. E. Lamp supplies the following elements and ephemeris for this object (*Astr. Nach.* No. 2780) from observations obtained at Cambridge, Mass., on May 12, and at Kiel on May 14 and 16:—

T = 1887 June 18·85945 Berlin M.T.

ω = 17 24·50
Ω = 245 8·81 } Mean Eq. 1887·0.
ι = 17 31 09
log *q* 0·13822

Ephemeris for Berlin Midnight.

1887.	R.A. h. m. s.	Decl. ° ′	Log *r*.	Log Δ.	Brightness.
May 28	15 39 11	20 20·6 S.	0·1492	9·6024	1·54
30	15 43 19	18 45·8			
June 1	15 47 35	17 8·6	0·1456	9·5919	1·61
3	15 51 56	15 29·8			
5	15 56 22	13 50·1 S.	0·1426	9·5854	1

The brightness on May 12 is taken as unity. Dr. L... describes the comet as being faint and round on May 14, and ... showing a nucleus.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1887 MAY 29—JUNE 4.

(For the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on May 29.

Sun rises, 3h. 53m.; souths, 11h. 57m. 6·9s.; sets, 20h. 1m.; decl. on meridian, 21° 37′ N.: Sidereal Time at Sunset, 12h. 29m.

Moon (at First Quarter on May 30) rises, 10h. 30m.; souths, 17h. 48m.; sets, 0h. 56m.*; decl. on meridian, 11° 40′ N.

Planet.	Rises. h. m.	Souths. h. m.	Sets. h. m.	Decl. on meridian ° ′
Mercury ...	3 55	12 7	20 19	22 49 N.
Venus ...	6 30	14 54	23 18	24 26 N.
Mars ...	3 28	11 22	19 16	20 9 N.
Jupiter...	15 55	21 13	2 31*	9 3 S.
Saturn...	6 53	14 59	23 5	22 2 N.

* Indicates that the setting is that of the following morning.

Occultations of Stars by the Moon (visible at Greenwich).

May.	Star.	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image ° °
29	45 Leonis...	6	20 37	21 34	69 314
29	ρ Leonis ...	4	23 10	0 21†	88 311
30	σ Leonis ...	4	19 46	20 6	152 188
June.					
2	94 Virginis	6	20 29	20 39	335 319
4	49 Libræ ...	5½	19 55	20 30	345 284

† Occurs on the following morning.

May. h.
29 ... 2 ... Mercury at least distance from the Sun.
30 ... 17 ... Venus in conjunction with and 2° 15′ north of Saturn.

June. h.
2 ... 12 ... Jupiter in conjunction with and 3° 22′ south of the Moon.

Variable Stars.

Star.	R.A. h. m.	Decl. ° ′		h. m.	
U Cephei ...	0 52·3	81 16 N.	... May 29,	1 57	*m*
			June 3,	1 37	*m*
δ Libræ ...	14 54·9	8 4 S.	... ,, 4,	2 18	*m*
U Coronæ ...	15 13·6	32 4 N.	... ,, 1,	2 6	*m*
W Herculis ...	16 31·2	37 34 N.	... ,, 4,		*M*
U Ophiuchi...	17 10·8	1 20 N.	... May 30,	2 34	*m*
			and at intervals of 20	8	
U Sagittarii...	18 25·2	19 12 S.	... May 29,	2 0	*m*
			June 1,	1 0	*M*
β Lyræ... ...	18 45·9	33 14 N.	... May 31,	23 0	*m*,
R Lyræ ...	18 51·9	43 48 N.	... ,, 31,		*M*
S Aquilæ ...	20 6·4	15 17 N.	... ,, 29,		*m*
δ Cephei ...	22 25·0	57 50 N.	... June 2,	3 0	*M*

M signifies maximum; *m* minimum; *m*. secondary minimum.

Meteor-Showers.

	R.A.	Decl.	
Near β Coronæ	227°	... 30° N.	
	290	... 60 N.	Rather slow.
From Vulpecula ...	303	... 24 N.	Swift.
Near ι Pegasi	333	... 27 N.	Very swift.

GEOGRAPHICAL NOTES.

PROF. GUIDO CORA has constructed a map of the district around Massowah on a scale of 1 : 200,000. He has been able to make use of a variety of original material, and the map will be of use to those interested in the events which are taking place in that region.

THE May number of *Petermann* begins with a short paper on the ethnology of British Columbia, by Dr. Fr. Boas (with map). Dr. H. Polakowsky contributes a paper on the proposed Nicaragua Canal from Greytown to Lake Nicaragua; Paul Sommrich, a paper on the Transvaal gold-fields; and Dr. Rink, on recent Danish exploration in Greenland. Herr Wichmann gives an abstract report of the proceedings of the German Geographentag at Karl-ruhe.

THE new number (Band v. Heft 2) of the *Mittheilungen* of the German African Society contains the results of several recent important African expeditions. There is a large-scale map and sections by R. Kiepert, of Böhm and Reichard's journey from Lake Tanganyika to the Lualaba, with remarks by Herr Reichard, observations on altitude, and on the meteorology of the region, by Danckelman. We have also a map of Standinger and Hartert's journey to Kano, Sokoto, and Gandu, with their journals, and remarks on the hypsometrical observations by Danckelman. Prof. Zöppritz contributes a paper on the late Herr Flegel's thermo-barometrical observations on the Niger. There is a letter from Lieut. Tappenbeck on his Congo exploration of 1885, and an analysis of Lieut. Kund's boiling-point observations by Danckelman.

ON ZIRCONS AND OTHER MINERALS CONTAINED IN SAND.

OWING to recent attempts to employ the brilliant light of incandescent zirconia and allied earths instead of that of gas or electricity, attention has been drawn to the sources of the rarer earths.

It occurred to me that an inexhaustible supply might be obtained from the small crystals of zircon so widely distributed in rocks, muds, and soils, if an easy method of concentration could be found. I wished particularly to examine some of the larger deposits of sand, especially the fine-grained deposits, but was stopped by want of the requisite appliances. The matter having been mentioned by a friend to the Director-General of the Geological Survey, I at once received permission to use the petrological laboratory attached to the Survey, and the following results were obtained therein.

The zircons were separated from the sand by means of Sonstadt's solution and borotungstate of cadmium.

by the first two samples. The samples were taken by me from a cutting recently made for the construction of a drain to connect "The Spaniards" and North-End, Hampstead. It was 2 or 3 feet wide, and 10 or 12 feet deep through great part of its length. It passed through a fine-grained yellowish sand, which was thrown out of the cutting or tunneled through in order to lay the drain-pipes. I made an average sample with as much care as though the sand had been a valuable ore which I was sampling for sale or purchase. It represented at least 1000 tons of sand in sight or cut through, and probably many acres of such sand on either side of the cutting. It consisted of grains so small as to pass almost entirely through a piece of cambric, 120 holes per square inch, stretched on a frame and used as a sieve. The average size of the grains was about the two-hundredth of an inch.

By means of dense solutions, vanning, analysis, and the constant use of the microscope, it was found that the sand had the following composition. It is given as an approximation to the truth, and does not, I think, vary more from it than must be expected in cases where it is not possible to get the minerals pure enough for weighing. Only under the microscope could the mixtures and impurities be estimated.

	Per cent.
Quartz, with 1 or 2 per cent. of flint fragments ...	about 75
Feldspar	,, 20
Grains attracted by a strong magnet	,, 2
Clay	,, 1
Zircons in recognisable crystals	,, $\frac{1}{2}$
Grains, more or less opaque, probably zircons	,, $\frac{1}{2}$
Rutiles	,, $\frac{1}{2}$
Tourmalines	,, $\frac{1}{10}$

In addition to the above, there were about 1 per cent. of grains over the density of 3·2, in regard to the composition of which I cannot at present say anything. A few appeared to be cleavage flakes of cyanite, but the majority were opaque earthy-looking bodies of various colours.

Feldspars.—These were nearly all of density equal to or lower than that of quartz. The majority were more or less cloudy, but some were quite transparent, showing the structure of microcline. A few showed the banded structure of plagioclase. Owing to the small size of the particles, and to their cavities and inclosures, I found it impracticable to get a satisfactory separation by dense solutions; and as it was impossible to distinguish the grains in all cases under the microscope, recourse was had to analysis of grains (consisting principally of quartz and feldspar) floated off from the denser minerals in a solution in which quartz floated and anorthite sank. It was found that they contained 94 per cent. of silica and 4·6 of alumina, with an unweighable trace of lime. The alkalies were not determined. This would correspond to about 20 per cent. of feldspar, but the estimate is perhaps rather high, as amongst the matter floated by the solution were found some particles which looked like glauconite covered by a transparent covering of varying thickness; also a little mica and some opaque grains of doubtful origin. It was interesting to note how the small fragments of feldspar have remained unchanged since the parent rocks were formed, and as they survived the disintegration of those rocks so they have continued unchanged in the sands. I saw several containing each a small zircon, and some contained what I think were microliths of apatite. The feldspars were mostly in angular fragments like the quartz.

The zircons are generally transparent and colourless prisms with double terminations of various kinds; many are more or less rounded and some wholly rounded as by attrition.

The rutiles are oblong and rounded grains, but many are sharply edged prisms, and a few have double terminations. Twins are not common, but both knee-shaped and kite shaped twins occur. These rutiles resemble those of the metamorphic rocks in which rounded grains and sharply defined crystals are found side by side.

The tourmalines are generally in flat plates, more or less rounded, but some are perfect crystals with double terminations. They vary much in colour and power of absorption. Various methods of concentrating the zircons were tried. The simplest was to wash the sand in air or water through a sieve with 100 holes to the inch, that being the smallest mesh I could meet with in sieves for sifting sands, such as the drift sand of North Devon, in which enrichment is thereby at once effected, as much enrichment takes place in working with sands that do not pass entirely through the sieve.

Samples of the Hampstead sand were sifted till [illegible] it was found that the zircons and rutiles, [illegible] and heavier than the sand, passed

through the sieve faster. By again sifting the 4 ounces which had passed till 2 ounces passed, a further enrichment was found to have taken place. The 2 ounces were again sifted on the same sieve till 1 ounce had passed, which was again sifted till ¼ of an ounce passed. This was examined quantitatively, and found to consist of 54 per cent. of quartz and feldspar, and 46 per cent. of dense minerals. By vanning and submitting the residue to the action of a strong magnet, almost nothing but zircons and rutiles remained. It is needless to say that much remained with the sand, especially in the latter parts of the operation.

A current separater was tried, but it seemed more difficult to work, though perhaps it might answer better on a larger scale, where it might be set to work automatically. There was no difficulty in getting a considerable enrichment, but it was evident that a great deal of care would be required in "sizing" the particles before a good separation could be effected. The most hopeful method seemed to be that of washing away the medium-sized grains of sand and afterwards sifting the sediment.

Perhaps in some of the streams running through the Bagshot or other sands natural eddies may be found or formed artificially from which enriched sand may be dredged, or it may be got on the sea-shore under sand-cliffs.

The object of the present communication is to draw attention to the matter in hopes that some deposit richer in zircons than the Hampstead sand may be found. Much care must be taken in sampling, because the sands, having been deposited from currents, must vary in composition. A trial is easily made by anyone accustomed to use a microscope and who knows the minerals by sight under such circumstances. A thimbleful of such sand as exists at Hampstead is enough for a trial by vanning, but if one of the dense liquids be used, from 10 to 20 grains by weight of the sand will give a good microscopic slide of the dense minerals. It may of course prove that the Hampstead sand is a residue of denudation in which the denser minerals have accumulated. In that case it is not improbable that other similar deposits may be found, some, perhaps, much more zirconiferous.

On the whole it appears that the matter is worthy of further attention. In some future communication I hope to be able to give an account of the composition of the matter attracted by a strong magnet, and also of the grains of earthy-looking minerals over the density of 3·2, and of any richer deposit of zirconiferous sand of which I can obtain reliable samples.

ALLAN B. DICK.

THE ROLLING CONTACT OF BODIES.[1]

WHEN two solid bodies roll upon each other, points in the surface of one successively come into contact with corresponding points in the surface of the other in a way which differs essentially from that which occurs in sliding contact, and it is the nature of this rolling-contact that the lecturer proposed to discuss in an experimental manner.

In the first place, it is well to understand clearly the nature of the relative motion of the two points which come into contact when the surfaces are such that no appreciable distortion of them takes place, and for this purpose one of the two bodies must be at rest. These may respectively be taken as the plane surface of the ground and a circular disk rolling upon it. An approximate representation of this motion is given by the end of the spokes of a wheel without its tyre. In this case it is seen that a point of the rolling body, when it is just coming into contact with the fixed surface, does so in a direction at right angles to the surface at rest, and also leaves it in the same direction. This action is very similar in kind to that which occurs with the continuous circle formed by the tyre. The path of a point in the rim can be drawn in a way visible to the audience by means of a piece of apparatus consisting of two circular glass plates held together by a hollow brass spindle in which slides an arm carrying a brush. The brush traces the well-known cycloid, of which the only portion now to be considered is that where it directly approaches the surface beneath. This part is perpendicular to that surface, and when epicycloids are drawn, by rolling the disk upon the arc of a circle, the same fact is brought out.

One body may, however, not merely roll upon another, and a normal pressure be exerted, but they may exert a tangential force upon each other. It is convenient to keep these two cases separate; examples of them being respectively the wheels of a railway carriage and those of the locomotive which draws it along. It is to be noted that the object in the former case is to permit one body to move relatively to another without permitting sliding contact of their surfaces, whilst, in the latter case, in addition to this, the object is to obtain such motion. There are, however, many cases in which it is merely the motion of a body about one point which is required, such as when motion is transmitted from the edge of one rotating disk to another, and then this distinction still more closely holds, as the normal pressure is only obtained so as to insure the necessary tangential resistance. Thus the objects of rolling motion may be classed as being—

(1) To *allow* the relative motion of one body to another with which it is in contact without permitting relative motion of that part of their surfaces in actual contact.

(2) To *obtain* the relative motion of such parts of the surfaces of bodies as are not in contact by means of statical contact of the parts which are.

The lecturer then proceeded to consider the practical proof of the smallness of the resistance to rolling in cases where the distortion of the surfaces in contact is very small, as illustrated by the small tractive force required for heavy bodies properly mounted on wheels or on roller-bearings; mentioning the case of a 12-horse-power engine, the shaft of which continued to rotate for three-quarters of an hour after the motive power was withdrawn; and another case, of a turntable weighing 14 tons, which was kept in motion by a weight of 3½ pounds acting upon it by means of a cord passing over a pulley. The small distortion of such surfaces when transmitting motion requiring expenditure of energy to maintain, was next made clear by giving certain facts as to the accuracy with which one surface was developed or measured out upon another. An account was given of experiments made with apparatus specially prepared by the lecturer to investigate this point. This apparatus consisted of two accurately turned brass disks properly mounted upon a frame, and the relative positions of these disks could be interchanged so that any minute differences in their peripheries could be detected. The experiments, which were very difficult to carry out accurately, showed that under the best circumstances, motion with an error of only 1 in 300,000 of the distance passed over could be obtained. This accurate measuring out of the surfaces one upon another was employed in various ways for purposes of measurement, and these, by means of models and diagrams, were briefly explained.

Although the foregoing facts prove that, under suitable conditions, distortion at the points of contact is very small, yet some resistance at these points *always* occurs, because no bodies are perfectly hard; and the nature of this distortion and consequent resistance was next discussed.

The explanation of the resistance opposed by a soft surface to a hard body rolling upon it, as first given by Prof. Osborne Reynolds, was applied by the lecturer to account for a very remarkable effect produced in the disk, globe, and cylinder integrator of Prof. James Thomson. This effect, which was the turning of the cylinder when the sphere was rolled along it in a horizontal direction, was reproduced by means of a large model. The action of a soft body rolling upon a hard surface was next considered, with the result of showing that the same reasoning would not account for the turning of the cylinder in the same direction as before with the above model, and the lecturer then proceeded, by means of diagrams, to offer an explanation of this and other phenomena. The various effects obtained with bodies of different relative degrees of hardness were discussed at length, but figures would be needed to make these points clear. Finally, an explanation was given of the cause of an error which always appeared in a certain important class of integrators caused by the slipping of the edge of a disk over a surface on which it rolled in circumstances under which it had apparently never been suspected that slipping did actually take place. This the lecturer had been enabled to discover and measure by means of a special piece of apparatus, a model of which was exhibited and the effects shown by its means.

The facts and reasoning, which were given in the lecture, all related to the rolling contact of bodies, and the lecturer ventured to think that, imperfect as the treatment of the subject had been, it was one of such importance, not merely from the point of view of the practical applications he had mentioned, but in its scientific aspect, dealing as it did from a novel point of view with the nature and properties of solid bodies, as to be worthy of being thus brought before the Royal Institution.

[1] Abstract of Lecture delivered at the Royal Institution, by Prof. Hele Shaw, on April 29.

A REMARKABLE METEOR.

ON March 17 last, about 4.15 p.m., the track of a brilliant meteor in the southern heavens, at an altitude of 30°, was observed by Mr. R. Brough Smyth, of Sandhurst, Victoria, Australia. Writing to us on March 19, Mr. Smyth says :—

"The line was silver-white and of considerable breadth. The sun was shining in a clear sky. Owing to the view being intercepted by large gum-trees growing in the grounds around my house, I could see only a portion of the arc described. Subsequently, a little after 5 o'clock p.m., the sky was obscured by a kind of mist or vapour at a great height—in colour between steel-grey and lead-grey, and with tints similar to those of the metal bismuth over the whole. All objects looked green or greenish in the strange light. The meteor was observed at Salisbury in South Australia, at Coleraine in the extreme west of Victoria, and at various places eastward—say over a distance of 400 [illegible]. It travelled apparently from east to west, and as far as [illegible]n was visible in the southern part of Australia only. In places it presented the appearance of a blood-red ball, at Beaufort the ball is said to have exploded with a loud [illegible]port, sending up a streak of fire, accompanied with the hissing of escaping steam, as from an engine. It left a cloud of greyish smoke. This smoke-like cloud was observed in other places. At Warrnambool on the west coast, and at Terang, twenty-five miles north-eastward, shocks of what were supposed to be earthquakes were felt at the time of the disappearance of the meteor. Cattle and horses galloped about in alarm, houses were shaken, windows rattled, and the wild fowl in the lakes were disturbed, and took wing. I inclose cuttings from the *Argus* containing accounts of this phenomenon."

The "cuttings" inclosed by Mr. Smyth are a series of telegrams, describing the phenomenon as seen in various parts of Australia. At Coleraine, "a brilliant ball of fire shot from the zenith in a clear sky to 30° above the horizon, and then disappeared as it exploded, leaving a large cloud of white smoke, which was visible for half an hour. Exactly six minutes subsequently, two distinct shocks like cannon reports were heard, with a perceptible tremor of the atmosphere. The phenomenon was witnessed by 500 persons." At Merino, "a most unusual phenomenon appeared in the eastern sky. A streak like smoke from a volcano appeared. Immediately after the appearance, a report like distant thunder was heard from the same direction. It was thought that an aerolite of immense size had fallen between Merino and Hamilton." At Stawell the "meteor appeared to burst just beyond the town in a cloud of smoke, which was immediately followed by a loud crash like thunder." From Terang it is reported that at Lake Keilambete "the black swans were noticed to rise suddenly off the lake. A rumbling noise appeared to pass under, causing the cattle grazing on the banks of the lake to scamper away, and on gaining some distance they were seen to look back. The noise was heard in other places, and seemed to pass to the south-west." At Portland, "three distinct reverberations like the booming of artillery were heard about 4 p.m." The people at Warrnambool, hearing, shortly after 4 o'clock, loud detonations like a volley of musketry, with subsequent dropping shots, rushed out of their houses; and "the cattle were paralyzed with fear at the sounds." The disappearance of the meteor over Beaufort, where it is said to have exploded, "was followed by earth tremors and a rumbling sound as of the firing of heavy artillery. The vibrations lasted for ten seconds. Several houses were shaken severely. No substance appears to have fallen to the earth."

SCIENTIFIC SERIALS.

THE contents of vol. lv. part 2, No. 4, of the *Journal of the Asiatic Society of Bengal*, are varied. They commence by a memoir on the land shells of Perak, by Dr. O. F. v. Möllendorff, in which 58 species (many new) are enumerated or described. Then follows an account of solar thermometric observations at Allahabad, by S. A. Hill, Meteorological Reporter to the Government of the North-West Provinces. The third memoir is an historico-geographical study on probable changes in the Punjab and its rivers, by R. D. Oldham, of the Indian Geological Survey, a paper on which much research has been expended, tending to prove that a second large river, independent of the Indus, once existed in the Punjab, and that the geological changes which converted a once fertile district into a desert probably date so recently as the early centuries of the Christian era. The next is a very important entomological investigation of the butterflies of Cachar, by Prof. Wood-Mason and Mr. L. De Nicéville, enumerating no less than 247 species obtained between the end of March and the beginning of October. A remarkable feature is the large number of *Hesperiidæ*, of which 53 distinct species were obtained. There are valuable notes on seasonal and local variation, and a considerable number of new species are described, and mostly figured on four plates, one of which is a chromo-lithograph executed in London, the others "autotype," and apparently very successful examples of what may be produced by the process as applied to natural history subjects. Dr. King follows with a short paper on some new species of *Ficus* from New Guinea, in which the author largely quotes from and anticipates a monograph on Indo-Malayan and Chinese figs prepared for the Linnean Society; the remarks are worthy of very careful study, and open up much new light on the somewhat obscure subject known as "caprification." The concluding paper is a very short one by Mr. J. S. Baly on a new species of *Hispa* destructive to the "dahn" crops in Chittagong. On the whole this part is one of the most valuable that have been issued by this long-established Society.

Proceedings of the Linnean Society of New South Wales, 2nd series, vol. i., part 4, February 22, 1887 (Sydney), contains :—*Zoology*: George Masters, catalogue of the described Coleoptera of Australia, part 6.—E. Meyrick, descriptions of new Lepidoptera. A large number of new species and several new genera are described; a new species of Thalpochares is given the name of Coccophaga, from the singular habits of the larva, which feeds solely on a Coccus infesting a Macrozamia.—E. P. Ramsay, notes on the eggs of various Australian birds; list of Western Australian birds collected at Derby; on the nest of *Pycnoptilus floccosus* (plate xx.); on a new species of Hapalotis (*H. bowerî*) (plate xviii.).—E. P. Ramsay and J. Douglas-Ogilby, on a new species of Apogon (*A. roseigaster*).—William Macleay, on a new species of Hoplocephalus (*H. collaris*).—C. W. De Vis, on new or rare vertebrates from the Herbert River; describes a new Pseudochirus (*P. mongan*), a new Dromicia (*D. frontalis*), and records the occurrence of some rare species.—A. J. North, notes on the bower birds, and some references to authentic descriptions of Australian birds' eggs.—*Botany*: E. Haviland, flowering seasons of Australian plants.—J. Stirling, on the Rutaceæ of the Australian Alps.—Baron von Mueller, on some hitherto undescribed plants of New South Wales. *Grevillea renwickiana* is described as quite procumbent, with elongated branches, being in this respect like *G. laurifolia* and *G. repens*, but differing from both in the larger and much less numerous flowers; also new species of Melaleuca, Bossiæa, and Pultenæa.—*Palæontological*: F. Ratte, notes on Australian fossils.—W. J. Stephens, on some new Labyrinthodonts (plates xiv. and xxii.).—J. Mitchell, on the geology of Bowning, N.S.W.

Zeitschrift für wissenschaftliche Zoologie, vol. lv. Part 2, April 13, 1887, contains :—Dr. O. Schultze, researches on the ripening and the fertilization of the amphibian ova, part 1 (plates xi. to xiii.).—Dr. Wilhelm Roux, on a fungus living parasitically in bones (*Mycelites ossifragus*) (plate xiv.). The author gives an account of the filaments of this fungus occurring in the bones of a large number of extinct forms of mammals, reptiles, and fishes.—Dr. Otto Zacharias, contributions to the pelagic and littoral fauna of the German Ocean. In this paper are described a large number of Entomostraca, Rotatoria, Hydrachnida, and Turbellaria, some new. In an appendix, S. A. Poppe describes a new species of Temorella from Holstein and Mecklenburg (plate xv.).—Dr. H. Strahl, on the walls of the yolk-sac and on the parablast in lizards (plate xvi.).—Dr. Joseph Heinrich List, on the glandular structures in the foot of *Tethys fimbriata*, L. (plate xvii.). These glands are found both on the upper and under side of the feet, and are of four different sorts; while some are slime organs, others may be phosphorescent organs.—Dr. Eugen Korschelt, on some interesting phenomena in the formation of the eggs of insects (plates xviii., xix.).

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, April 28.—"On the Homologies and Succession of the Teeth in the Dasyuridæ, with an Attempt to

trace the History of the Evolution of Mammalian Teeth in general." By Oldfield Thomas, British Museum (Natural History). Communicated by Dr. Albert Günther, F.R.S.

The true homologies of the different teeth in the Marsupialia, and especially in the *Dasyuridæ*, have long been in a state of confusion, a confusion that has been chiefly in regard to the premolars, of which some members of the family have two, others three, while generalized Placentals have four, and it is therefore necessary to prove which teeth have been successively lost in order to find out the correct homologies of the remainder.

Firstly, as to which of the three premolars of ordinary Marsupialia has been lost in *Dasyurus*, with only two, it is shown that it is the last premolar, or pm.^{4}, that is missing in this genus.

Next, it was necessary to find out which of the original four premolars had disappeared in the ordinary three-toothed genera of the Polyprotodonts, and this has been able to be done by the fortunate discovery of a specimen of *Phascologale* in which there are four premolars on one side, the additional tooth being inserted behind the first premolar. The missing premolar is therefore pm.^{3}, the resulting premolar formula of *Phascologale* and *Thylacinus* being P.M. $\frac{1.0.3.4}{1.0.3.4}$ and of *Dasyurus* P.M. $\frac{1.0.3.0}{1.0.3.0}$.

The milk dentition in several of the *Dasyuridæ* is then described, and also that of the Mesozoic *Triacanthodon serrula* (Owen), which is definitely proved to have a true Marsupial milk dentition.

An attempt is then made to trace out the history of the evolution of mammalian teeth in general, and it is suggested that the process by which a milk tooth was developed consisted of two stages, firstly, a preliminary retardation of the permanent tooth, and secondly, of the development of a temporary tooth in the gap in the tooth-row caused thereby; the retardation in the first case being useful for packing purposes in a large-toothed animal, while in a small-toothed form the same retardation, if present by inheritance, would cause a more or less disadvantageous gap, best filled by the assumption of a milk tooth.

Following out this idea, it is shown how easily the transition from the Metatherian to the Eutherian state of tooth-change may have taken place, a transition by the help of which a complete series of diagrams can be drawn up, following the history of each individual tooth, from the dentition of the earliest mammals, homodont and monophyodont, down to the varied forms of dentition, heterodont and diphyodont, existing at the present day.

For the Edentates alone it is necessary to draw up a special branch of tooth development arising directly from the Prototheria, a branch for which the name of "Paratherian" is proposed.

Physical Society, May 14.—Prof. W. E. Ayrton, Vice-President, in the chair.—Mr. T. Mather was elected a member of the Society.—The following papers were read:—On a modification of a method of Maxwell's for measuring the coefficient of self-induction, by Mr. E. C. Rimington. The method referred to is given in Maxwell's "Electricity and Magnetism," § 778, vol. ii., and is called "comparison of the electro-static capacity of a condenser with the electro-magnetic capacity of a coil." The apparatus used consists of a Wheatstone's bridge having the coil in one, and the condenser as a shunt to the opposite, arm. In order that no deflection may be produced, either for steady or unsteady currents, a troublesome double adjustment of the resistances is necessary, and to obviate this the modification was devised. It consists in placing the condenser as a shunt to only part of the arm, and this part can be varied by sliding contacts without altering the whole resistance of the arm. An ordinary resistance balance for steady currents is first obtained, and the sliders are then adjusted until no deflection is produced on breaking the battery circuit. Under these circumstances it is shown that $L = Kr^2\frac{D}{B}$, where K is the capacity of the condenser, r the resistance between the sliders, and D and B the resistances of the arms in which the coil and condenser are placed. The conditions of maximum sensibility are investigated, and also those under which a telephone may replace the galvanometer; in the latter it is shown that the only possible solution is when $r = B$, *i.e.* Maxwell's arrangement. The author believes his modification would be made much more sensitive by adopting the "cumulative" method used by Profs. Ayrton and Perry in their secohmmeter: and in his case neither the speed nor the "lead" need be known. Mr. W. N. Shaw asked whether any serious difficulties were experienced with telephones, owing to electro-static capacities of wires, &c., and Mr. W. E. Sumpner pointed out that the particular arrangement given in Maxwell is not always the most sensitive, as was shown in his remarks at the last meeting of the Society of Telegraph-Engineers. Mr. Bosanquet thought the method a valuable one, and hoped many experiments would be made on coils whose coefficients were calculable, in order to find out the differences between calculated and observed results. Prof. Ayrton referred to the paper by Prof. J. J. Thomson in the Philosophical Transactions, and pointed out that the formula there given for the capacity of a condenser in electro-magnetic measure, is identical with that given in Maxwell, § 776, when the printer's error of interchanging a and a in the denominator for R_2 is corrected.—On the production of sudden changes in the torsion of a [illegible] by change of temperature, by Mr. R. H. M. Bosanquet. A fine hard-drawn platinum wire, four or five feet long, was as a suspension for a ballistic galvanometer, and exhibited p liar phenomena. The steel needles were replaced by brass o and the peculiarities investigated. When the room was warme the needles swung round nearly 70° for a few degrees rise of temperature, and remained in about the same position for further rises. If it was now cooled a few degrees (3° or 4° F.), they quickly returned to their initial position. The author has not found a complete explanation, but believes it to be due to unequal expansion, and loose contact amongst molecules, and has devised a simple mechanism to illustrate his meaning. Remarks and suggestions were made by Prof. Perry, Mr. Lant Carpenter, and the Chairman.—On a magnetic potentiometer, by Mr. A. P. Chattock, read by Prof. Reinold. The "so-called" magnetic resistance between two points on a magnetic circuit may be expressed as the ratio of the difference of potential to the total induction passing from one to the other (provided there be no magnetomotive force between them). From the fact that the volume integral of induction through a wire helix of constant cross-section is proportional to the average difference of potential between its ends, it follows that any alteration in that difference of potential will give rise to an E.M.F. in the helix proportional to that alteration. Hence, if the wire be connected to a ballistic galvanometer, the combination may be called a magnetic potentiometer. A helix is formed by winding wire uniformly on a piece of solid india-rubber, or canvas gas-tubing, of constant cross-section, using an even number of layers to avoid external inductive effects, and leaving a small space between the turns so as to allow the tube to bend without elongating. Experiments made to measure the difference of potential between the ends of a magnet gave satisfactory results. One end of the helix was held stationary at one end of the magnet, whilst the other was moved quickly to the other end of the magnet, and the resulting throw of the galvanometer observed. This was next done at two operations, and the sum of the two throws was very nearly equal to the first. The results can be reduced to absolute measure by passing the helix through a coil of n turns, bringing its ends together, and starting or stopping a current, C, in the coil, the resulting throw of the galvanometer being noticed. The magnetomotive force used in this experiment is $4\pi nC$. An interesting discussion followed, in which Prof. Perry, Mr. Shaw, Prof. Ayrton, and Mr. Bosanquet took part, the latter mentioning a measurement of magnetic potential made by himself some years ago.—In consequence of the absence of Prof. S. P. Thompson, his paper on secondary generators was postponed till next meeting.

Geological Society, May 11.—Prof. J. W. Judd, F.R.S., President, in the chair.—The following communications were read:—Further observations on *Hyperodapedon gordoni*, by Prof. T. H. Huxley, F.R.S. The author briefly noticed the circumstances under which he first described the occurrence of Lacertilian and Crocodilian fossils in the Elgin sandstones, and the confirmation which his views as to the Mesozoic age of these remains had received from the discovery of *Hyperodapedon* in English Triassic rocks and in India. The original type of *Hyperodapedon gordoni* from Elgin was, however, in bad condition, and the receipt at the British Museum of a second much better preserved skeleton, found in the Lossiemouth quarries of the same neighbourhood, had enabled him to add considerably to the known characters of the genus, and to compare it more thoroughly both with the recent *Sphenodon* (or *Hatteria*) of New Zealand and with the Triassic *Rhynchosaurus articeps*, several

specimens of which are in the British Museum palæontological collection. The recently discovered *Hyperodapedon* skeleton was of nearly the same size as that formerly described, and must have belonged to an individual about 6 or 7 feet in length. The specimen was exposed by the splitting of a large block of sandstone, and comprised the skull, the vertebral column as far as the root of the tail, all the bones of the left and of part of the right fore-limb, and those of the right hind-limb, the whole almost in their original relations. The bones were described in order and compared with those of *Sphenodon*, the most important differences in *Hyperodapedon* being the following:—(1) The centre of the presacral vertebræ are ossified throughout and more or less opisthocœlous, especially in the cervical region. (2) The anterior cervical vertebræ have long and strong ribs. (3) The external nares are not separated by bone. (4) Conjoined præmaxillary bones form a long, conical, curved, pointed rostrum, which is received between the rostral processes of the mandible. All these were devoid of teeth and probably sheathed in horn. (5) The palatal area is very narrow in front and wide behind, with strongly curved lateral boundaries. (6) The posterior maxillary and palatal teeth are multiserial. (7) The rami of the mandible are united in a long symphysis, behind which they diverge widely, and the dentigerous edges are strongly concave upwards as well as outwards. (8) The mandibular teeth in front are set into a close, apparently continuous palisade, and become distinct and conical only at the posterior end of the series. (9) The fore-foot is remarkably short and stout, with metacarpals of equal length. The relations of *Rhynchosaurus* to *Hyperodapedon* and *Sphenodon* were then dealt with, the first-named being shown to occupy in some respects an intermediate place between the two others. The skull of *Rhynchosaurus* resembles that of *Hyperodapedon* in its single anterior nasal aperture, its præmaxillary and mandibular rostral processes, and in having more than one series of palatal teeth; but in general form and in the shape of the maxillæ, palatal bones, and rami of the mandible it departs far less from *Sphenodon* than *Hyperodapedon* does. Some comparisons of the limb-bones were also made. The three genera mentioned were shown to form a particular group, which, however, had no claim to ordinal distinction, and appeared to form a family, Sphenodontidæ, of the Lacertilia, comprising two sub-families, Rhynchosaurinæ (including *Rhynchosaurus* and *Hyperodapedon*) and Sphenodontinæ. The fact that in this Lacertilian group the highest known degree of specialization, as shown in *Hyperodapedon*, was attained as early as the Triassic epoch, showed that in Permian times, or earlier, Lacertilia existed which differed less from *Sphenodon* than either of the Rhynchosaurinæ did. Not only was the Lacertilian type of organization clearly defined in the Triassic epoch, but it attained a degree of specialization equal to that exhibited by any modern lizard. The reading of this paper was followed by a discussion, in which the President, Dr. Geikie, Prof. Seeley, Mr. Lydekker, Prof. Boyd Dawkins, and others took part.—On the rocks of the Essex drift, by Rev. A. W. Rowe.—On Tertiary Cyclostomatous Bryozoa from New Zealand, by Mr. Arthur W. Waters.

EDINBURGH.

Royal Society, April 18.—Sir W. Thomson, President, in the chair.—Prof. Rowland's photographs of the solar spectrum were exhibited.—The President read a paper on ship-waves, and another on the instability of fluid motion. Both papers appear in the *Phil. Mag.*—Mr. D. S. Sinclair gave a communication on an experimental research in magnetism.—A paper by Mr. A. H. Anglin on the summation of certain series of alternants was submitted.—Prof. Crum Brown read a paper by Mr. H. Marshall on cobaltic alums.—Mr. G. N. Stewart submitted a synopsis of researches on the effect produced on the polarization of nerve by stimulation.

May 2.—Sir Douglas Maclagan, Vice-President, in the chair.—Prof. J. B. Haycraft read the third part (on the sense of smell) of a paper on the objective cause of sensation.—Prof. Crum Brown read a paper on the physics of noise. His object is to investigate the various components which make up ordinary noises, such as a hissing sound.—Prof. Dittmar and Mr. C. A. Fawsitt communicated a paper on the physical properties of methyl alcohol.—Prof. Dittmar also discussed the instability of the double salts of $M''SO_4.R'_2SO_4 + 6H_2O$ of the magnesium series.—Mr. J. Rattray described a diatomaceous deposit found at North Tolsta, Lewis.

PARIS.

Academy of Sciences, May 16.—M. Janssen in the chair.—Obituary notices of the late M. Boussingault, member of the Section for Rural Economy, who died on May 11, by MM. Schloesing, Troost, and the President.—On some deviations from the normal direction of sound calculated to render ineffective the fog-signals and similar appliances employed in navigation, by M. H. Fizeau. The paper, written with reference to some recent shipping disasters during foul weather, shows on theoretical grounds that, the surface of the sea being at times warmer than the surrounding atmosphere, the aerial strata must in calm weather decrease in temperature upwards to a certain height above sea-level. This occurs not only at night, but also frequently during the day in foggy weather. Hence the sounds of the fog-signals, intended to be propagated horizontally, are necessarily affected by the differences of atmospheric temperature, those nearest the surface of the water acquiring greater velocity than those traversing the higher strata. Thus is at times produced a sort of "sound mirage," perfectly analogous to the well known corresponding phenomena of light. Once the cause of the deviations is understood, the means of counteracting them will easily suggest themselves.—Effects of earthquakes on magnetic instruments, by M. Mascart. The reports of magnetic disturbances received from various stations in France, England, Germany, Russia, and other European countries, show great discrepancies as to the time and intensity of the shocks; but whether these discrepancies are to be attributed to possible errors of observation, to the difference in the character of the instruments, or to physical causes, cannot at present be determined. If the cause of the disturbances is really electric, its very mechanism is absolutely unknown.—Observations of Barnard's new comet, *c* 1887, made at the Paris Observatory (equatorial of the West Tower), by M. G. Bigourdan. This comet, discovered on May 12, at Cambridge, in the United States, was seen at Paris on May 14, when it presented the appearance of a round nebulosity of 1′ diameter, and of the thirteenth magnitude, with considerable central condensation, notwithstanding its slight altitude above the horizon.—On the direct determination of the differential coefficient $\frac{dp}{dt}$, relative to saturated vapours, by M. A. Perot. It is shown that the mechanical equivalent of heat may be determined by the well-known relation—

$$L = \frac{1}{E} T (u' - u) \frac{dp}{dt},$$

which is obtained by applying to a liquid mixture and its vapour the principle of equivalence, and that of Carnot. In order to approximately determine this quantity, the author has undertaken to measure on the same sample of pure ether, at a temperature of 30°, the different parameters entering into the preceding relation—u', u, L, and $\frac{dp}{dt}$. To determine $\frac{dp}{dt}$ he employs a special method, which enables him to measure separately the two corresponding quantities dp and dt. The determinations have been made for the temperatures 29° to 31° inclusive, within which interval they may be represented by the formula—

$$\frac{dp}{dt} = 2{\cdot}2750 + (t - 29)\,0{\cdot}0834.$$

—Intertropical diurnal and annual variations of terrestrial magnetism (second note), by M. Ch. Lagrange. By comparing the observations recorded at two stations on either side of and equidistant from the equator, such as Bombay and St. Helena, Hobartown and Toronto, the author finds that there exists in the atmosphere and in the earth a system of currents moving east and west, whose strata of greatest intensity penetrate the atmosphere, descending in the hot season below the surface of the earth and again rising in the cold season. This system seems to prove the reality of Ampère's general system of currents extended to the earth and the atmosphere. From this it also follows that the existence of these aërial magnetic currents involves a diminution of temperature with elevation. Consequently these currents are one of the factors, possibly the chief factor, in the thermic system of the globe, so that a fundamental connexion exists between meteorological phenomena and those of terrestrial magnetism.—On the reproduction of alabandine, by M. H. Baubigny. By the process here described the author has obtained some beautiful octahedric crystals, presenting all the characteristics of alabandine (MnS): the same crystalline form, colour, and

density, about 4.—Contribution to the study of the alkaloids, by M. Oechsner de Coninck. Having in a previous paper described the reaction of potassa on a combination of the iodide of ethyl with nicotine, the author here confirms by a fresh line of observation the relation of nicotine to the pyridic and dipyridic series.—On some fossil woods found in the Quaternary formations of the Paris basin, by M. Emile Rivière. These specimens were found associated with the animal remains already frequently described by the author. A microscopic study has enabled him to determine three different vegetable species: Palm, Cedroxylon, and Taxodium. The last-mentioned was especially abundant in the Miocene epoch, and appears to be older than the non-fossilized specimens from time to time discovered in the boggy districts of Switzerland.

BERLIN.

Physical Society, April 22.—Prof. Du Bois-Reymond, President, in the chair.—Dr. Gross explained his theoretical views on the heat of solution of magnetised iron, and showed why, in accordance with these, the heat of solution of magnetised iron must be greater than that of unmagnetised. One result of these views was that a piece of magnetised and unmagnetised iron in a conducting fluid capable of dissolving the iron must give a current; this he has already demonstrated two years ago (see NATURE, vol. xxxi. p. 596). The current in such an element as this flows across the fluid from the magnetised to the unmagnetised pole, and is independent of the nature of the magnetisation. The source of the electric current is in this case, according to the views of the speaker, to be sought for in the loss of specific magnetisation which the molecules of iron undergo as they pass from the solid to the fluid condition. Of the various solutions of salts of iron which were used in these experiments, only neutral salts of ferric oxide were found to yield a result, while the salts of ferrous oxide gave no current. The cause of this is, according to the speaker, that only the ferric salts lead to a solution of the magnets. Dr. Nichols has quite recently carried on some experiments on the heat of solution of magnetised iron, and has obtained the same experimental results, namely that the heat of solution of magnetised iron is greater than that of unmagnetised, although he starts with theoretical views respecting the magnetic potential of solid iron and iron in solution which are diametrically opposed to those of Dr. Gross.—The President exhibited a Bourdon's manometer, and explained its use for the measurement of alterations of blood-pressure in living animals. In connexion with this the President gave a full account of the physical portions of the research which Dr. Grunmach has carried out on the influence of elasticity on the rate of progression of the pulse-wave. The most important points of this research have already been communicated in the report of the last meeting of the Physiological Society on April 15 (NATURE, May 12, p. 48).

Physiological Society, April 29.—Prof. Du Bois-Reymond, President, in the chair.—Dr. Onodi, of Buda-Pesth, gave an account of the anatomical investigations which he carried on during his two visits to the Zoological Station at Naples. In the first place he busied himself with the anatomy of the ciliary ganglion, which he examined microscopically in twenty-five different species of Selachians. From what he found in these lower vertebrates, as well as from observations which he had an opportunity of making on the embryos of cartilaginous fishes and chicks, he has come to the conclusion that the ciliary ganglion must be reckoned in with the sympathetic plexus. In addition to the above researches Dr. Onodi was occupied with investigations on the roots of the vagus, and he communicated a number of interesting details on their relations in the Selachians.—Dr. König spoke on Newton's law of colour-mixing, explaining its principle, and illustrating it with the aid of a Newton's colour-chart. He then developed the three propositions which Grassmann has deduced from the Newtonian law, and which, as is well known, are as follows: (1) when two spectral colours are mixed the resulting compound colour is a spectral colour lying between the other two, but mixed with white; (2) when one of the two colours which is being mixed is continuously changing, then the resulting compound colour also changes continuously; (3) similar colours when mixed give similar compound colours. Of these three propositions the first has not been confirmed by later experimental researches, but this does not diminish the value of Newton's law of the mixing of colours: it only becomes necessary to substitute a triangular colour-chart for the circular one put forward by Newton. The second proposition was fully confirmed by experience. The third proposition, which may also be expressed by saying that the compound colour is independent of the intensity of its separate constituents, was not confirmed by experiments. The speaker has alone, and in conjunction with Herr Breduhn, carried out careful measurements on trichromatic and dichromatic eyes, and has always observed a difference in the compound colour as the result of marked differences in intensity of the compounded colours. The validity of Newton's principle in its general form is therefore considerably shaken by this discovery, and must be confined to narrow limits of variations of intensity.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

The Agricultural Pests of India: Surgeon-General E. Balfour (Quaritch).—Schriften der Naturforschenden Gesellschaft in Danzig (Danzig).—The Storage of Electrical Energy: G. Planté (Whittaker).—Manual of Bacteriology: E. M. Crookshank (Lewis).—Chance and Luck: R. A. Proctor (Longmans).—Manual of Scientific Inquiry, 5th edition: edited by Sir R. S. Ball (Eyre and Spottiswoode).—Elementary Trigonometry: Rev. T. Roach (Clarendon Press, Oxford).—Our Bird Allies: T. Wood (S.P.C.K.).—Dandelion Clocks: J. H. Ewing (S.P.C.K.).—Agriculture in some of its Relations with Chemistry, 2 vols.: F. H. Storer (Low).—The Fungus-Hunter's Guide: W. D. Hay (Sonnenschein).—Forestry of West Africa: A. Moloney (Low).—Shores and Alps of Alaska: H. W. Skarr (Low).—The Races of the British Isles (Quaritch).—Rousdon Observatory, vol. iii., Meteorological Observations for the Year 1886: C. E. Peek.—Transactions of the Seismological Society, vol. x. (Yokohama).—New Commercial Plants and Drugs, No. 10: T. Christy.—Quarterly Journal of the Geological Society, vol. xliii., part 2, No. 170 (Longmans).—Bulletin of the American Geographical Society, 1886, No. 3 (New York).

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THURSDAY, JUNE 9, 1887.

THE ZOOLOGICAL RESULTS OF THE "CHALLENGER" EXPEDITION.

Report on the Scientific Results of the Voyage of H.M.S. "Challenger" during the Years 1873-76 *under the Command of Capt. George S. Nares, R.N., F.R.S., and of the late Capt. Frank Tourle Thomson, R.N.* Prepared under the Superintendence of the late Sir C. Wyville Thomson, Knt., F.R.S., &c., and now of John Murray, one of the Naturalists of the Expedition. Zoology—Vol. XVIII. Parts 1 and 2, with a Volume of Plates. (Published by Order of Her Majesty's Government, 1887.)

VOLUME XVIII. of the Zoological Reports of the *Challenger* Voyage well merits to be called enormous, as it contains no less than 1800 pages. It contains but a single memoir, "On the Radiolaria," by Prof. Ernst Haeckel, of Jena, and is accompanied with a volume of 140 plates.

A great work like this demands more than a passing notice, for even in this age of scientific labour one stands amazed at the physical energy, not to refer to the scientific knowledge, that could have accomplished such a result. Ten whole years of the author's life were devoted to this monograph, which will ever be a worthy monument of a most enduring kind.

Some fifty years ago Meyen, and shortly after Ehrenberg, first described some forms of Radiolaria. Meyen has the merit of having observed and noted the first of these curious forms in a living state, but to Prof. Huxley we are indebted for the first accurate observations on some kindred forms met with by him during the voyage of the *Rattlesnake* in the tropical seas. Ehrenberg no doubt was the first to call attention to the exceedingly great numbers of forms that were to be found in the group, but although he was not ignorant of the researches of his colleague, Johannes Müller, whose memoirs were published in the same Academy's Transactions as his own, he never seems to have paid the slightest attention to them, nor does he even allude to the name given to the group by Müller, that of Radiolaria, by which they are now known.

Just twenty-five years ago Haeckel published his well-known "Monograph of the Radiolaria," which with its splendid atlas of plates, was, and is still, an indispensable work for the student. In this all the species known either by figures or descriptions were reviewed, and arranged in 15 families and 113 genera, of which latter 46 were new; the number of forms observed alive amounted to 144, most of which are figured, in a manner that has not, we think, been equalled, certainly not surpassed.

In 1862, Zittel described the first fossil Radiolaria from the chalk; in 1876, John Murray established the family Challengerida; and above all, in 1879, Richard Hertwig showed the essential differences in the formation called the "central capsule," and in accordance therewith divided the Radiolaria into six orders. From this on, with the exception of the various important works on the fossil forms by Emil Stohr, Dante Pantanelli, Butschli, Dunikowski, and D. Rust, the whole record has been filled in by Haeckel, and it has been almost exclusively based on the collections of the *Challenger*.

These Radiolaria, or Capsulate Rhizopoda, form a peculiar class of the Rhizopoda—Haeckel's "Protista." This class is exclusively marine, and, while possessing many of the features of the Rhizopods, differs from them in the possession of a peculiar "membrane" dividing the cell-body into two distinct parts—the "central capsule" or the internal part with the nucleus, and the external part or "extra-capsulum" with the calymma; the protoplasm of both parts communicates through fine pores, which pierce the capsular membrane. The central capsule is composed of three essential parts, viz. the central nucleus, the intra-capsular sarcode, and the capsule membrane. Besides these elements, the central capsule contains very commonly an internal skeleton, fat and pigment granules, crystals, and vacuoli. The outer part of the Radiolarian body is also constantly composed of the calymma, or a thick extra-capsular "jelly-veil." The matrix or maternal tissue of the external protoplasm and the pseudopodia again very commonly contains fat and pigment granules, the skeleton and vacuoli, and, in addition, "xanthellæ" or "zooxanthellæ," peculiar yellow cells which contain starch, and are unicellular yellow Algæ living as "symbiontes" in true symbiosis with a great number of Radiolaria. The skeleton may be either siliceous or acanthinic, and is sometimes wanting. The four sub-classes, as described in this Report, contain 20 orders; and these, 85 families, which include 739 genera, with 4318 species, of which latter 3508 are described as new.

Radiolaria occur in all the seas of the world, in all climatic zones, and at all depths. Probably under normal conditions they always float freely in the water, whether their usual position be at the surface or at a certain depth or near to the very bottom of the sea. Hitherto, no observation has been recorded which justifies the assumption that Radiolaria live anywhere upon the bottom of the sea, either attached or creeping. However able they may be to creep when they fall on a solid basis, they seem normally always to float freely in the water, with pseudopodia radiating in all directions.

As regards their local distribution and its boundaries, the Radiolaria show in general the same relations as other pelagic animals. Since they are only to a very slight extent, if at all, capable of active horizontal locomotion, the dispersion of the different species from their points of development is dependent upon oceanic currents, the play of winds and waves, &c. These passive migrations are here, however, as always, of the greatest significance, and bring about the wide distribution of individual species in a far higher degree than any active wanderings could do. Anyone who has ever followed a stream of pelagic animals for hours, and seen how millions of creatures closely packed together are in a short time carried along for miles by such a current, will be in no danger of under-estimating the enormous importance of marine currents in the passive migration of a marine fauna. The number of cosmopolitan species which live in the Pacific, Atlantic, and Indian Oceans is relatively large. In each of three great ocean basins, too, many species show a wide distribution. On the other hand,

there are very many species which are known only from one locality, and probably many small local faunas exist, characterised by the special development of particular groups. From the very richness of the material, Prof. Haeckel has found it impossible to work out completely the local distribution of all the species.

From the tropics the abundance of species seems to diminish regularly towards the Poles, and more rapidly in the northern than in the southern hemisphere; the latter also appears to possess more species than the former: a limit to Radiolarian life towards the Poles has not yet been found. The greater abundance of Radiolaria in the tropical seas is to be accounted for by the more favourable conditions of existence, rather than by any difference in temperature. One station (271) of the *Challenger* Expedition, situated almost on the Equator, in the Mid-Pacific, exceeds all other parts of the world hitherto known in respect of its wealth of these forms; and more than 100 new species are described from it. The fauna of the Pacific Ocean exceeds that of both the Indian and Atlantic, but the fauna of the Indian Ocean is that least known.

In reference to the bathymetrical distribution, it seems certain that numerous species of this class are found at the most various depths of the sea, and that certain species are limited to particular vertical zones, and are adapted to the conditions which obtain there. In this respect three different Radiolarian faunas may be distinguished—the "pelagic," "zonarial," and "abyssal." More than half of all the species known as recent belong to the last fauna.

The chapter on the geological distribution is full of interest. Radiolaria are found fossil in all the more important groups of the sedimentary rocks of the earth's crust. Whilst a few years ago their well-preserved siliceous skeletons were only known in considerable quantity from Tertiary marls, very many are now known to occur in Mesozoic, and a few in Palæozoic, strata. By the aid of improved modern methods of research, it has been shown that many hard siliceous minerals, especially cryptocrystalline quartz, contain numerous well-preserved Radiolaria, and sometimes these are composed almost entirely of closely compacted masses of such siliceous shells. The Jurassic quartzes (Switzerland), as well as the Tertiary marls (Barbados) and clays (Nicobar Islands), may be regarded as "fossil Radiolarian ooze"; and, since specimens have also recently been found both in Silurian and Cambrian strata, it may be inferred that Radiolaria are to be found in all fossiliferous sedimentary deposits, from the oldest to those of the present day. Among the Miocene Radiolaria, numerous species are not to be distinguished from the corresponding still living forms. On the other hand, those genera which are rich both in species and individuals (recent as well as fossil) present continuous series of forms which lead gradually and uninterruptedly from old Tertiary species to others still living, which are specifically indistinguishable from them

As Chapter XI. of the introductory portion of the Report, Prof. Haeckel gives a very valuable account of the progress of our knowledge of the Radiolaria from 1862 to 1885. In his earlier monograph he had already given a critical discussion of the works which had appeared prior to 1862: we find here a full list of the publications from 1834 to 1884, in which list a little of the author's old trenchant style of criticism breaks out; for he has heaped together in an appendix, to which he gives a somewhat needlessly offensive name, "all the absolutely worthless literature, which contains either only long-known facts or false statements, and which may therefore be entirely neglected with advantage." While we would not, for all the Radiolaria in the sea, give the list of this "foul" literature, we may relieve the reader's mind by at once mentioning that the name of Ehrenberg does not appear in it, and that the value of the laborious works of the great but too self-reliant German in this field meets with all proper appreciation.

The unicellular nature of the Radiolaria was first established by Richard Hertwig in 1879, and was brought by him into conformity with our present histiological knowledge and the new reform of the cell-theory. Huxley, who was the first to examine living Radiolaria with any accuracy, declared, so long ago as 1851, that *Thalassicolla nucleata* was a unicellular Protozoon. Later, both Johannes Müller (1858) and Haeckel (1862), recognising the peculiar "yellow cells" which occur in many Radiolaria, in large numbers, as true nucleated cells, thought it impossible to maintain this view; and it was not until Cienkowski (1871) and Brandt (1881) had shown that these "yellow cells" did not form part of the Radiolarian structures, but are symbiotic unicellular Algæ, that it was possible to revive and demonstrate anew the unicellular nature of the Radiolaria.

From a morphological stand-point the individuality of the unicellular elementary organism is obvious in the solitary Radiolaria (Monobia); and the whole body with all its constituent parts, and not merely the central capsule, is to be looked on as a cell. But this unicellular organisation must be noted as differing from that of all other Protista, inasmuch as an internal membrane (capsule membrane) separates a central from a peripheral portion.

The membrane of the central capsule is invariably present at one period or another of the life of the organism. Karl Brandt, indeed, has recently stated that in some forms it is absent; but Haeckel has recognised its presence in over one thousand species, and even in some of those in which Brandt was unable to find it. It is often very delicate and may easily be overlooked, though the application of the proper reagents will render it always discernible. Those Radiolaria in which for a time it is absent are young of species in which the membrane is only formed immediately before sporification, and persists but for a short time.

All Radiolaria possess a nucleus, but they present two different conditions in respect of its behaviour, since in their young stages they are uninuclear, and in later stages they are multinuclear. Before the formation of swarm-spores the nucleus divides into many nucleoli. Thus the nucleus is pre-eminently the organ of reproduction and inheritance. The division of the originally single nucleus into many small nuclei may take place at very different periods, so that Haeckel divides the Radiolaria into the "precocious" and the "serotinous." Into the subject of the skeleton formation and that of phylogeny the space at our command will not allow us to enter; it will suffice to say that they are treated at great length and with consummate skill.

In such an onerous task as that of describing this mass of varied forms, one always, as the author observes, "runs the risk of either doing too much or too little in the way of creating species"; but he contents himself with the reflection that in the light of the theory of descent this danger is of little consequence.

In the carrying out of the troublesome duty of making the many thousands of required measurements, the author gratefully thanks his friend Dr. Reinhold Teuscher, of Jena, for the patient and careful manner in which he performed this part of the work. The figures of new species, about 1600 in number, which appear in the atlas accompanying the Report, were nearly all drawn with the camera, partly by Mr. A. Giltsch and partly by Prof. Haeckel; but the former has drawn all the figures on the stone in a very masterly way, so that the illustrations present a splendid series of beautiful forms, like the stars in the firmament for number, and surpassing these in the wonderful diversity and complexity of their outlines.

It was indeed a fortunate circumstance that so distinguished a naturalist, with such an intimate knowledge of the Radiolaria, should have been willing to undertake such a task, and exceedingly fortunate for science that he should have been enabled thus to finish it.

A GERMAN TREATISE ON THE VEGETABLE KINGDOM.

Die natürlichen Pflanzenfamilien. Von A. Engler und K. Prantl. (Leipzig: Engelmann, 1887, &c., being issued in numbers at irregular intervals.)

WITH the first three numbers of the above-named work, which are now before us, Profs. Engler and Prantl have embarked on an enterprise of some magnitude. The editors, having recognized the want of a comprehensive treatise, in German, on the Vegetable Kingdom, which should at once be scientifically sound, and yet be written in a style suitable for the use of those who are not professed botanists, have determined to meet that want. With this object they have enlisted the assistance of a number of collaborators: anyone who is conversant with the literature of Botany produced in Germany in recent years will see, on reading the list of names, that Dr. Engler has secured the co-operation of a very powerful staff, including many of the most prominent representatives of the science in that country. With their aid the editors propose to produce a work, according to some 5000 pages octavo: the whole is to be divided into five parts, one of which will be devoted to the Cryptogams, under the editorship of Prof. Prantl; one will treat of the Gymnosperms and Monocotyledons, and the remaining three of the Dicotyledons, under the editorship of Prof. Engler. The production of the several parts will proceed simultaneously, and they will appear in numbers, at intervals during the next five or six years: thus the distribution of the cost (which in itself is not excessive, considering the quality and extent of the work) over a lengthened period, will bring the book within the reach of a wide constituency.

The first three numbers will give some idea of what will be the scope and character of the work as a whole. One of these is the first instalment of the *Palmæ*, by Dr. Drude. It opens with twenty-six pages of text, illustrated by numerous carefully chosen and excellent woodcuts, on the morphology and anatomy of the vegetative organs, the inflorescence, fruit, and seed of the plants of this order; then follow notes on the distribution, affinities, and uses of the family, and finally its classification. A detailed description of the genera succeeds this general treatment, and it is illustrated by numerous good figures representing the habit of the plants, and dissections of their flowers: this will, in fact, be somewhat like an illustrated and abbreviated "Genera Plantarum," written in German, and in a semi-popular though sound style.

The second number issued contains the *Juncaceæ*, by F. Buchenau, and the *Stemonaceæ* and *Liliaceæ* by Dr. Engler. The subject-matter is treated in the same spirit as the above, and it may be assumed that this method will be pursued throughout the whole work.

But a more special interest attaches to the number which was third in its order of issue; and that on two distinct grounds: first, because from it we gain a more general idea of the plan and scope of the work, and secondly because it is chiefly the work, and probably the last work, of the late Prof. Eichler, a botanist whose loss will be very widely felt (see NATURE, vol. xxxv. p. 493).

The first pages of this number, written by Dr. Engler, give in brief the general plan of the whole work; the main lines of classification being those in common use, though some of the terms used have not as yet been generally accepted. They are as follow:—

I. Mycetozoa.
II. Thallophyta:
  (*a*) Schizophyta.
  (*b*) Algæ.
  (*c*) Fungi.
III. Embryophyta zoidiogama (= Archegoniatæ):
  (*a*) Bryophyta.
  (*b*) Pteridophyta.
IV. Embryophyta siphonogama (= Phanerogamæ):
  (*a*) Gymnospermæ (= Archispermæ).
  (*b*) Angiospermæ (= Metaspermæ).

Then follows the general treatment of the Gymnospermæ, of which four classes are distinguished, the Cycadinæ, Cordaitinæ, Coniferinæ, and Gnetales. It is worthy of note that here the fossil forms are taken into account, and Cordaitinæ, as well as fossil forms of the Cycadaceæ and Coniferæ, are described in their proper places. It will be unnecessary after what has already been said to follow the mode of treatment of the Gymnosperms further; suffice it to say that, while due prominence is given to the external morphology and classification, the results of recent investigation on the development of the sporangia and embryo find a place, *e.g.* those of Treub and Warming on the Cycads, and of Strasburger and others on the Coniferæ. A peculiar interest will attach to the pages on the morphology of the female cone in the Coniferæ, since this will be the last expression of the opinion of Eichler on a subject to which he had devoted special attention.

While extending a welcome to this new enterprise, we may compare it with other undertakings of a somewhat similar nature. Among the comprehensive classificatory works of recent years, the most prominent is

the "Genera Plantarum" of Bentham and Hooker; but the most ardent admirers of that solid book could not expect it to appeal to the laity: it is designed for the use of specialists, and they alone will use it. Between this and the illustrated text-books intended for students there has been hardly any intermediate in this country, though Lindley's "Vegetable Kingdom," a book which still holds its place as a classic, served in the past a part not altogether unlike that which Dr. Engler's book may be expected to serve in the future. It is, however, in France that the nearest approach has been made to the idea of Dr. Engler. In the "Traité de Botanique" of Le Maout and Decaisne we have a volume profusely illustrated, and dealing with the vegetable kingdom as a whole: the English translation of this, edited by Sir J. D. Hooker, is familiar to all British botanists. Again, the "Histoire des Plantes" of Baillon, which is still in progress, is a classificatory work of large size, well illustrated as regards external morphology, but somewhat deficient in description of the internal details: his "Dictionnaire de Botanique," which commenced in 1876, is also still in progress, and covers, in dictionary form, much the same ground as his "Histoire." These are, then, the chief illustrated and descriptive works with which Drs. Engler and Prantl will have to compete. If we may judge from the first three numbers, the competition, though keen, will be in favour of the new enterprise, and that chiefly on the ground that the authors of it take a more general view of the subject. They do not confine their task to the description and delineation of external form, classification, and distribution. While giving due prominence to these branches, they also incorporate the results of recent investigations of anatomy and development. F. O. B.

OUR BOOK SHELF.

Nomenclature of Colours for Naturalists, and Compendium of Useful Knowledge for Ornithologists. By Robert Ridgeway, Curator, Department of Birds, United States National Museum. Ten coloured plates, and seven plates of outline illustrations. (Boston: Little, Brown, and Co., 1887.)

THIS will be a very welcome volume to naturalists in general, and ornithologists in particular. We do not know that everybody will agree with the principles laid down by the author, but he has, at all events, brought together a considerable number of colours, and given them very definite names for purposes of comparison, and a mere glance at the coloured plates will show how very important it is that every variety of green shown in Plate 10, for instance, should have its special name and admit of easy reference.

The comparative vocabulary of colours, which occupies a considerable proportion of the first part, is also a very valuable combination, and should be in the hands of naturalists of all civilized countries, as we get the English, Latin, German, French, Spanish, Italian, Norwegian, and Danish equivalents of all the colours shown in the coloured plates, and a great many more.

The *pièce de résistance* in the part of the volume which has been prepared chiefly for the use of ornithologists is a glossary of technical terms. It seems to us to have been very carefully done. A study of the plates illustrating the various feathers of birds, and the various birds' eggs, with the attached nomenclature, is certain to lead to a gradually increasing care in description. There is no doubt that the book will prove of very great value to many naturalists.

English Tobacco Culture, &c. Edited by E. J. Beale, F.L.S. (London: E. Marlborough and Co., 1887.)

THIS little book will serve as an important guide to farmers in conducting experiments in the cultivation of tobacco. It gives a detailed account of the origin of the movement for determining whether tobacco could be relied upon as a farm crop in Great Britain, and, if so, whether it could be cultivated to yield a profit to the grower. These two questions, it is maintained, have been answered in the affirmative by the results of last year's experiments, but this conclusion is founded more upon the appearance of the plants than upon actual results in the production of good commercial tobacco.

Seventeen varieties of tobacco were grown last year in this country, and a full description is given of the plants of each variety, with well-executed illustrations, showing the general appearance and distinctive features of the fully-developed plants. For each description of tobacco grown an "Estimated Balance Sheet" has been prepared, and the anticipated profit, amounting in some cases to as much as £25 and even £27 per acre, is very encouraging for farmers who may think of undertaking experiments in tobacco cultivation.

Perhaps the most useful part of the book is that devoted to directions for conducting the several operations of tobacco culture. These include the preparation of the land; the sowing of the tobacco seed; the transplanting of the young seedlings; the transferring of the plants to the prepared ground; and their subsequent treatment until finally harvested and cured. Altogether the book is prepared with great care, and its publication at the present time is very opportune.

Life of Charles Darwin. By G. T. Bettany. (London: Walter Scott, 1887.)

THIS is one of the series of volumes entitled "Great Writers." It was not to be expected that Mr. Bettany would be able to tell us anything absolutely new about the illustrious man of science concerning whom so much has already been written. He has, however, succeeded in presenting in a bright and attractive style the leading facts of Darwin's career, and he has done good service by taking pains to show that Darwin was not only a great thinker and discoverer, but a man of a singularly pure and noble character. Mr. Bettany's exposition of the results of Darwin's labours is brief, but clear and accurate, and he tries to mark as distinctly as possible the various stages in the process by which the theory of evolution as Darwin conceived it was itself evolved.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Thought without Words.

MAY I demur to the Duke of Argyll's statement that monkeys and dogs have no true reasoning powers? Long and careful attention given to the action of animals consequent on true reasoning power, has led me to an opposite conclusion. I do not trouble you with instances, or could give very many; and I have frequently seen reasoning power exercised after obvious thought over the best course to pursue. Then, *are* animals speechless among themselves? I think not, and believe they speak freely to one another at needed times, in their own language. And I certainly with my own domestic animals can understand in a certain sense their language. I clearly know

what they ask for, or what they wish to call my attention to, from the tone of the voice and its modulations, and this is, I assume, language as regards them. On the main question, I should hold with Prof. Max Müller from my own personal experience. H. STUART WORTLEY.

South Kensington Museum, May 21.

I HAVE just noticed in a recent number of NATURE (May 12, p. 28) a letter from Mr. Francis Galton, in which he endeavours to prove that thought without words is by no means an impossibility. May I advance a small amount of confirmatory evidence which must, I think, have come within the notice of most people? This evidence is to be found in that peculiar state of mind produced when, as we say, we have a word "on the tip of the tongue." In this case the *idea* which the word, when found, will represent is most vividly present to the mind, but it is an idea only. No language is needed to make it recognizable even though, as often happens, the idea may be of the most complicated and abstract kind. HAROLD PICTON.

May 31.

Diatoms in the Thames.

IN NATURE, vol. xxxii. p. 223, you were good enough to publish a note from me respecting the occurrence in great profusion of small gelatinous bodies in the water surrounding the Isle of Sheppey. The same conditions prevailed at about the same time last year, and in all probability will reappear at the latter end of this month.

I have now to record that since the middle of April the sea hereabout has been what fishermen call "foul" from another cause. While the water has been unusually clear, in it have been floating an enormous quantity of diatoms. The most abundant is *Coscinodiscus concinnus*, the large disks of which can be seen by the naked eye in any sample of sea water dipped at random. Indeed in bright sunlight they can easily be observed in the sea itself. The other forms are *Rhizosolenia setigera*, and *Eucampia zodiacus*.

At low water the sands lying between the Thames and the Medway have been coloured a rich dark brown by the diatoms left stranded there.

The effect on marine life seems to have been somewhat varied. Mollusks appear to have thriven on the abundant food; and as shrimps and whitebait have been found in abundance in their usual haunts, it may be presumed that they have not been much annoyed by the diatoms. On the other hand, the flat fishes have been greatly disturbed, and could not be found on the banks usually frequented. Some fishermen said they had gone right away, and would not return till the water ceased to be "foul." Yet this could hardly have been the case, as some have since been caught on the Essex flats gorged with young cockles.

During the past fortnight I have examined the water at various points around Sheppey, and have invariably found the diatoms. In using the tow-net during this period, I have been struck by the scarcity of animal life. Besides the diatoms, a few Noctilucæ, larval Spios, and two Isopods were all that I noticed. That at least some diatoms are obnoxious to fish was settled by Mr. Pearcey, who, in conducting tow-netting investigations in the Shetland Isles in 1884, found that in regions where large floating banks of the diatom *Rhizosolenia shrubsolii* (Cleve) occurred animal life was almost entirely absent; and Mr. Isaac C. Thompson, of the Liverpool Marine Biological Society, has recorded a somewhat similar experience in 1885 off the North Wales coast.

It will be interesting to ascertain from which direction these countless myriads of diatoms have reached the Thames, and within what limits they have been found. To this end I invite observers round the British coast to examine the water in their respective localities, and to publish the result.

In water obtained from the coast of Holland I could not detect a single diatom.

I have reason to believe that an abundant influx of the same character has taken place in previous years, but coming at a time of year when the weather is not often favourable for conducting marine observations, the facts have escaped scientific notice. W. H. SHRUBSOLE.

Sheerness-on-Sea.

P.S.—The above was written about a fortnight ago, and now (May 18) the gelatinous masses are beginning to appear.—W. H. S.

The Structure of the Nostochineæ.

I WAS glad to see in NATURE, vol. xxxv. p. 594, a suitable notice of Prof. Borzi's very interesting paper on the above subject. So far as regards the discovery of the continuity of the protoplasm in this group of plants, I should like to be allowed to state that in my paper "On the Constitution of the Cell-wall and Middle Lamella," read February 10, 1884, and published in the Proceedings of the Cambridge Philosophical Society, vol. v. part ii., I drew attention to the fact that in *Nostoc* I had observed a continuity of the protoplasm between adjacent cells. But I simply stated the bare fact, and my note was therefore even more pronouncedly "una brevissima comunicazione" than that of Wille's on *Stigonema*, to which Prof. Borzi refers.

Clare College, Cambridge. WALTER GARDINER.

Curious Phenomenon in Capillarity.

FOR some years past I have been in the habit, when putting up at obscure hotels and remote "dák bungalows" during inspection tours, of putting a few drops of the cheap disinfectant known as "Little's soluble phenyle" into my tub before bathing. The bulk of the liquid, when dropped into clear water, diffuses downwards as a milky white emulsion, giving beautiful imitations of inverted cumulus clouds; but a small portion of it, perhaps some oily impurity in the mixture (which is sold under the trade mark C_6H_5, and should therefore presumably be a definite compound), instantly spreads out over the surface as a drop of oil would do, and then, strange to say, after the lapse of about half a second, and usually before the film has extended more than half-way across the tub, it again contracts. The contraction of the film proceeds until it is only two or three inches in diameter, after which its size appears to remain stationary; but about this time the distinct outline of the film usually disappears, owing to the gradual mixing of its substance with the water below—a circumstance which leads me to believe that the film is not caused by an oily impurity, but by a part of the "phenyle" itself, which possesses the property of emulsifying with water. Temperature seems to have no effect on the phenomenon, beyond perhaps modifying the rate at which the film expands and contracts, the effect being apparently exactly the same whether the liquid be added to a cold bath at 60° or to a hot one at 100° F.

Have any of your readers observed this phenomenon, or can anyone give a satisfactory explanation of it? According to the usual theory of the subject, the surface-tension of water in contact with air is greater than the tension of a phenyle-air surface *plus* that of a phenyle-water surface, and hence the film of phenyle spreads like one of oil. But after a time, when the phenyle gets partially emulsified, the sum of the tensions of the two phenyle surfaces must be greater than that of the water surface to make the film contract, and apparently after some further time a condition of equilibrium is established. Is there anything in the process of emulsification, or dividing a liquid up into minute globules suspended in another liquid, that will account for these changes of surface-tension?

Naini Tal, India, May 2. S. A. HILL.

Sense of Taste or Smell in Leeches.

I HAVE recently observed very well marked phenomena, similar to those described by Dr. C. O. Whitman (*Quart. Journ. Micro. Science*, vol. xxvi. new series, p. 409). I picked up with my fingers a stone from the soft muddy bottom of a shallow, torpid stream. Returning to the same spot a few minutes afterwards, I noticed a number of leeches (apparently *Hirudo* sp.) swimming near the spot. On the following day, suspecting that they had "smelt" or "tasted" my hand in the water, I first stirred the surface of the mud with a stick, but no leeches appeared; after the water was clear again I "washed my hands" in the water without disturbing the mud, and very soon a number of leeches came up and swam about. The soft mud in which they live is about a foot deep, and although the disturbance of the surface mud with a stick was not sufficient to bring them out, the "smell" or "taste" of my hands seems to have spread down and extended over an area of more than a yard.

Last year I had an opportunity on these hills of observing the very keen "scent" of the land leeches, who will come towards one's self or one's horse from the banks on either side of even a wide road. A. G. BOURNE.

Ootacamund, Nilgiris, April 11.

Lisping.

A CLERGYMAN, with usually an exceptionally distinct utterance, was observed one Sunday morning at the beginning of the service to speak with a pronounced lisp. After a time it wore off, and his speech became as clear as usual. Has it ever occurred to anyone what a very simple thing may cause a lisp? The case in question was owing to a tiny slice of lozenge sticking to the roof of the mouth just to the left of, and close to, the front tooth. This almost imperceptible impediment was sufficient to render the speech so indistinct as to resemble a marked lisp. Of course as the lozenge dissolved the lisp became no longer observable, and the speech assumed its ordinary clearness.

These being the facts, the question that occurs to every thoughtful mind is, If the cause of lisping be so simple, why cannot the remedy be as simple and yet effectual?

The answer I leave to be supplied by some of your scientific readers. A NON-LISPER.

ETIOLOGY OF SCARLET FEVER.[1]

AMONG the infectious or zymotic diseases there are two at any rate (namely, scarlet fever and diphtheria) of which it may be said that their spread is to a lesser extent dependent on defective domestic sanitation than is the case with some of the other zymotic diseases, as, for instance, typhoid fever. Indeed, it is maintained by competent authorities that scarlet fever and diphtheria do not invade the houses of the poor with faulty sanitation with greater frequency or with greater severity than those of the well-to-do, however perfect the sanitary arrangements. This view is based on the important experience gained during the past twenty years, viz. that epidemics of scarlet fever and diphtheria have been brought about by milk. I may here state by way of explanation that a fact well established, and needing no further comment, is that scarlet fever and diphtheria are, like small-pox, measles, whooping-cough, and typhus fever, communicable directly from person to person. This mode of infection, doubtless an important one, and coming into operation in single cases wherever the elementary rules of isolation and disinfection are transgressed, altogether sinks into insignificance when compared with the infection produced on a large scale, if a common article of diet like milk should become in some way or another the vehicle of contagium, as has been proved to be the case in a number of epidemic outbreaks. These epidemics, known as milk scarlatina, milk diphtheria, and I may add also milk typhoid, have this in common, that almost simultaneously, or at any rate within a short time, in a number of houses, having no direct communication by person or otherwise with one another, there occur sometimes singly, sometimes in batches, as it were, cases of illness: scarlet fever, diphtheria, or typhoid fever as the case may be. And it was this peculiar character which pointed to a condition which must have been common to all these households. On closer examination it was indeed found that all these households had this, and only this, in common, that they were all supplied with milk coming from the same source—that is to say, from the same dairyman. Other houses supplied with milk from a different source escaped; and further it was shown that, as soon as the consumption of the suspected milk ceased also, the epidemic, as such, came to an end, except of course the cases due to secondary infection from person to person. The Medical Department of the Local Government Board have had for years past their attention fixed on these milk epidemics, and in the Reports of the Medical Officer many of these are described with great detail; amongst these, Dr. Ballard's Report in 1870 on enteric fever in Islington, Dr. Buchanan's in 1875 on an outbreak of scarlet fever in South Kensington, and Mr. Power's on an outbreak of scarlet fever in St. Giles and St. Pancras in 1882, are specially to be referred to. Mr. Ernest Hart has tabulated all the outbreaks of milk epidemics that have been investigated until 1881, in vol. iv. of the Transactions of the International Medical Congress for 1881. Now, analyzing these outbreaks as far as they refer to scarlet fever, there are several of them where the assumption that the milk acquired the power of infection by contamination from a human source cannot be excluded. This infection if proven would stand on the same footing as if due to contagion from person to person, for it is clear whether the contagium is conveyed from one person to another by air, food, drink, or other articles, it always remains contagion from person to person. Now, in some of the epidemics tabulated by Mr. Hart, and recorded by subsequent observers, *i.e.* after 1881, this mode of milk contamination cannot be excluded, as I said before; but comparing the dates when the milk might be supposed to have become so contaminated with the dates when the milk has actually produced infection, it will be found that a certain discrepancy exists, and as will be shown later another mode of infection, viz. from a person affected with scarlatina to the cow, and through the cow to the milk and then to human beings, cannot be excluded either. There are other epidemics recorded in these tables, in which the mode of infection of the milk is not ascertained; and in a third set, the milk acquired infective power in some way or another, but certainly not from a human source. As an illustration of the first group of epidemics, *i.e.* probable contamination from a human source, I will refer to the table given by Mr. Ernest Hart on page 539:—

1881, April.	Keswick.	J. Robertson, M.D., M.O.H.	A dairy closely adjoined a house where scarlet fever had existed for several weeks. The cows were milked, every night and morning, into an open tin can carried across an open yard past the affected house.	The children who first caught scarlet fever in the locality played about the yard whilst in a state of desquamation.	On one particular day a general epidemic of scarlet fever broke out in the town, between thirty and forty families being invaded. All those suffering from the disease received their milk-supply from this particular dairy-farm. Some member of every family supplied had either a scarlatinal sore throat or scarlet fever on this day. Other families supplied from a different source escaped the disease.	A lodger had the milk raw for supper and was attacked. His landlady boiled her milk the same night and escaped.

[1] Lecture delivered by Dr. E. Klein, F.R.S., at the Royal Institution on Friday, May 27, 1887.

Now, mark this, that on one particular day the fever broke out. We will return presently to this point.

As an illustration of the second kind (viz. probably not from a human source), I will refer to the outbreak of scarlet fever in Oxford in the spring of 1882, recorded by Dr. Darbishire in the St. Bartholomew's Hospital Reports, vol. xx.

The substance of Dr. Darbishire's Report is this:—Three cows were kept by those who sold the milk, and nine houses, containing eighty-five persons in all, were supplied morning and evening; the milk was never stored, as there was generally barely enough at each milking for all the customers. In the house to which the cows and paddock belonged, there was a case of diphtheria in a young lady. She was removed to the infirmary on March 1. The cowman had a child ill with scarlet fever in his cottage from February 27 till March 3. On March 3, Dr. Darbishire had this child removed to the hospital and the cowman's cottage thoroughly disinfected; the cowman left his cottage to sleep in lodgings near, the care of the cows having been handed over to another man, engaged for that purpose. Now, if the milk had become infected from either of these two cases (one diphtheria and the other scarlet fever), this must have occurred for the first before March 1, for the other before March 3; and as the period of incubation of scarlet fever is known to be as a rule less than seven days, it follows that March 3, being the last day on which the milk could have received the contagium from a human being, March 10 would be the last day on which scarlet fever could have been produced by that milk, and the majority of cases of scarlet fever must have occurred before that day, as one cannot assume that in all these cases the period of incubation was protracted to such length as seven days. But mark what really did happen. Dr. Darbishire states that no case occurred till March 10, on which day 2 cases of sore throat and 1 case of scarlet fever occurred; on March 11, 1 case of sore throat; March 12, 2 of sore throat and 1 of scarlet fever; March 13, 4 of sore throat and 2 of scarlet fever; March 15, 1 of sore throat and 1 of scarlet fever; March 16, 2 of sore throat and 1 of diphtheria; March 17, 1 of sore throat; March 18, 1 of sore throat.

Now, all these cases were proved by Dr. Darbishire to have been caused by that milk. There occurred subsequently other cases, but these were traced to have been due to secondary infection from person to person.

This is a good illustration of a milk epidemic, in which the milk most probably did not receive the contagium by human agency. And there are other milk epidemics which on analysis of dates lead to the same conclusion. The infection of this milk was probably brought about as I shall show you hereafter in some other way.

As an instance of the third kind, viz. where milk has clearly not been infected from a human source, I will refer to Mr. Power's Report in 1882 on an epidemic outbreak of scarlet fever in St. Giles and St. Pancras. "The disease was distributed with a milk service derived from a Surrey farm. In this case two facts could be affirmed: the one that a cow recently come into milk at this farm had been suffering from some ailment, seemingly from the time of her calving, of which loss of hair in patches was the most conspicuous manifestation; the other that there existed no discoverable means by which the milk which had coincided with scarlatina in its distribution, could have received infective quality from the human subject." (Medical Officer's Report for 1885-86, pages v. and vi.)

The Medical Department of the Local Government Board, have from these facts drawn the conclusion that "distrust must be placed on the universally accepted explanation that milk receives infective properties directly by human agencies," and further that "the question of risk from specific fouling of milk by particular cows, suffering, whether recognized or not, from specific disease, was seen to be arising." This view received striking confirmation and proof by a report of an outbreak of scarlet fever that occurred at the end of 1885, and the beginning of 1886, in the North of London, which was investigated by Mr. Power; his report is published *in extenso* in the Report of the Medical Officer of the Local Government Board for 1886. I will here give you the substance of it. Mr. Wynter Blyth, Medical Officer of Health for Marylebone, "had last December observed a sudden outbreak of scarlatina in his district to be associated with the distribution of milk coming from a farm at Hendon, and had found reason for believing that the disease had prevailed exclusively amongst customers furnished with milk from that source." Mr. Power on a more extended inquiry found that a similar prevalence of scarlatina had occurred about the same time in other parishes in and near the metropolis that were furnished with milk from the same farm. By careful inquiry, Mr. Power could with certainty exclude any contamination of the milk from a human source, or that anything of the kind known as "sanitary" conditions could have had any concern with the infectivity of the milk. Mr. Power showed conclusively that only certain sections of the milk-supplies of this farm, and finally only certain cows from which these sections of milk were derived, had any relation to the observed results. "In the end," says the Medical Officer, "he has demonstrated, beyond reasonable doubt, the dependence of the milk scarlatina of December on a diseased condition of certain milch cows at the farm—a condition first introduced there in the previous month by some animals newly arrived from Derbyshire; and he finds strong circumstantial evidence for believing that the later phenomena of this dependence were brought about through the extension of the diseased condition of one set of animals to another set, after the fashion of an infection."

Now this disease, as it presented itself in some of these Hendon cows, consisted in the presence of sores in different parts of the skin with loss of hair in patches, ulcerations on the udder and teats, and a visceral disease, notably of the lungs, liver, kidney, and spleen, which, although milder in character, very much resembled the visceral lesions occurring in cases of human scarlet fever. By experiment it was shown that the matter of the ulcers of the udder is possessed of infective power, inasmuch as on inoculation into the skin of calves the same ulcers are reproduced; further, it was shown that in the ulcers of the cow there existed in large numbers a species of micrococcus, which, on being planted on artificial nutritive media, such as are used for the study of bacteria, produces in a few days a crop of micrococci, possessed of very distinct characters by which they are distinguishable from other bacteria.

When calves are inoculated from a cultivation of this micrococcus, they become, after an incubation period, affected with a cutaneous and visceral disease the same as the disease of the Hendon cows. From the blood of these animals the same microbe was recovered by cultivation.

To sum up, then, it has been shown that at this Hendon farm there existed certain cows affected with a communicable disease which, in many points of its pathology, bears a great resemblance to human scarlatina; further, that the milk of these cows gave scarlet fever to human beings; and, lastly, that a particular microbe was obtained from these cows, which in calves produced a disease similar to the one from which those cows were suffering. In order to complete the evidence thus far obtained, it was necessary to prove that scarlet fever in man is due to the presence and multiplication in the blood and tissues of the same micrococcus, and that this microbe, if obtained from human scarlet fever, produces in the cow the same disease as is produced by the micrococcus of the Hendon cows. Now, this proof has been satisfactorily given. In the first place, it has been shown that in the blood and

tissues of persons affected with scarlet fever there occurs the same micrococcus as was present in the cow, both being identical in microscopical and in cultural characters. In the second place, it was found that the action of this microbe on animals is exactly the same as the micrococcus found in the Hendon cows. Calves and mice, after inoculation or feeding with a trace of the growth of both sets of micrococci, become affected with cutaneous and visceral disease similar to human scarlet fever; in calves, the disease is of the same mild type as in the Hendon cows. I have lately ascertained that milch cows inoculated with the human scarlet fever micrococcus developed readily a disease identical in every respect with the Hendon disease, inclusive of the ulcers on the teats, and the sores and loss of hair in patches in different parts of the skin. Further, it was shown that from the blood and the tissues of these animals infected with one or the other set of cultivations, the same micrococcus was recovered. I will remind you that, in all infectious diseases which have been proved definitely to be associated with a particular species of microbes, this microbe introduced into a susceptible body thrives and multiplies, and thus sets up the diseased condition, differing of course with the different species of microbes. I think I may after this say that this microbe, *Micrococcus scarlatinæ*, is the cause of human scarlet fever; further, that it produces in bovine animals a disease identical with the Hendon disease and human scarlet fever, and that consequently, while the cow is susceptible to infection with human scarlet fever, it can in its turn be the source of contagium for the human species, as was no doubt the case in that milk epidemic from the Hendon farm.

I shall now give a striking piece of evidence well in harmony with what I have mentioned hitherto. In October 1886, Prof. Corfield forwarded to me certain tins of condensed milk, sold under the name of "Rose brand." This milk was under suspicion of having produced scarlet fever in a number of persons that had partaken of it. From one out of three tins of this condensed milk, I have obtained by cultivation a microbe which in every respect, morphologically and in cultures, is the same as the microbe obtained from the Hendon cows and from human scarlet fever. The action of the microbe of the condensed milk was also tested on animals, calves and mice, and it was found that it produced the identical disease that was produced by the microbe of human scarlet fever, and of the Hendon cows. I may add that this Rose brand of condensed milk is, like all condensed milk, obtained from cows' milk. The Rose brand is a cheap article, and meant for the poorer classes; probably it has not been sufficiently heated in the tins before sealing the latter; that this is so can be inferred from the fact that every tin of this brand which I opened contained some organisms. Thus, for instance, I find that one tin contained the scarlet fever microbe and another species of micrococcus; another tin contained a harmless species of micrococcus only; and a third tin opened contained a micrococcus and a species of bacillus.[1]

Another piece of interesting evidence concerning the *Micrococcus scarlatinæ* is this: there occurred during the beginning of this year a severe epidemic of scarlet fever in Wimbledon. This epidemic was also traced to milk coming from a particular farm. In one of the houses supplied with this milk there occurred cases of scarlet fever amongst human beings, and at the same time a pet monkey, who also consumed a good deal of the milk, became ill; it died after five days. I had the opportunity to make a *post-mortem* examination of this animal, and there could be no doubt about its having died of scarlet fever. From the blood of this monkey I obtained by cultivation the same micrococcus as was obtained from human scarlet fever, from the Hendon cows, and from the condensed milk. Experiments made on animals with this micrococcus of the Wimbledon monkey showed that the same disease is produced both by inoculation and by feeding.

It having been proved, then, that the cow is susceptible to infection with scarlet fever from man, the next important question is this, How does the milk of such infected cows assume infective power? Clearly in one of two ways: first, either the milk becomes infected by the milker during the process of milking, particles of contagium being rubbed off the ulcers of the udder or teat; or, the milk *per se* is possessed of infective power—that is, it being a secretion of a constitutionally diseased animal. From previous and from more recent observations, I am inclined to think that both views hold good.

I now come to the question, How is the spread of scarlet fever by milk to be controlled and checked? This question resolves itself into three parts. First, prevention of infection of the cow by man, directly or indirectly; second, prevention of infection of the cow by the cow; and third, destruction of the contagium of the milk of such cows.

As regards the first, all those rules which have been laid down to prevent infection of one human being from another, of milk or any dairy utensil by contact or otherwise with a person suffering from scarlet fever or coming from an infected house, apply also here; and this part of the subject comes under the general aspect of the proper sanitary management of dairies, which is acted upon in all well-managed dairies.

As regards the second, viz. prevention of infection of the cow from the cow, this is obviously more important and more difficult to be carried out. I say obviously, because one cow affected with the disease is capable of communicating it to others in the same farm, and when moved to another farm also to the cows there.

The disease in the cow being of a mild character is easily overlooked. The disease in the skin of the cow may be present and slight, or may be absent in its more conspicuous manifestation, whereas the visceral disease is of so mild a character that it requires an expert to diagnose it. When a cow shows the disease of the skin and on the udder well pronounced, such an animal will have to be carefully examined for visceral disease. I need hardly say that amongst the many cutaneous disorders of the cow, known and unknown, there may be one or the other which bears a resemblance to the cutaneous disorder occurring in scarlatina; such cutaneous disease must be carefully excluded before an animal is condemned; but, if visceral disease should be diagnosed as well, the animal should be carefully isolated and its milk should not be used. And it must be clear from this that every dairy should be permanently under the supervision of an expert, and in this the veterinary profession should be as eager for the work as the medical sanitary officers are, and for some time past have been. But judging from the attitude assumed by the veterinary authorities I am afraid the veterinary profession has not yet grasped the full responsibility that rests on them, both towards the general public and the dairy farmers. Instances are on record, when, on the milk from a particular farm having been proved or even suspected to bear any relation to a scarlet fever epidemic, the business of such farm became temporarily or even permanently suspended, and the pecuniary loss of the owner of such farm irrevocable. That the disease in the cow which I have described to you as scarlet fever is as yet unknown to the veterinary profession does not do away with the existence of such disease, and I venture to say that the fact of its being as yet unknown to and unrecognized by them should stimulate them to try to recognize it.

Now the third question, as to the destruction of the

[1] It is well known that no species of micrococci hitherto known are capable of surviving a temperature of 212° F., *i.e.* of boiling water; many of them are killed by an exposure to 180°–190° F.

contagium in the milk. This, I am glad to say, is very easily carried out. Heating milk up to 85° C. or 185° F., that is, considerably under the boiling-point, is perfectly sufficient to completely destroy the vitality of the microbe of scarlet fever. In harmony with these experiments on the influence of heat on the microbe of scarlet fever, I can quote, besides the observation given above by Dr. Robertson, also the following observations recorded by Dr. Jacob, Medical Officer of Health of High Ashurst and Headley, and reported in 1878, to this effect. Between June 1 and 7, there were fifteen cases of scarlet fever in three distant houses, the inmates of which had had no communication with infected persons, but had all been supplied with milk from a farm where a certain cowman worked. This cowman had in his family several children ill with scarlet fever. The cowman continued working the cows during the illness of his children, though he did not himself have the fever, and the milk was not taken into his cottage; but the point which I wish to bring out is this, that other houses besides those in which scarlet fever had broken out had been supplied with the same milk, but no scarlet fever occurred in them, and why? because all these had consumed only the scalded milk.

I should therefore strongly urge that all milk should be boiled, or at any rate heated to at least 85° C. (that is 185° F.) before being consumed. Judging by the large number of cases of scarlet fever recorded in these milk epidemics, one is justified in saying that a considerable percentage of the total number of cases of scarlet fever would have been avoided thereby. Not all, because unfortunately the rules of isolation of patients suffering from scarlet fever are not always rigorously carried out, and therefore infection from person to person will occur. Nor would prevention of scarlatina by milk exclude scarlatina by cream,—cream cannot be easily subjected to heat; and in the epidemic of scarlet fever that occurred in South Kensington in 1875, and that was investigated by Dr. Buchanan, cream was the vehicle of the contagium. But considering the prominent position that milk occupies in every household with children, the possibility of infection with scarlet fever by raw milk deserves careful attention.

THE SECOHMMETER.

A CIRCUIT containing self-induction acts as if it had a larger resistance than its true one when a current is started in it, and a smaller resistance when the current is stopped. Hence, if balance be obtained with a Wheatstone's bridge in the ordinary way, the fact of any of the arms possessing self-induction, or of any one of the arms having a condenser attached to it, will produce no effect on the balance if the battery circuit be rapidly made and broken, provided that the rapidity of make and break be not too great for the currents in the arms of the bridge to reach their steady values each time that the battery circuit is made, and to die away each time that it is broken. If the currents have not time to reach their steady value when the battery circuit is closed, and to die away when it is broken, then self-induction in any one of the arms will produce a disturbance in the balance; but such a method of measuring a coefficient of self-induction would lead to very complicated formulæ, and is not worth developing with the view of obtaining a simple method of measuring self-induction.

It therefore occurred to us to consider whether, without employing such rapid makes and breaks as would prevent the currents reaching their steady values, the self-induction of a circuit might not be made to act as an apparent steady definite increase of the resistance of that circuit which could be measured in the ordinary way with a Wheatstone's bridge or differential galvanometer; and by this means the measurement of a coefficient of self-induction would simply resolve itself into the measurement of a resistance. And this problem we solved in the following way, in the spring of 1886:—

The coil, the coefficient of self-induction of which it is desired to measure, is placed in one of the arms of a Wheatstone's bridge, the three other arms consisting of ordinary doubly-wound resistance coils possessing no appreciable self-induction, and not only is the battery circuit rapidly made and broken, but, in addition, after each closing of the battery circuit the galvanometer circuit of the bridge is either short-circuited or broken, so as to cut out the galvanometer, and after each breaking of the battery circuit the galvanometer circuit is either unshort-circuited or closed again, so that the galvanometer is now operative again. In this way all the successive impulses of the galvanometer needle that are produced on starting the current in the coil with self-induction produce then *cumulative* effects, but the successive impulses of the needle that, under ordinary circumstances, would be produced on the needle in the opposite direction are cut out. Hence the self-induction possessed by one of the arms causes that arm to apparently increase in resistance by a definite amount depending on the coefficient of self-induction and the number of operations performed per minute. This apparent increase of resistance produces a deflection of the galvanometer which can be noted, and its value ascertained by comparing it with the deflection produced with steady currents when one or more of the arms of the bridge is altered by a known amount, as in making the Rayleigh test. But since the necessity of having to read the deflection limits the speed of performing the double make and break operation, in order that the spot of light may not be sent off the scale, we soon replaced this comparative deflection *cumulative* method by a much more sensitive *zero cumulative* method; and instead of reading the galvanometer deflection we re-establish the balance, and bring the needle back to zero, by altering one or more of the arms of the bridge, as in making an ordinary resistance test with a Wheatstone's bridge.

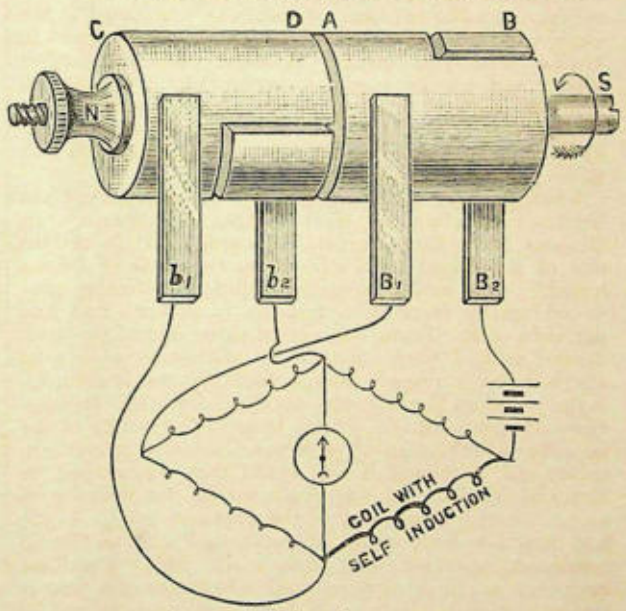


FIG. 1.—Preliminary Apparatus.

The first apparatus for enabling measurements of self-induction to be made in this way was constructed in the spring of 1886, under the superintendence of one of our assistants, Mr. Mather. It consisted of a double commutator, shown in Fig. 1, the spindle, S, to which the

commutators were locked by the nut, N, being rotated at any speed by a small electromotor, not shown in the figure, to which was attached a Young's speed indicator, which registered the speed of rotation at any moment. The brushes, B_1, B_2, b_1, b_2, were fixed to the baseboard and joined to the bridge, as indicated in the figure. When the double commutator was rotated by the motor (of which the speed was correctly adjusted by means of a Varley's flexible carbon-resistance), the portion A B caused the battery circuits to be periodically made and broken, while the other portion, C D, periodically short-circuited and unshort-circuited the galvanometer, so that the following cycle of operation, called for simplicity *one operation*, was performed any desired number of times per minute :—

Battery circuit.	Galvanometer short circuit.
Make.	While broken.
While made.	Make.
Break.	While made.
While broken.	Break.
Make.	While broken.

If we call

$$\frac{\text{angle between the slits in the two commutators}}{360^\circ}$$

the lead or l, so that l will be equal, for example, to $\frac{1}{4}$ when each of the cycle of operations given in the table lasts for one-quarter of a revolution, then we have shown that

$$L = \frac{l}{n}\sigma \text{ second-ohms},$$

where n is the number of revolutions of the commutator per second, and σ the apparent increase of resistance of the coil with self-induction, or

$$L = \frac{60 l \sigma}{N} \text{ second-ohms}$$

where N is the number of revolutions per minute.

A number of experiments were made in the summer and autumn of last year, and they showed that this new method was very accurate and furnished an extremely sensitive test for the absolute measurement of a small coefficient of self-induction.

By the simple addition, therefore, of such a commutating arrangement as we have described to an ordinary Wheatstone's bridge, it becomes possible, whenever the resistance of a coil electro-maget, &c., is being measured, to measure also the coefficient of self-induction in absolute measure, by a zero method which is as sensitive for the measurement of self-induction as the ordinary Wheatstone's bridge method is for the measurement of resistance.

The instrument previously described requires an electromotor to drive it, and a speed-indicator to register its speed, hence it would be too cumbersome for every-day work. It therefore became necessary to devise commercial apparatus, and this was done as follows :—

Attached to the commutator of our self-induction apparatus is a box, B (Fig. 2), fitted with weighted elastic sides made of corrugated steel, which fly out more and more, under the action of centrifugal force, as the box is rotated faster and faster. A stout glass tube, G G', of comparatively small bore, open at both ends, is cemented into a collar in the axis of the box, and rotates with the box. The box is completely filled with mercury, and the tube partially, hence when the volume of the box expands as its sides fly out the length of the column of mercury in the tube diminishes, and the length of the column at any moment is a measure of the speed of rotation of the box. In the neck of the collar, C, in which the tube is cemented, there is a steel tap attached to an axial spindle passing through a tube inside the box, and projected out of this tube at the other end of the box. If this spindle be turned relatively to the box, the tap is opened or closed. At the commencement of the experiment the tap is opened, and the handle, H, is turned with the right hand, faster and faster, until, on depressing the key, K, with the left hand from time to time, the galvanometer needle is seen to be approaching zero, or the spot of light the zero position on the scale. The key may now be kept depressed, and on turning the handle a little faster a speed is at length reached producing exact balance—if the handle be turned faster, the needle or spot of light deflects to one side of the zero, if more slowly to the other—at this moment the trigger, T, is lightly touched with the left hand, and a spring is liberated. This has the effect of producing a resistance to the rotation of the tap-spindle, which previously was rotating freely with the rotating box, and the tap is thus turned off, cutting off the connexion between the mercury in the glass tube and that in the box. Consequently the mercury in the tube remains, even after the instrument is stopped, of exactly the same length that it had when the trigger was touched. The position of the end of thread of mercury in the tube is now read off on the scale attached, and the apparent increase of resistance of the coil, electro-magnet, or whatever it may be, divided by the number on the scale, gives the required coefficient of self-induction in second-ohms without any further calculation.

The instrument is, therefore, direct-reading.

At first, rotating commutators similar to those shown in Fig. 1 were employed with the apparatus shown in Fig. 2 ; next the brushes were made of a variety of different forms, so as to press *radially* on the rotating commutators to prevent the wear altering the lead, and thus changing the sensibility of the instrument ; but this form of commutator has at length been entirely superseded by the two oscillating arms, or brushes, A, A, worked by a cam. Each arm is composed of several pieces of hard copper, contact being made through the ends, as in many of the switches now used for electric-light work. The end of each brush alternately rubs on a flat piece of phosphor bronze, P, P, when it makes contact, and on a *flat* piece of glass or agate, g, when it does not. This form of commutator we found superior for our purpose to the double cylindrical one, since, with the two oscillating arms, the lead can be more easily varied for adjustment ; and this slight adjustment of the lead, we may here mention, forms the fine adjustment in the construction of this direct-reading instrument. Further, the slow wearing of this form of brush does not alter the lead ; consequently the value of the graduations of the scale remains constant.

The temperature adjustment of the instrument is effected by moving the scale until the zero is opposite the end of the thread of mercury when the instrument is at rest.

Following the precedent of naming an instrument after the name of the unit employed—for example, "ammeter," "voltmeter," "ohmmeter," "wattmeter,"—it seems desirable to call this instrument after the name of the commercial unit of self and mutual induction. The absolute electro-magnetic unit of self and mutual induction is 1 centimetre, a name used by all scientific nations. But the commercial unit of self and mutual induction is $99{,}777 \times 10^4$ centimetres, or the second-ohm, which is about 2·3 in a thousand less than 10^9 centimetres, or one earth's quadrant. Now, in spite of the difference between these two numbers, which, although small, it is a pity to lose sight of, the English word "quadrant" is not used in French, therefore it would not be well to suggest this word as the international name for the unit. Yet it is most important that some name should be universally adopted, since the use of simple familiar names has much to do with making people familiar with the laws of the

effect measured by the unit. The unit of electro-static capacity, the farad, has been called after the greatest experimental worker in electricity; it would therefore seem appropriate that the unit of electro-magnetic capacity should be called after Maxwell, the greatest mathematical worker in electricity. We do not, however, like to propose this, as we feel there might be difficulty in obtaining the general acceptance of the name of an Englishman, however great, unless it were sanctioned by an International Electrical Congress, or unless the man's name was intimately associated in men's minds with self and mutual induction. And Maxwell's large contribution to the subject of electro-magnetic induction is surrounded by his equally large contributions to all other branches of

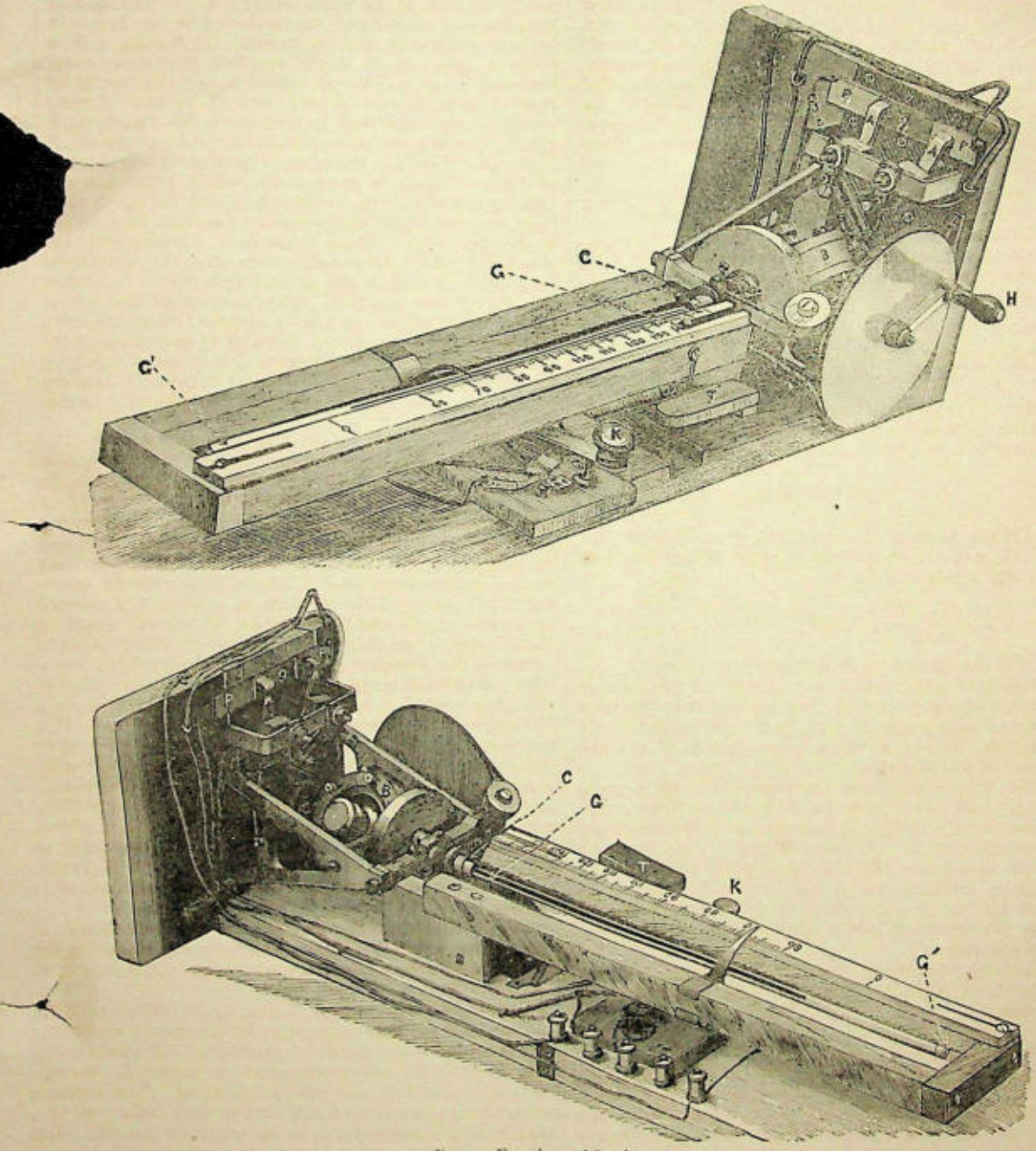


Fig. 2.—Experimental Secohmmeter.

electricity and magnetism—a giant surrounded by giants is not prominent. Coming to the last two years, we are glad that the leader and all those who have followed him in taking part in the widening of our ideas on self-induction are still with us. Hence we are driven to suggesting a temporary name for the unit, and as the first three letters in "second" are common to the name in English, French, German, Italian, &c., and ohm is also common, we venture to suggest 'secohm" as a provisional name, and our instrument we will therefore call a "secohmmeter."

Unless the glass tube in the secohmmeter just described be rather long, either the sensibility or the range of the instrument must be limited; but a very long straight tube

would make the instrument inconveniently large, and a rapidly rotating *spiral* tube would probably break, from centrifugal force acting on those parts of the tube that were not on the axis of rotation. Hence, in the latest form of secohmmeter, Fig. 3, we have been led to employ a *stationary* spiral glass tube, G, with its end cemented into a stationary hollow steel conical plug fitting mercury-tight in the collar of the rotating metal box, B, with its weighted elastic sides. This arrangement simplifies the tap mechanism, as the tap now is not rotating, also many small improvements have been introduced into this last form: for example, at all the joints there is mercury under pressure, so that there is no tendency for air to be drawn into the apparatus at the joints, a fault which sometimes occurred with the earlier form of the apparatus, and led to irregularities in the readings from a bubble of air in the box acting on an air spring, or from air in the glass tube altering the length of the thread of mercury. The temperature adjustment in this last form of the secohmmeter is made by screwing a screw in or out, which slightly alters the volume of the stationary portion of the mercury vessel. The fly-wheel F has been made to have

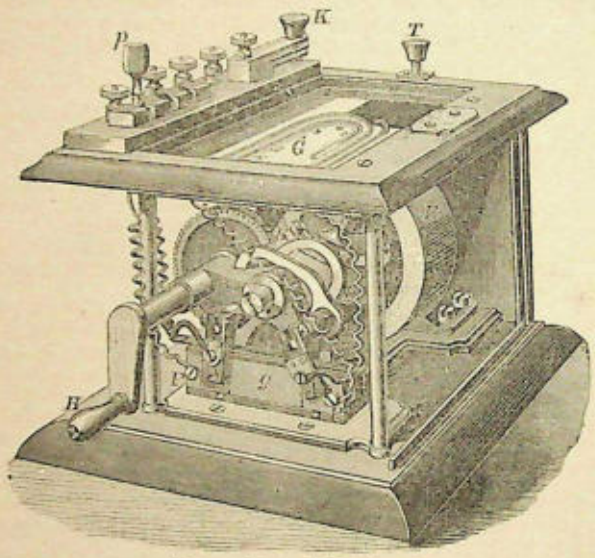


FIG. 3.—Improved Secohmmeter.

a much larger moment of inertia, and the box B is placed inside it, so as to be screened from damage.

Mutual Induction.

If we wish not merely to determine the coefficient of self-induction, L, of a coil, S, but also the coefficient of mutual induction, M, between it and any other coil, we first exclude the other coil from the battery circuit and determine L in the manner already described. We next include the other coil in the battery circuit, and repeat the experiment with the secohmmeter; then, as shown by one of our students, Mr. Sumpner (to whom our thanks are due for the most able assistance that he has rendered in this investigation)—

$$M = \frac{p}{p+r}\left(\frac{60\,l}{N}\sigma - L\right),$$

or if N_1 and σ_1 are the speeds and apparent increase of resistance in a first experiment, and N_2 and σ_2 in a second, we have

$$L = 60\,l\,\frac{\sigma_1}{N_1}$$

$$M = \frac{p}{p+r}\,60\,l\left(\frac{\sigma_2}{N_2} - \frac{\sigma_1}{N_1}\right),$$

where p is the resistance of the arm of the bridge opposite the coil S, and r the resistance of the arm joining p and S.

Capacity.

We have also shown that, if, instead of placing a coil with self-induction in one of the arms of the bridge, the arm be shunted with a condenser, there will be an apparent diminution of the resistance of that arm, since such a shunted condenser acts as if it had a negative self-induction. This apparent diminution divided by the product of the square of the actual resistance of the arm into the reading of the scale of the instrument corresponding with the speed at which balance is obtained gives the capacity absolutely in farads. The formula is, therefore, far simpler than that given by Clerk Maxwell for the absolute measurement of the capacity of a condenser, by placing it on one of the arms of the bridge and rapidly reversing the connexions of the condenser with the bridge.

Secohmmeter without Speed Indicator.

Lastly, all known zero galvanometric methods of comparing the coefficients of self or mutual induction with one another, or with the capacity of a condenser, can be increased enormously in sensibility by the use of the secohmmeter, and, since in such cases the speed of rotation need not be known, a very simple form of secohmmeter without speed indicator can be employed. The comparison of the coefficients of self or mutual induction with one another, or with the capacity of a condenser, is usually effected by tests that are completed during the growth or the dying away of a current, since it is only during the variation of a current that self or mutual induction, or the electro-static capacity of a condenser, evidence themselves. The effect of an error in the balance only lasts for a very short time, and therefore is very small if the error be small, that is, the tests are not sensitive. But by the use of the secohmmeter it is now possible not merely to measure the coefficients of self and mutual induction and the capacities of condensers absolutely, but, in addition, to secure the same high degree of sensibility with comparison tests that have hitherto had to be completed during the growth or dying away of a current that it is customary to obtain in the use of the Wheatstone bridge for measuring resistances with steady currents.

W. E. AYRTON.
JOHN PERRY.

THE FOSSIL FISHES OF MOUNT LEBANON.

THE last published part of the Transactions of the Royal Dublin Society (May 1887) contains a memoir on the fossil fishes of the chalk of Mount Lebanon, in Syria, by James W. Davis, which is an important contribution to a very interesting subject.

The existence of fossil fishes in the chalk of Mount Lebanon has been known from remote antiquity; Herodotus refers to them, and various statements about them are recorded in writings scattered over the period between the fourteenth and eighteenth centuries. In our own century, Louis Agassiz, Pictet, Haeckel, Costa, Botta, Fraas, and others, have added greatly to our knowledge of the various species met with, and now this memoir of Mr. Davis, illustrated as it is by twenty-four excellent plates, several of which are folding plates, brings up our knowledge of these remains to the most recent date.

For the chief material on which this memoir is based the author is indebted to the zeal and energy of the Rev. Prof. Lewis, who, during his residence in the American College at Beyrout, availed himself of every opportunity of collecting specimens of these fossils, and succeeded in accumulating a very large series of new forms. Many of these have been acquired for the British Museum Natural

History Department; the rest are in the possession of Mr. Robert Damon, of Weymouth. In addition to Prof. Lewis's collection, Mr. Davis has availed himself of the material already existing in the British Museum, chiefly from the fine collections of the late Sir Philip Egerton and the Earl of Enniskillen, the latter of whom, we notice, communicated this memoir to the Royal Dublin Society, of which he was a very old member.

The two principal localities in which fish remains are found in the Lebanon are at Hakel and at Sahel Alma. In order to reach Hakel, it is necessary to go to Djebail, the ancient Byblos, a small village situated on the coast, about seventeen miles north of Beyrout. Hakel is about six miles and a quarter from Djebail, in a north-easterly direction. M. Botta describes the locality as being in a deep valley, situated at a great height above the sea-level. The beds containing the fish remains are upon the slope of the hill on the right, in ascending towards the village of Hakel. The beds are considerably displaced, and vary much in their direction and inclination; the sides of the mountain are covered with debris, and it is in this debris that the fishes are found. The debris is in the form of thin foliated slabs, exhaling when struck a strong odour of sulphureted hydrogen; these contain irregular beds of flint, or siliceous limestone, which inclose the fossils. The Sahel Alma locality is situated below the convent of this name, which is about eleven miles from Beyrout. The convent is built on ground sloping rapidly towards the sea, the surface soil is covered with mulberry-trees, and beneath this is the marly chalk containing the fish remains. It is an argilo-calcareous stone, sometimes laminated, soft, and without appreciable odour. There are parts of a deep gray colour, almost resembling a plastic clay. The fish impressions occur in considerable numbers, both of species and individuals, mixed with some species of Crustacea. The species of fish found in the two localities are very seldom the same. The opinions of authors vary as to the geological age of these fish beds. Agassiz hesitated as to whether they should be considered as pertaining to the Jurassic epoch or to that of the chalk; whilst Haeckel was doubtful whether to place them between the chalk and the Tertiary formations. Pictet considered that the large number of extinct forms, and the great differences between the fauna of the fish beds and that existing in the sea at the present time, made it impossible to attribute the remains to a Tertiary period; on the other hand, the entire absence of ganoid fishes appeared to indicate that they are of a period anterior to the Jurassic, and that they must consequently have belonged to that of the Cretaceous period. Dr. Oscar Fraas places the beds as the upper ones of the Turonian group, corresponding to the chalk marl, and below the white chalk and the Maestricht beds.

No less than sixty-three new species are described by Mr. Davis, and a number of species of other authors are re-described. Extremely beautiful drawings of most of these, from the original specimens, by Miss E. C. Woodward, accompany the memoir, which will be received with interest by all palæontologists.

The printing and paper of this volume well deserve our praise, and are fully up to the style of the recent memoirs published by the Royal Dublin Society.

COMPLIMENTARY DINNER TO PROFESSOR TYNDALL.

WE are glad to be able to announce that a complimentary dinner is to be given to Prof. Tyndall on the occasion of his retirement from the Chair of Physics in the Royal Institution. Prof. Tyndall has still before him, we hope, many a long year of fruitful research, but it would have been strange if the present opportunity had been allowed to pass without an adequate expression of the gratitude which is felt by large classes of his countrymen for the services he has already rendered to science. His great reputation he has won by severe and long-continued labour, the value of which is most highly estimated by those who are most capable of forming a judgment on its worth. Prof. Tyndall has not only made additions to the sum of human knowledge; he has also done much to aid the process by which the English public are acquiring a new conception of the place that properly belongs to science in modern life, and of the need for applying scientific method to departments of thought and work from which it has hitherto been too often rigidly excluded. Moreover, by his popular expositions of the results of inquiry in the branches of physics he has shown that science, so far from being in any sense hostile to literature, can receive full justice only when it is handled by writers who are masters of literary expression. The books in which Prof. Tyndall has appealed to the general public have marked an era in the intellectual development of many of his readers, and his works will always serve to remind men of science of the possibility of presenting profound and accurate thought in luminous and attractive forms.

We print the letter which the Honorary Secretaries are now sending to the members of scientific Societies and to various representative men.

Science Schools, South Kensington,
June 6, 1887.

DEAR SIR,—The retirement of Prof. Tyndall from the Chair of Natural Philosophy in the Royal Institution affords a fitting occasion for a formal recognition of the great services which he has rendered to the cause of scientific progress.

Prof. Tyndall has therefore been invited to a complimentary dinner which will take place at Willis's Rooms on Wednesday, June 29, at 7 o'clock.

The chair will be taken by the President of the Royal Society, who, it is hoped, will be supported by a large and representative body both of scientific men and of others who appreciate the importance to the nation of scientific instruction and of the promotion of natural knowledge.

The Committee hope that you will be able to attend, and in this case we shall be glad if you will kindly fill up the accompanying form and return it to us at your earliest convenience.

Tickets will be 30*s*. each, and the Committee request us to state that it will be necessary to hold gentlemen who receive tickets responsible for that sum, even if they should unfortunately be prevented from attending the dinner.

The early return of the accompanying form is desirable, as it will be impossible to find room for more than 280 persons. Should more than that number apply, the Committee will, as far as possible, distribute the tickets in the order of application. In any case, a further communication will be addressed to you.

We are, dear Sir,

Faithfully yours,

J. NORMAN LOCKYER }
ARTHUR W. RÜCKER } *Hon. Secs.*

The following is a list of those who have up to the present consented to serve on the Committee:—

Chairman, Prof. G. G. STOKES, President of the Royal Society.

The MARQUIS OF SALISBURY, K.G., F.R.S., Chancellor of the University of Oxford.
The DUKE OF DEVONSHIRE, K.G., F.R.S., Chancellor of the University of Cambridge, and of the Victoria University.
The DUKE OF ARGYLL, K.G., F.R.S., Chancellor of the University of St. Andrews.
The Right Hon. JOHN INGLIS, D.C.L., LL.D., Chancellor of the University of Edinburgh.
The EARL OF ROSSE, F.R.S., Chancellor of the University of Dublin.
The EARL GRANVILLE, K.G., F.R.S., Chancellor of the University of London.
Sir F. ABEL, C.B., F.R.S., ex-President of the Chemical Society.

Prof. J. C. ADAMS, F.R.S., ex-President of the Astronomical Society.
Prof. W. G. ADAMS, F.R.S., ex-President of the Physical Society.
Sir GEORGE B. AIRY, K.C.B., F.R.S., ex-Astronomer-Royal, and ex-President of the Royal Society.
Sir W. BOWMAN, Bart., F.R.S., formerly Secretary to the Royal Institution.
Sir F. BRAMWELL, F.R.S., Secretary to the Royal Institution, and ex-President of the Institution of Civil Engineers.
Prof. CAYLEY, F.R.S., ex-President of the British Association.
Prof. CLIFTON, F.R.S., ex-President of the Physical Society.
W. CROOKES, Esq., F.R.S., President of the Chemical Society.
W. H. M. CHRISTIE, Esq., F.R.S., Astronomer-Royal.
WARREN DE LA RUE, Esq., F.R.S., ex-President of the Royal Astronomical and Chemical Societies.
Prof. DEWAR, F.R.S., Professor of Chemistry in the Royal Institution
Colonel DONNELLY, C.B., Secretary to the Science and Art Department.
Prof. P. M. DUNCAN, F.R.S., ex-President of the Geological Society.
W. T. THISELTON DYER, Esq., F.R.S., Director of the Royal Gardens, Kew.
Dr. EVANS, Treasurer of the Royal Society, and President of the Society of Antiquaries.
Prof. FLOWER, F.R.S., Director of the Natural History Department, British Museum.
Prof. G. CAREY FOSTER, F.R.S., ex-President of the Physical Society.
Prof. M. FOSTER, Secretary of the Royal Society.
F. GALTON, Esq., F.R.S., President of the Anthropological Society.
Prof. GAMGEE, F.R.S., Professor of Physiology in the Royal Institution.
A. GEIKIE, Esq., F.R.S., Director-General of the Geological Survey.
Sir W. GROVE, F.R.S., ex-President of the British Association.
Dr. HIRST, F.R.S., ex-President of the Mathematical Society.
Sir J. HOOKER, F.R.S., ex-President of the Royal Society.
Prof. HUXLEY, F.R.S., ex-President of the Royal Society.
Prof. JUDD, F.R.S., President of the Geological Society.
Sir JOHN LUBBOCK, F.R.S., ex-President of the British Association.
HUGO MÜLLER, Esq., F.R.S., ex-President of the Chemical Society.
Prof. ODLING, F.R.S., ex-President of the Chemical Society.
Sir LYON PLAYFAIR, K.C.B., F.R.S., ex-President of the British Association.
Lord RAYLEIGH, Secretary of the Royal Society.
Admiral Sir G. H. RICHARDS, K.C.B., F.R.S., ex-Hydrographer to the Navy.
Sir H. E. ROSCOE, F.R.S., ex-President of the Chemical Society, and President-Elect of the British Association.
Prof. BALFOUR STEWART, F.R.S., President of the Physical Society.
General R. STRACHEY, F.R.S., President of the Royal Geographical Society.
Sir W. THOMSON, F.R.S., President of the Royal Society of Edinburgh.
Captain WHARTON, R.N., F.R.S., Hydrographer to the Navy.
Professor A. W. WILLIAMSON, Foreign Secretary of the Royal Society.

M. BOUSSINGAULT.

STUDENTS of agricultural chemistry have received with much regret the tidings of the death of M. Boussingault, one of the earliest and most eminent investigators in this branch of science. He was born at Paris on February 2, 1802, and obtained his scientific education at the School of Mines of St. Étienne. When little more than twenty years of age, he went as a mining engineer to Columbia, South America, where he remained ten years. During his residence in South America he made the acquaintance of Alexander von Humboldt, who warmly praised his work in chemistry, meteorology, geography, and astronomy. On his return to France, M. Boussingault was appointed Professor of Chemistry at Lyons. He married the sister of M. Lebel, who had been his fellow student at St. Étienne, and by his marriage he became, with his brother-in-law, joint proprietor of the estate of Bechelbronn, in Alsace. Here he set up the first laboratory that had ever been established on a farm, and carried on a long series of important researches.

From the time of his marriage, Boussingault generally spent about half the year in Paris, and the other half in Alsace. In 1836, he published a paper on the quantity of nitrogen in different foods, and on the equivalents of the foods, founded on the amounts of nitrogen they contained. This was his first important contribution to agricultural chemistry. It was soon followed by others, which secured for him, in 1839, the honour of being elected a member of the Institute. Among his publications in 1837 and 1838, were papers on the amount of gluten in different kinds of wheat, on the influence of the clearing of forests on the diminution of the flow of rivers, on the meteorological influences affecting the culture of the vine, and on the principles underlying the value of a rotation of crops. In connexion with this last subject he brought out many new facts, which seem to have been of essential service to Liebig. In 1843, much attention was attracted by a work entitled "Économie Rurale," in which M. Boussingault embodied the results of many of his original investigations. A translation, under the title of "Rural Economy in its Relations with Chemistry, Physics, and Meteorology," was published in this country, and made the author's name widely known among English agriculturists. In a review of this translation in 1845 the *Agricultural Gazette* described the work as "the most important and valuable book for farmers which the chemists of the present century had produced—not so attractive as the clever paragraphs of Prof. Liebig, but much more than compensating for want of brilliancy by solid worth."

In an excellent biographical sketch of Boussingault, printed in the *Agricultural Gazette*, January 6, 1879, it is pointed out that, although his attention was by no means limited to subjects bearing on agriculture, by far the greater number of his researches had relation to the problems it suggests. "Thus," says the writer, "the amount and condition of the combined nitrogen in the atmosphere, in the aqueous depositions from it, in rivers and springs, and in the soil, have been investigated. The amounts of nitrogen, phosphoric acid, &c., in different manuring substances have been determined, and their comparative values estimated accordingly. The question of whether or not plants assimilate the free nitrogen of the air has again and again been taken up, the weight of the evidence always serving to confirm the conclusion that they do not. Very recently, too, he has made experiments in regard to some functions of the leaves of plants. Lastly, in the sphere of animal chemistry, he has from time to time devoted himself to the elucidation of important points, such as the sources in the food of the fat of the fattening animal, the assimilation of mineral constituents, the question whether any of the nitrogen of the food or of the animal is exhaled, and so on." Most of the results of his investigations relating to agricultural chemistry are given in his work "Agronomie, Chimie agricole, et Physiologie," published in seven volumes, the first of which appeared in 1860, the last in 1884.

M. Boussingault received many honours from foreign Governments and from scientific Societies both at home and abroad. In 1878, the Council of the Royal Society awarded the Copley Medal for his numerous and varied contributions to science, especially for those connected with agriculture.

In 1848, Boussingault was elected a member of the National Assembly, where he sat as a Moderate Republican, and for a short time he was a member of the Conseil d'État. In 1851 he was dismissed, on account of

his political opinions, from his position of Professor at the Conservatoire des Arts et Métiers; but this step caused so much discontent among scientific men, and was so vigorously resented by his colleagues, who threatened to resign in a body, that the Government had to reinstate him.

He died on May 11, 1887, in his eighty-sixth year.

NOTES.

THE "Ladies' *Soirée*" at the Royal Society held last night was carefully prepared and largely attended. We shall refer at length next week to some of the objects exhibited.

THOSE who have made the arrangements for the great national ceremony at Westminster Abbey in connexion with the Queen's Jubilee cannot, it would appear, be congratulated on the manner in which they have discharged one of the most important of their functions. On so striking an occasion all the highest interests of the nation ought to be adequately represented; yet some of the most vital of these interests have been practically ignored. "A Student" has alluded to the matter in a letter to the *Times*, and his remarks seem to be worthy of attention. Having referred to the eminent fitness of Westminster Abbey for a ceremony of this kind, he says:—"I imagined gathered together there all the men who by their deeds, their discoveries, their inventions, their writings, or their noble lives and ideas, have helped during the Queen's reign to make England what she is at the present moment, and I imagined, too, that the list of the names of those present might be a roll fit to be handed down to the remotest posterity as an authoritative statement of England's most illustrious citizens in the present year. Proud that the English Government had resolved to act upon such a noble idea, I have been endeavouring to express my enthusiasm and gratitude to many that I have met, with the result that I have found either that my view of the Government's intention was perfectly wrong or that it is being carried out in such a manner that the thing promises to be an expensive and unworthy farce. I have been informed by some who should know *that among those who have already been invited hardly the name of any representative of literature, science, or art has been included.*"

THE Queen has intimated her intention of accepting the Albert Medal, which has been awarded to her by the Council of the Society of Arts. The Albert Medal is annually given for "distinguished merit in promoting arts, manufactures, or commerce."

ALL who remember the important aid rendered by Governor Sendall to the Government Eclipse Expedition to the West Indies last year will be glad to see by a recent *Gazette* that a C.M.G. has been conferred upon him. The same *Gazette* also included the name of Dr. Hector for the step of K.C.M.G. This is also another unexceptionable appointment. We are glad that the authorities at the Colonial Office are making such wise selections; the order of St. Michael and St. George bids fair to eclipse that of the Bath, the civilian distinctions connected with which seem more and more rarely to come in a scientific direction, and to be more and more limited to the spending rather than the thinking departments.

SOME important appointments have just been made at University College, London. Dr. William Ramsay, Principal of, and Professor of Chemistry in, University College, Bristol, has been appointed to fill the Chair of Chemistry, vacant by the resignation of Dr. Williamson; Dr. Sydney Ringer, F.R.S., has been made Holme Professor of Clinical Medicine, in succession to the late Dr. Wilson Fox; and Mr. Victor Horsley, F.R.S., succeeds Dr. Bastian (resigned) as Professor of Pathology.

WE referred lately (p. 87) to a Bill introduced into the House of Commons by Sir Henry Roscoe, empowering any School Board, local authority, or managers of a public elementary school, to provide day technical and commercial schools and classes. Mr. James Stuart has introduced a corresponding measure for the establishment of evening schools and classes which shall give instruction in continuation of that obtained in public elementary schools. The subjects to be taught include the elements of such portions of science as may be likely to be useful to artisans and other persons engaged in industrial and agricultural occupations; also elementary mechanics, mechanical drawing, the elements of art and design, the use of ordinary tools, commercial arithmetic, and commercial geography. For providing these evening continuation schools the powers of School Boards or other local authorities are to be in all respects the same as for providing ordinary public elementary schools. Further, there is to be the power of providing or contributing to the maintenance of laboratories or workshops in endowed schools for the purpose of carrying on classes under the Bill. The schools and classes thus provided are to be subject to the inspection of the officers of the Committee of Council on Education or of the Science and Art Department, and no scholar is to be admitted to a school or class who has not passed an examination in the sixth standard. It is also proposed that School Boards or other local authorities shall have power to provide evening schools and classes, either in connexion with "evening continuation schools" or not, for the purpose of giving instruction in a particular group of subjects, among which are arithmetic, geography, elementary science, drawing, wood-carving, and modelling. The conditions as to these schools and classes do not differ from those as to the continuation schools, except that the standard to be passed previously to admission is the fourth, not the sixth. For any of the subjects taught in evening schools or classes under the Bill the Committee of Council on Education are empowered to give grants on such conditions as they may lay down.

WE learn that the Bentham Trustees have purchased for presentation to the Library of the Royal Gardens, Kew, the unique collection of portraits of *Bromeliaceæ* which were accumulated during a life-long study of the order by the late Dr. Morren, Professor of Botany in the University of Liége. Some of the drawings, which are in all cases of life size, were exhibited at the recent reception of the Royal Society.

IN an article printed in NATURE on January 13 (vol. xxxv. p. 248), Mr. D. Morris dealt with the important question of botanical federation in the West Indies. He again discusses this subject in the sixth Bulletin of Miscellaneous Information, just issued from the Royal Gardens, Kew. For the last hundred years the cultivation of the sugar-cane has been the only important industry in the West Indies, and the fall in the price of cane sugar has seriously affected the general condition of the population. It is estimated that one-half of the surface of these islands, with the exception of Antigua and Barbados, is better fitted for other cultivation than that of the sugar-cane. Fresh industries might therefore be safely started, and Mr. Morris is careful to point out that "by too close an adhesion to purely sugar-growing habits and methods the people act injuriously to their best interests and neglect the numerous resources at their command." It is, however, absolutely necessary that any new enterprises which may be undertaken shall be carried on by persons equipped with adequate knowledge; and no real progress can be made unless the people of the various islands provide themselves with small but good botanical establishments in connexion with the Botanical Department in Jamaica. Something has already been done in this direction. At Grenada a

Botanic Garden is in course of being established under the charge of Mr. W. R. Elliott; and, with the sanction of the Legislature, £100 has been granted for the formation of a botanical station at Dodd's Reformatory, Barbados. A botanical station, for which £300 has been voted, is being made near Castries, St. Lucia. Mr. Morris is of opinion that the prospects of the scheme for botanical federation in the West Indies are, upon the whole, very good. The recent appointment of Mr. William Fawcett to the post of Director of the Botanical Department at Jamaica appears, he thinks, to offer every hope of success to the scheme. "It is also anticipated," Mr. Morris says, "that, while granting valuable aid to the smaller islands, Jamaica, as a centre, will herself derive, both directly and indirectly, considerable benefit from such vigorous and systematic working as would naturally arise in her own area as well as from a larger interchange of plants and seeds with the neighbouring islands."

In connexion with the sixtieth meeting of German Naturalists and Physicians, which is to be held at Wiesbaden from September 15 to 24, there will be an important scientific exhibition. It is intended that the exhibition shall include the latest and best instruments and apparatus used in the study and in the teaching of science and medicine. The following are among the groups to be represented:—Surgery, physical diagnosis and therapeutics; ophthalmology, gynæcology; laryngology, rhinology, and otiatry; orthopædia, dentistry, chemistry, instruments of precision, with subdivision for microscopy; instruments and apparatus aiding instruction in natural history, geography, equipment for scientific travel, photography, anthropology, biology and physiology, hygiene, electro-therapeutics and neurology, and pharmacology. Applications are to be addressed to the Exhibition Committee, 44 Frankfurterstrasse, Wiesbaden.

On Friday, the 3rd inst., the work of constructing the canal which is to connect the German Ocean with the Baltic Sea was formally begun by the German Emperor. The ceremony, which took place at Holtenau, on the Bay of Kiel, consisted of the laying of the foundation-stone of a lock near the Baltic end of the canal. It is estimated that the total cost of the undertaking will be 156,000,000 marks (about £7,800,000). This sum has already been voted by the Reichstag and the Prussian Parliament. The canal is being constructed mainly for naval and military purposes, but in times of peace it will be open to the merchant ships of all nations. The German authorities calculate that it will be used annually by about 18,000 vessels, with a collective tonnage of 5,500,000, and yielding a revenue of 4,125,000 marks (about £206,250).

On Wednesday, the 15th inst., at 3 p.m., Sir H. W. Acland will distribute prizes to students at the Medical School of St. Thomas's Hospital. The ceremony will take place in the Governors' Hall.

Lord Cadogan has offered to present a site for the Free Public Library which is to be erected in Chelsea. He also promises to give £300 worth of books, to which Lady Cadogan adds a gift of £50.

On Tuesday evening a meeting, held in the lecture-hall of the Polytechnic Institution, Regent Street, decided that an effort should be made to secure the establishment of a Free Public Library in Marylebone. Prof. Huxley, who presided, said it was proposed that £20,000 should be raised to cover the cost of the site and building, and he was able to announce that £10,500 had already been promised. If they succeeded in their object, as he was sure they would, they could go to the authorities and the ratepayers and say, "We have done our part of a public duty, now perform yours."

The Corporation of London have voted a donation of one hundred guineas towards the thousand pounds required by the Bethnal Green Free Library Committee for the further development of the Institution.

On the 3rd inst. several shocks of earthquake occurred in Northern California and Western Nevada. They were distinctly felt in the Yosemite Valley.

During the earthquakes in the Sierra Madre, five persons were killed and nineteen injured at Bapipe (Sonora province), and five persons were killed at Oputa. Both towns were completely destroyed. The inhabitants, as well as those of the towns of Barceraca and Quasa, are living in the open fields, shocks being still felt continually. Some places which were quite dry formerly are now submerged.

The Oficina Central Meteorolójica de Chile is endeavouring to keep up and improve the meteorological service of the Republic. Vol. xviii. of its *Anuario*, containing the observations for the year 1886, has been recently published. The first observations published by the Office were for 1869, but for several years past the publication has fallen into arrears for want of sufficient funds. Since the re-organization of the Office in 1885, the *Anuario* has appeared in two-monthly parts, and the management of the service is now intrusted to a Committee composed of members of the Faculty of Sciences at the University of Santiago. There are now twenty-eight stations at which observations are being taken or in course of establishment; the most northerly station is Iquique (lat. 20° 12′ S.), and the most southerly Punto Arenas (lat. 53° 10′ S.), but there are none between this and Ancud (lat. 41° 52′ S.). Many of the stations are provided with the best instruments, ordered from Europe, and the Central Office has a complete outfit of self-recording instruments. The Astronomical Observatory at Santiago has also published meteorological observations, independently, from 1873–84, together with curves of the automatic records.

The *Annalen der Hydrographie und maritimen Meteorologie* for May contains a notice of a fall of volcanic ashes, at Finsch Harbour, on the eastern coast of New Guinea, which lasted from 7 a.m. till about 11 a.m. on February 5 last, and covered the country round with a thin layer of light-gray ashes. On February 2 the whole sky appeared gray, and at noon the sun was of a blood-red colour, while lunar halos and rings occurred for several nights. Captain von Schleinitz states that the north-west monsoon, which prevails at this season, had ceased for four days, and was replaced by fresh southerly winds, but made its appearance again at noon on the 4th. From this he concludes that the volcanic eruption which caused the fall of ashes might have occurred either to the north or south, as the fall did not take place with either the northerly or southerly wind, but during a calm, the ashes having remained suspended for some time. He thinks that a northerly origin is most probable, although they might have been carried thither from an easterly or westerly direction by an upper air-current, or that the volcanoes in Vulcan Island and Lesson Island may have shown unusual activity during the period in question.

The Monthly Weather Review, published by the Chief Signal Officer of the United States, and referred to in our issue of last week (p. 110), has now been received for the six months ending December 1886, making the series complete up to February 1887.

The recent cyclone in the Bay of Bengal, to which we referred last week (p. 110), did much injury both on sea and land. Commenting on the fact that the Viceroy has telegraphed to the Sheriff of Calcutta expressing the regret and sympathy felt by himself and the members of the Government, the Calcutta Correspondent of

the *Times* says:—"It is to be hoped that this sympathy will take the practical form of the authorizing an extension of the telegraph to the Andamans and Diamond Island. The latter locality is now recognized as the birth-place of cyclones, and the importance of getting early intimation of their approach cannot be over-estimated."

WE have to record the death of Dr. Karl Friedländer, Professor at the Berlin University, an eminent pathologist and anatomist; also of Dr. Alexander Ecker, Professor at the Freiburg University, a well-known anatomist and anthropologist, and founder of the Ethnographical Museum at Freiburg. Dr. Ecker died at the age of seventy.

THE General Meetings of the Geographical Society and the anical Club of Thuringia took place at Saalfeld on June 5.

HE largest Apicultural Meeting and Exhibition ever held in rmany will take place at Hanover from September 22 to 25.

THE Council of the Royal Meteorological Society are anxious to obtain photographs of flashes of lightning, as they believe that a great deal of research on this subject can be pursued only by means of the camera. In a letter which has been sent to persons likely to be interested in the subject, the Council express a hope that now the thunderstorm season is approaching, many photographers may be found willing to take up this branch of their art. It is pointed out that the photography of lightning does not present any particular difficulties. If a rapid plate and an ordinary rapid doublet with full aperture be left uncovered at night during a thunderstorm for a short time, flashes of lightning will after development be found in some cases to have impressed themselves upon the plate. The only difficulty is the uncertainty whether any particular flash will happen to have been in the field of view.

A NEW chlorobromide of silicon has been isolated by Prof. Emerson Reynolds from a large quantity of crude silicon tetrabromide. A current of dry hydrogen was first driven through the crude bromide to remove free bromine, and the residue, after shaking with mercury, was afterwards subjected to fractional distillation. An early fraction, that passing over between 140° and 144°, was separately collected, and, by repeated refractioning, was found to consist largely of a portion boiling at 140°–141°, which proved to be pure silicon chlorotribromide, $SiClBr_3$. This liquid fumes in the air, and, on addition of water, is decomposed into a mixture of silicic, hydrobromic, and hydrochloric acids. It is of considerable theoretical interest, inasmuch as it completes our knowledge of the following series of compounds, in which chlorine and bromine mutually replace each other, and the end members of which are formed by the tetrachloride and the tetrabromide of silicon respectively: $SiCl_4$, $SiCl_3Br$, $SiCl_2Br_2$, $SiClBr_3$, and $SiBr_4$. This series is now perfectly analogous to the one formed by the compounds of chlorine and bromine with carbon.

A NEW quantitative reaction of very wide application, by means of which any desired substitution of chlorine may be readily effected in a large number of hydrocarbons, is described by MM. Colson and Gautier in the last number of the *Annales de Chimie et de Physique*. It simply consists in heating in a sealed tube the calculated quantities of hydrocarbon and phosphorus pentachloride on the supposition, shown by analysis to be well founded, that the pentachloride is dissociated into the trichloride and free chlorine, which latter acts precisely like free chlorine. The great value of this means of substitution is at once seen to consist in the fact that, instead of the uncertain results obtained by the graduated use of free chlorine, it now becomes possible to obtain a quantitative yield, in an easily separable form, of the particular chlorine derivative desired. Thus, in order to obtain benzal chloride, the starting-point in the artificial preparation of indigo, it is only necessary to heat together to 195° for two hours in a closed vessel the calculated quantities of toluene and phosphorus pentachloride.

WE understand that the Rev. J. B. Lock intends to write a "Statics for Beginners" as a complement to the "Dynamics for Beginners" which was recently noticed in these columns. A Key is now being prepared, under Mr. Lock's superintendence, to his well-known "Arithmetic for Schools."

IN their report for the session 1886–87 the Council of the Institute of Actuaries say that the prosperity of the Institute has been fully maintained during the past year. Referring to the new offices at Staple Inn Hall, the Council trust that they have at last secured a permanent and suitable home for the Institute, corresponding to its higher dignity and its ever-increasing duties.

AN International Exhibition is to be held at Glasgow during the summer of 1888. The guarantee fund already exceeds £240,000, and is being increased. The objects of the Exhibition, as stated in the prospectus, are "to promote and foster industry, science, and art, by inciting the inventive genius of our people to still further development in arts and manufactures; and to stimulate commercial enterprise by inviting all nations to exhibit their products, both in the raw and finished state." Examples of the manufactures of Glasgow and the surrounding districts—chemical, iron, and other mineral products, engineering, shipbuilding, electrical and scientific appliances, and textile fabrics—will be shown; and similar and more varied exhibits may be expected from other parts of Great Britain and from the Continent. Promises of support have also been received from America, India, the Canadian, Australian, Cape, and other colonies. The site, which has been granted by the Glasgow Corporation, extends to sixty acres, and the buildings will cover about ten acres.

IN an article in the current number of the *Entomologist*, Mr. J. T. Carrington speaks of a phenomenon which has frequently puzzled him when hunting for insects on salt-marshes. He refers especially to the marshes of the River Medway. The tide often completely overflows the marshes, and for an hour or two turns the collecting-ground into an arm of the sea, with multitudes of rippling wavelets. During this period there is not a sign of an insect flying over the water. "As the tide recedes, and little islands of the taller plants appear through the water," says Mr. Carrington, "we notice the first indication of moths appearing. When the water has left the marsh we examine the wet and sloppy ground, and find multitudes of delicate Tortrices and plumes in perfect condition, flitting about as though nothing had happened to disturb their comfort. Now, where were these moths when the tide covered the marsh some two or three feet deep? One can hardly imagine they were under the water all the time, though there was not a sign of them over it. Many times have I watched this rising and falling of the tide, but never solved the problem."

IN the June number of the *Zoologist*, Mr. Murray A. Mathew describes what he calls "a strange capture of a hare." A neighbour of his in Pembrokeshire was crossing one of his fields late in the evening when he heard a hare crying. He went in the direction, expecting to find a hare in a trap, but was astonished to come across one attacked by a hedgehog, which was holding on to one of its hind legs. The hare (fully-grown) seemed paralyzed by fear, and allowed itself to be lifted up. Directly the hedgehog was shaken off the hare died, although the injury it had received from the bite of its assailant was but slight.

A NEW weekly newspaper, devoted more especially to the commercial side of the chemical and allied industries, is being

issued by Messrs. Palmer and Howe, of Manchester. It is called the *Chemical Trade Journal*, and is edited by Mr. George E. Davis. Two numbers have already appeared.

THE additions to the Zoological Society's Gardens during the past week include two Egyptian Jerboas (*Dipus ægyptius*) from Egypt, a Moorish Toad (*Bufo mauritanica*) from Tunis, presented by the Hon. Terence Bourke; a White-crowned Pigeon (*Columba leucocephala*) from the West Indies, presented by Lieut.-Colonel W. G. Dawkins; a Common Trumpeter (*Psophia crepitans*) from Demerara, presented by Mr. G. H. Hawtayne; a Crowned Horned Lizard (*Phrynosoma coronatum*) from Texas, presented by Mr. Claude A. Millard; two Egyptian Jerboas (*Dipus ægyptius*) from Egypt, deposited; two Cape Sparrows (*Passer arcuatus*), four Alario Finches (*Alario alario*) from South Africa, purchased; a Wapiti Deer (*Cervus canadensis*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

COMET 1887 *e* (BARNARD, MAY 12).—Dr. H. Oppenheim supplies the following improved elements for this comet in Dun Echt Circular No. 147:—

T = 1887 June 17·2209 Berlin M.T.

$\pi - \Omega$ = 15° 40′ 19″
Ω = 245 13 1 } Mean Eq. 1887·0.
ι = 17 31 52
log q = 0·14288

Ephemeris for Berlin Midnight.

1887.	R.A. h. m. s.	Decl. ° ′	Log Δ.	Log r.	Brightness.
June 13	16 13 43	7 50·3 S.	9·6026	0·1432	1·5
15	16 18 17	6 20·5			
17	16 22 51	4 53·9	9·6077	0·1429	1·5
19	16 27 26	3 30·8			
21	16 32 1	2 11·4 S.	9·6182	0·1433	1·4

The brightness on May 14 has been taken as unity.

MINOR PLANET No. 266.—This object has received the name of Aline.

THE PARALLAX OF α TAURI.—Prof. Asaph Hall has published in the *Astronomical Journal*, No. 156, a determination of the parallax of this star deduced from measures of the position-angle and distance of the eleventh magnitude companion made with the Washington 26-inch refractor between October 2, 1886, and March 15, 1887. The resulting values of the relative parallax are: from measures of angle, $\pi = +0''\cdot163 \pm 0\cdot0409$, and from measures of distance, $\pi = +0''\cdot035 \pm 0\cdot0431$. The mean value of the parallax of α Tauri from these observations is therefore $\pi = +0''\cdot102 \pm 0''\cdot0296$. It will be remembered that M. O. Struve recently published a determination of the parallax of this star, referred to the same comparison-star, and found $\pi = +0''\cdot516 \pm 0''\cdot057$.

MADRAS MERIDIAN OBSERVATIONS.—A volume of Madras astronomical observations at last! In 1887 Mr. Pogson publishes the results of the meridian circle work during 1852, 1863, and 1864. A prefatory epistle addressed to Sir M. E. Grant-Duff, late Governor of Madras, speaks of "the removal of certain arbitrary and suppressive restrictions which have prevented me and my predecessors from attempting anything of the kind for considerably more than thirty years past," but gives the reader no more definite information as to the reason of this unparalleled delay in publication, nor why the Madras Observatory should have thus fallen from the high position which it formerly held. The instrument with which the observations now published were made is a transit-circle constructed by Messrs. Troughton and Simms, in consultation with the late Mr. Carrington. The object-glass is of 5½-inches aperture, and the circle of 42-inches diameter. It was brought into use in May 1862, and was devoted to the observation of stars down to the fifth magnitude, the moon and accompanying stars, Mars and comparison stars at successive oppositions, minor planets, and as many stars of more than 120° N.P.D. as could be found, not less than the eighth magnitude. The present volume contains star places only. The ledgers and catalogues of mean places for each year are given separately and take up much more space in printing than is necessary for mere annual results. Altogether 227 stars were observed in 1862, 782 in 1863, and 1000 in 1864. A comparison between the Madras places of time-stars and those of the Nautical Almanac (on the R.A.'s of which those of Madras depend) shows a good agreement in R.A., but in N.P.D. a mean excess of the former of +0″·7, which "renders it certain that the Polar Distances will require some further small correction before being formed into a final general Catalogue."

ASTRONOMICAL PHENOMENA FOR THE WEEK 1887 JUNE 12-18.

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on June 12.

Sun rises, 3h. 45m.; souths, 11h. 59m. 29·5s.; sets, 20h. 14m.; decl. on meridian, 23° 9′ N.: Sidereal Time at Sunset, 13h. 37m.

Moon (at Last Quarter on June 13) rises, 0h. 5m.; souths, 5h. 13m.; sets, 10h. 30m.; decl. on meridian, 10° 32′ S.

Planet.	Rises. h. m.	Souths. h. m.	Sets. h. m.	Decl. on meridian. ° ′
Mercury ...	4 46 ...	13 16 ...	21 46 ...	25 12 N.
Venus ...	7 4 ...	15 6 ...	23 8 ...	21 21 N.
Mars ...	3 2 ...	11 9 ...	19 16 ...	22 7 N.
Jupiter...	14 57 ...	20 16 ...	1 35* ...	8 51 S.
Saturn...	6 6 ...	14 11 ...	22 16 ...	21 49 N.

* Indicates that the setting is that of the following morning.

Variable Stars.

Star.	R.A. h. m.	Decl. ° ′		h. m.	
U Cephei	0 52·3 ...	81 16 N. ...	June 13,	0 55	*m*
			,, 18,	0 35	*m*
R Crateris	10 55·0 ...	17 43 S. ...	,, 15,		*m*
U Virginis	12 45·4 ...	6 10 N. ...	,, 13,		*M*
R Hydræ	13 23·6 ...	22 42 S. ...	,, 12,		*m*
R Boötis	14 32·2 ...	27 14 N. ...	,, 18,		*m*
δ Libræ	14 54·9 ...	8 4 S. ...	,, 18,	1 26	*m*
U Coronæ	15 13·6 ...	32 4 N. ...	,, 14,	21 31	*m*
U Ophiuchi... ...	17 10·8 ...	1 20 N. ...	,, 15,	1 0	*m*
W Sagittarii ...	17 57·8 ...	29 35 S. ...	,, 13,	1 0	*M*
R Scuti	18 41·5 ...	5 50 S. ...	,, 18,		*m*
β Lyræ...	18 45·9 ...	33 14 N. ...	,, 17,	2 0	*M*
R Delphini	20 9·5 ...	8 45 N. ...	,, 18,		*M*

M signifies maximum; *m* minimum.

Meteor-Showers.

	R.A. °	Decl. °	
Near β Lyræ	282	32 N.	
ζ Cygni	320	32 N.	
β Piscium	345	0	Very swift.

GEOGRAPHICAL NOTES.

IT may interest our readers to know that a full account of Baron Nordenskjöld's narrative of his very interesting journey across Greenland has been published in German by Brockhaus, of Leipzig, with numerous maps and illustrations. Doubtless, like the same explorer's previous narratives, it will soon appear in an English dress. We are assured that Nordenskjöld will not undertake any Antarctic expedition before 1888 or 1889, if, indeed, he undertakes it at all, which is highly doubtful. He has much to do still before the publications connected with the *Vega* Expedition are complete, and he has a variety of other work in hand which must be finished before he enters on any new undertaking.

THE paper read at Monday's meeting of the Royal Geographical Society was one of unusual novelty and interest. It described the exploration which Mr. H. E. M. James, of the Bombay Civil Service, in company with two friends, made last spring and summer in Manchuria. The region explored extends from the Yellow Sea to beyond 45° N., and between 122° and 130° E. long. A considerable section of the journey was over virtually new ground, and as Mr. James is a careful observer, and, we believe, a botanist, and an accurate describer, his paper is of some scientific value. He has at least been able to add some precise features to our maps of the region. The paper contains

a useful general account of Manchuria and its history. Mr. James calls it the Manitoba of Asia. What with the depletion of the country for military service and the influx of immigrants from China, there is little of the old Manchu population left. Nearly all special Manchu customs have disappeared, and the language itself is now only spoken in a few remote valleys. Mr. James's party started from Newchang and went north to Mukden. Thence they went due east up the beautiful and well-wooded valley of the Hun. This is a particularly rich region, and is being rapidly colonized. The first day Mr. James began to collect he found no less than five kinds of lilies of the valley, and it was common to see whole hill-sides covered with masses of that flower. On account of the flooded state of the rivers, it took them a month to reach Mau-erh-shan, the furthest Chinese outpost on the Yalu, at the south foot of the Lao-ling Mountains. Thence they struck northwards across the mountains to the junction of the Sungari and Tang-ho, four days march. Here they looked again for the snowy peaks of 10,000 to 12,000 feet high, reported by previous writers on Manchuria; they were assured that such peaks existed in all the region. An official guided them back south-east to the Pei-shan Mountains, a sort of knot in which the Yalu, the Tumen, and the Sungari take their rise. For a long distance the route was over a succession of ranges covered with dense forests, with only at long intervals a hut of a ginseng cultivator, sometimes in the crater of an old volcano. Bogs also were frequent, and gave much trouble. It was the ninth day before they actually began to ascend the mountain itself. The lower slopes are covered with birch and pine, leading to a delightful grassy plateau dotted with trees, and rich open meadows bright with flowers of every imaginable colour. As they approached the needle-like peaks of Old White Mountain, the noise of underground streams was frequently heard. The steep sides of the two-peaked upper ridge shines white with disintegrated pumice-stone. On reaching the saddle and looking over the edge, the party found themselves looking down into a crater, at the bottom of which, about 350 feet below, was a beautiful lake, of the deepest and most pellucid blue. The lake was about 6 miles in circumference. The height of the mountain is not more than 8000 feet. The party then proceeded north to Kirin and Tsitsikar, through forests and swamps, and, lastly, across Mongolian steppes. Then, proceeding eastwards and southwards, the country to the east of the previous route was explored, Mr. James learning much by the way of the country and the people. Altogether the journey has been a fruitful one, and shows how much can be done for science by our Indian officials when they have the inclination and are properly trained.

WE have already referred to the remarkable journey of Mr. Carey in Central Asia. Information has now been received from him showing how the second year of his journey was passed. In May 1886 he started from Châklik, with the object of exploring some of the northern regions of Tibet. He passed south, across the Altyn and Chinan Mountains, and reached the foot of a high chain, which is probably the true Kuen-lun. Here he had to travel a considerable distance eastwards, through barren and difficult country, until an opening was found leading to the valley of the Ma-chu, the head-source of the Yang-tse-kiang. After falling down the river some distance, Mr. Carey had to turn northwards again, and recross the Kuen-lun. He now found himself in the Tsaidam region, and made an interesting round journey from a place called Golmo and back to the same point, during which he saw a good deal of the nomadic Kalmucks and Mongols who inhabit the comparatively low valleys of Tsaidam. In the autumn, Mr. Carey made a second journey across the Kuen-lun, and then, again turning northward, struck straight across the Tsaidam country and the Gobi, to Sachan and Hami, whence he travelled to Urumtsi in the Tian-shan. Thence the party left for Yarkand, whence a start was made on March 7 for Ladak. A great part of the ground traversed by Mr. Carey is new, and he and his assistant, Mr. Dalgleish, are the only Englishmen who have ever travelled through the entire length of Chinese or Eastern Turkestan.

M. CONSTANTIN NOSILOFF writes to the Royal Geographical Society of his intention to undertake this year a summer expedition to Nova Zembla. His object will be (1) to prepare a detailed map of the coasts and interior of the island; (2) to study the hydrography of the coast, and make observations regarding the movements of the ice in the Kara Sea, and in the straits leading to it; (3) to make meteorological observations, and to collect zoological and botanical specimens; (4) to study the ethnography of the Samoiedes.

THE ANNUAL VISITATION OF THE ROYAL OBSERVATORY.

THE Report of the Astronomer-Royal to the Board of Visitors, read at the annual visitation of the Royal Observatory on Saturday last, refers to the period of twelve months from 1886 May 21, to 1887 May 20, and exhibits the state of the Observatory on the last-named day.

The following are among the points of most general interest:—

I. Buildings and Grounds.

Above the extended portion of the upper computing-room, a dome 18 feet in diameter is to be erected, in which it is proposed to mount a Cooke 6-inch equatorial, a photo heliograph tube being attached to the same mounting. The combined instrument will command a complete view of the sun throughout the day—an important consideration, as the work of the present photoheliograph is seriously interfered with by trees and the Lassell dome. The new instrument will be available for occultations, phenomena of Jupiter's satellites, and other occasional observations.

II. Astronomical Observations.

Transit-Circle.—The regular subjects of observation with the transit-circle are the sun, moon, planets, and fundamental stars, with other stars from a working Catalogue. On the conclusion of the observations for the Ten-Year Catalogue at the end of 1886, a new list of some 3000 stars was prepared, to include all the stars in Groombridge's Catalogue and in the Harvard Photometry, which had not been observed at Greenwich since 1867. The Annual Catalogue of stars observed in 1886 contains about 1665 stars.

The observations for the Ten-Year Catalogue, epoch 1880, were concluded at the end of 1886, special efforts being made in the latter part of the year to make the Catalogue as far as possible complete to the sixth magnitude inclusive. It is estimated that the Catalogue will contain about 4000 stars, all of which, with very few accidental exceptions, have been observed at least three times in R.A. and N.P.D., the total number of observations being about 40,000 in each element.

The following statement shows the number of observations made with the transit-circle in the twelve months ending 1887 May 20:—

Transits, the separate limbs being counted as separate observations	6366
Determinations of collimation error	304
Determinations of level error	410
Circle-observations	5983
Determinations of nadir point (included in the number of circle-observations	385
Reflexion-observations of stars (similarly included) ...	602

About 400 transits (included in the above number) have been observed with the reversion-prism, to determine personality depending on the direction of motion.

The value found for the colatitude from the observations of 1886 is 38° 31′ 22″·03, differing by 0″·13 from the assumed value; the correction to the tabular obliquity of the ecliptic is +0″·65, and the discordance between the results from the summer and winter solstices is −0″·25, indicating that the mean of the observed distances from the Pole to the ecliptic is too great by +0″·12.

The mean error of the moon's tabular place (computed from Hansen's lunar tables, with Prof. Newcomb's corrections) is +0·029s. in R.A. and +0″·34 in longitude as deduced from ninety-seven meridian-observations in 1886. The mean error in tabular N.P.D. is −0″·66, which would appear to agree with the observations of the sun in indicating that the mean of the observed N.P.D.'s is too great.

As regards the computations for the Ten-Year Catalogue, a large amount of preparatory work has been done in the application of corrections to the observations as printed to reduce them to a homogeneous system, and some progress has been made in the formation of the Catalogue results. The proper motions actually used have been thoroughly revised for every observation in the period 1877-86, and corrections applied where, as occasionally happened, different proper motions had been used in the same year. A comparison has been made of the R.A.'s of clock-stars as observed in the last ten years and as computed from the Nine-Year Catalogue, epoch 1872, with Auwers' recently published proper motions, the result of which is to show that the Greenwich observations are better represented by these than by the proper motions in use hitherto, and it has therefore been

decided to adopt Auwers' proper motions throughout. Preparations have accordingly been made for reducing the observations in the Ten-Year Catalogue to the epoch 1880, with Auwers' proper motions wherever available.

It has appeared doubtful whether the reading of the exterior thermometer placed near the north wall of the transit-circle room represents the true temperature of the external air as affecting the refraction for the sun and other southern objects in the daytime. A discussion of simultaneous readings of the exterior, front court, and meteorological standard thermometers, which is being made by Mr. Thackeray, shows systematic differences between the first and last at the time of observation of the sun, the mean monthly excess of the meteorological standard over the exterior thermometer for the ten years 1877–86 ranging from +0°·7 in December to +2°·1 in May and August and +2°·6 in September. The reading of the front court thermometer (which is at a distance from any building) appears to agree closely with that of the meteorological standard, and it has been adopted, from the beginning of this year, in computing refractions for the sun, moon, planets, and stars south of the zenith observed in the daytime, the exterior thermometer being still used for northern stars as probably representing better the temperature of the air on the north side of the transit-circle. The systematic differences in thermometer readings have a sensible effect on the position of the ecliptic as deduced from observations of the sun, the discordance in the results between the summer and winter solstices found when the reading of the exterior thermometer are used being rendered insensible when corrections are applied to reduce to the reading of the meteorological standard thermometer.

Altazimuth.—The total number of observations of various kinds made in the twelve months ending 1887 May 20 is as follows, the observations of the moon having been as usual restricted to the first and last quarters in each lunation :—

Azimuths of the moon and stars	356
Azimuths of the azimuth mark	208
Azimuths of the collimating mark	242
Zenith distances of the moon	181
Zenith distances of the collimating mark ...	240

The altazimuth observations are completely reduced to March 31, so as to exhibit errors of moon's tabular R.A., N.P.D., longitude, and ecliptic N.P.D., and the manuscript for the printer has been prepared to the same date.

Equatorials.—Various additions have been made to the Lassell equatorial with a view to making it available for astronomical photography and for general use. A delicate slow motion in R.A. (with differential wheels) and a firm N.P.D. clamping arm with fine motion in N.P.D. have been applied, the steadiness and general usefulness of the telescope being greatly increased by these additions. The Corbett 6½-inch refractor has been mounted below the tube of the reflector and parallel to it to serve as a directing telescope in taking photographs and also for observation of occasional phenomena. A camera to take circular plates 8½ inches in diameter (giving a field 1° 58′ in diameter) has been mounted at the principal focus of the Lassell mirror, and some trial photographs of the moon, Procyon, Regulus, γ Leonis, and Præsepe, have been taken.

The construction of the new 28-inch refractor has been delayed by difficulty in obtaining the disks of glass. Messrs. Chance are engaged in removing a bunch of fine veins from the flint glass disk, and have every hope of being able very shortly to report the disk practically perfect ; and M. Feil's successor has successfully moulded a crown disk from which he believes that he has removed all defects.

The south-east and Sheepshanks equatorials are in good order. Some trouble has been experienced with the water-supply for the driving clock of the former instrument, and an alteration in the arrangements for maintaining the pressure has been made at the Kent Waterworks, since which the working has been found quite satisfactory.

The Cooke 6-inch equatorial is being mounted in the south ground for trial as to the practicability of using curved plates for stellar photography and other questions which have been raised at the Paris Conference on Astronomical Photography.

III. Spectroscopic and Photographic Observations.

For determination of the motions of stars in the line of sight, 206 measures have been made of the displacement of the F line in the spectra of 26 stars, and 20 measures of the *b* lines in 8 stars, besides comparisons with lines in the spectrum of the moon made in the course of the night's observations of star motions, or of the sky on the following morning, as a check on the general accuracy of the results. The observations of Sirius since the date of the last Report indicate that the apparent displacement of the F line (which was originally towards the red and subsequently towards the blue) is now insensible. The displacement of the F line in the spectrum of Algol has been measured as frequently as possible during the winter months, in order to ascertain if any evidence could be obtained of rapid orbital motion such as would result from the hypothesis of the variability of Algol being caused by the transits of a large satellite. A sufficient number of observations has not yet been obtained to allow a definite conclusion to be formed, but as far as the observations go there are indications of a variation of the motion in the line of sight corresponding to orbital motion having the same period as that of the star's variability.

A photographic corrector, consisting of a concave crown and convex flint lens (in contact), placed about 30 inches within focus, has been applied to the telescope of the south-equatorial to correct the chromatic aberration of the object-glass for the photographic rays without alteration of the focal length. A Dallmeyer doublet (formerly used in the photoheliograph) has been employed to enlarge the primary image about 7½ times, so as to give on the photographic plate an image on a scale of about 0·45 inch to one minute of arc, or 15 inches to the sun's diameter. A number of trial photographs of Castor, γ Virginis, Venus, Jupiter, and Saturn have been obtained. The photographs of the double stars appear to be susceptible of very accurate measurement, and several of the photographs of Jupiter show the four satellites, the belts, and the red spot. A photograph of γ Virginis, showing the components widely separated, has also been taken at the primary focus, the Dallmeyer enlarging doublet having been removed. It is intended also to use the photographic corrector with the Dallmeyer doublet to obtain photographs on a large scale of sunspots, craters on the moon, and other objects of small angular dimensions. The field of view with the photographic corrector is necessarily very restricted.

For the year 1886, Greenwich photographs are available on 199 days, and photographs from India and Mauritius filling up the gaps in the series on 164 days, making a total of 363 days out of the 365 on which photographs have been measured, the record being thus practically complete for 1886.

As regards the photographic reductions :—

The Greenwich photographs have been measured in duplicate as far as 1887 April 28, and the measures have been completely reduced so as to exhibit heliographic longitudes and latitudes of spots and areas of spots and faculæ.

The photographs from India and Mauritius have been received from the Solar Physics Committee as far as March 10 and February 20 respectively, and these have all been measured, and the measures completely reduced.

IV. Magnetical Observations.

The observations have been continued on the same lines as in former years, changes in the magnetic declination, horizontal force, and vertical force being continuously recorded by photography and the absolute values of magnetic declination, horizontal force, and dip being determined from time to time by eye-observation. Earth currents in two directions nearly at right angles to each other are also photographically registered. For these last the ordinates have hitherto been measured on an arbitrary scale, and it appeared desirable to obtain the data for expressing this in terms of the accepted electrical units. The authorities of the Post Office Telegraphs have courteously given every assistance in regard to the requisite electrical measurements, and an electrical balance for measuring resistance, a standard cell, and a galvanometer of the Post Office pattern have been procured under their auspices. In October last, Mr. H. R. Kempe, of the Post Office Telegraphs, made some measures of the resistances of the earth current wires, but the conditions were not then favourable for insulation. Subsequently the wires were damaged in the snowstorm of December 26-27 last, and were temporarily repaired on January 25. It is believed that they are now restored to their normal condition, and arrangements are being made to obtain the value of the difference of electric potential between the two earth-plates on each line corresponding to a given length of ordinate on the photographic register. An experimental set of measures of resistance has been taken recently.

The following are the principal results for magnetic elements for 1886:—

Approximate mean declination		17° 55′ West
Mean horizontal force... ...		3·9379 (in British units)
		1·8157 (in Metric units)
Mean dip		67° 26′ 38″ (by 9-inch needles)
		67° 26′ 45″ (by 6-inch needles)
		67° 27′ 40″ (by 3-inch needles)

The declination and horizontal force magnets were thrown into vibration by the earthquake shock of February 23, the extent of vibration being 20′ in declination and 0·004 of the whole horizontal force in that element. The motion commenced at 5h. 37·6m. Greenwich civil time, and a second double disturbance of much smaller amplitude (possibly accidental) was registered from 7h. 39m. to about 7h. 57m. At the request of M. Mascart, a copy of the photograph has been sent to him for discussion with other records of the earthquake which he is collecting. In view of the importance of the study of earthquakes, it appears desirable that a suitable seismograph should be procured for the Observatory.

V. Meteorological Observations.

The mean temperature of the year 1886 was 48°·7, being 0°·6 below the average of the preceding forty-five years. The highest air temperature in the shade was 89°·8 on July 6, and the lowest, 16°·5, on January 7. The mean monthly temperature in 1886 was below the average in January, February (6°), March, June, and December, and above the average in September, October, and November. In the period of 156 days from 1886 December 16 to 1887 May 20 the mean temperature was 3°·1 below the average of twenty years, the daily temperature being below the average on 115 days.

The mean daily motion of the air in 1886 was 291 miles, being 7 miles above the average of the preceding nineteen years. The greatest daily motion was 857 miles on December 8, and the least, 56 miles, on October 8. The recorded pressures in 1886, exceeding 20 lbs. on the square foot, were 27·6 lbs. on March 31, and 23·5 lbs. on December 9.

During the year 1886, Osler's anemometer showed an excess of about 17 revolutions of the vane in the positive direction N., E., S., W., N., excluding the turnings which are evidently accidental.

The number of hours of bright sunshine recorded by Campbell's sunshine instrument during 1886 was 1228, which is about twenty hours above the average of the preceding nine years. The aggregate number of hours during which the sun was above the horizon was 4454, so that the mean proportion of sunshine for the year was 0·276, constant sunshine being represented by 1.

The rainfall in 1886 was 24·2 inches, being 0·5 inch below the average of the preceding forty-five years.

VII. Chronometers, Time Signals, and Longitude Operations.

The number of chronometers now being tested at the Observatory is 225.

The first seven chronometers in the competitive trial of 1886 were exceptionally good, the first chronometer being superior to any we have previously had on trial, except the first in 1882.

For the annual trial of deck-watches, which commenced last November, fifteen watches were entered, and of these nine were purchased for the Navy, the first three being classed "A," or equal, in performance, to an average box-chronometer.

A supplementary trial took place in February and March, for which nine deck-watches were entered, and of these seven were purchased for the Navy, the first two being classed "A."

The watches in each trial were rated for a period of nine weeks, viz. two weeks (dial up) in the room at a temperature of 50° to 55°, four weeks in four different positions in the oven (dial up, pendant up, pendant right, pendant left, arranged symmetrically) at a temperature of about 80°, and three weeks (dial up) in the room. When the period of rating in any position was less than a week, weekly rates were inferred from the rate for the period by simple proportion.

In order to compare the performance of the several watches, "trial numbers," representing deviations in weekly rates, have been formed on the same general principles as for the chronometer trials. The trials in different positions introduce, however, a new element, and an arbitrary weight must be assigned to them in combining them with the trials "dial up." It has been considered that when the watch is worn in the pocket the pendant will generally be "up," and that not more than one-third of the deviation "pendant right" or "pendant left" is likely to have practical effect.

Putting a = Difference between greatest and least weekly rates "dial up,"

b = Greatest difference between one week and the next "dial up,"

c = Difference between weekly rates "pendant up" and "dial up,"

d = Difference between weekly rates "pendant right" and "dial up,"

e = Difference between weekly rates "pendant left" and "dial up,"

the quantity $c + \frac{d}{3} + \frac{e}{3}$ may be taken as the measure of the deviation in weekly rate due to positions in ordinary wear. Half weight has been given to this quantity in combining it with the trial number "dial up" $(a + 2b)$, on the assumption that the deck-watch would be usually lying "dial up" and that it would not be carried in the pocket more than eight hours a day on the average. Thus the quantity $a + 2b + \frac{1}{3}(c + \frac{d}{3} + \frac{e}{3})$, has been adopted as the trial number for deck-watches. It has been arranged that for the future all pocket chronometers and deck-watches rated at the Observatory after repair shall be tested in positions.

The automatic drop of the Greenwich time-ball failed on one day only during the past twelve months. On three days the ball was not raised on account of the violence of the wind, and on five days on account of accumulation of snow on the mast.

As regards the Deal time-ball, there have been twelve cases of failure owing to interruption of the telegraph connexions, and on three days the violence of the wind prevented the raising of the ball. For fourteen days after the snowstorm of December 26–27, no signals were sent to or received from the Deal time-ball tower, telegraphic communication being interrupted. There have been four cases of failure of the 1 p.m. signal to the Post Office Telegraphs.

The arrangements for hourly time-signals at Devonport to be given by a local clock, corrected daily by the help of a time-signal at Greenwich at 10 a.m., have been carried out under Captain Wharton's directions, and a return signal from Devonport (serving as a test of the accuracy with which the local clock was corrected) has been regularly received at Greenwich (at 13h. 0m. 39s. G.C.T.) since November 22, with the exception of 36 days following the snowstorm of December 26–27, when there was interruption of the telegraphic communication with the West of England, and of 23 days when no return signal was received. The failures occurred for the most part on Sundays. The plan appears to answer well, and it seems desirous that apparatus should be provided by the Government to enable the Committee of Lloyd's to establish hourly signals at the Lizard on the same system.

The new contact apparatus of the Westminster clock was brought into action on 1886 May 22, and the automatic signals from the clock have been received regularly from that date, except on three days following the snowstorm of December 26–27. The error of the clock was insensible on 25 per cent. of the days of observation, 1s. on 40 per cent., 2s. on 22 per cent., 3s. on 11 per cent., and 4s. on 2 per cent. On one day the signal was 15s. late, and on another day 10s. late.

A suggestion has been made that in view of the importance of the connexion of the British and Continental Surveys, the telegraphic difference of longitude between Greenwich and Paris, which was originally determined with great care in 1854, should be confirmed in order to complete the network of telegraphic longitudes which have been determined of late years by Continental astronomers. It seems desirable that Greenwich Observatory, which, under Sir G. B. Airy's direction, took such an active part in utilizing the telegraph for the determination of longitude, should now assist in completing the cycle. The necessary exchange of observers and signals could conveniently be carried out in the summer of next year, when the French geodetists will, I understand, be prepared for their share of the work.

The Report concludes with the following general remarks:—"As the result of an International Congress on Astronomical Photography held at Paris in April on the invitation of the

French Academy of Sciences, at which fifty-six representative astronomers from all parts of the world were present, a scheme has been approved for the formation of a photographic map of the heavens by the concerted action of a number of Observatories in both hemispheres. This scheme provides for two series of photographs, the one intended to contain all stars down to the fourteenth magnitude inclusive, and the other, taken with short exposure, specially designed to give accurate positions of brighter stars down to the eleventh magnitude, so that it may be possible to form an extensive Catalogue of reference-stars for the first series, and thus to give the means of accurately determining the position of any star on the photographic map down to the fourteenth magnitude. The instruments with which this work is to be jointly carried out are to be photographic refractors of 0·33m. (13 inches) aperture and 3·43m. (11 feet 3 inches) focal length, and the Directors of the following ten Observatories have already announced that they are prepared to take part in the enterprise: Algiers, Bordeaux, Paris, Toulouse, and Vienna in the northern hemisphere; La Plata, Melbourne, Rio de Janeiro, Santiago da Chile, and Sydney in the southern hemisphere. It seems fitting that Greenwich should take its share in a scheme which will in a few years so greatly extend our knowledge of the places of the fixed stars, and thus serve to carry out one of the principal objects for which the Astronomer-Royal was appointed.

"On a review of the work of the past twelve months, it will be found that the activity of the Observatory has increased in various directions. The number of meridian observations is much larger than usual; additions have been made to the work of the magnetical and meteorological branch; there have been continuous trials of chronometers and deck-watches (requiring special arrangements in each case), which have made large demands on my own time, as well as on that of Mr. Turner and of Mr. Lewis. Extraneous work in connexion with the Navy has also absorbed a good deal of time that would otherwise have been free for scientific investigations. Questions connected with gun-directors, mirrors for electric search-lights, and binoculars for the Navy, have continued to engage our attention, and since the date of the last Report 510 telescopes and 35 binoculars for the Navy have been sent to the Observatory for examination, whilst it is to be presumed that a further supply of 500 binoculars, now on order, will be forwarded here to be tested in due course.

"Whilst it seems desirable that such directly utilitarian work should be undertaken at the Observatory, as being the only existing Government establishment where it can be done efficiently, I feel it necessary to point out that the existing staff is inadequate for these extraneous duties in addition to the well-defined work for which the Observatory is primarily maintained. By great efforts, which can hardly be sustained for an indefinite period, the current reductions have been kept up, notwithstanding the large number of observations obtained in the last twelve months, but the ulterior discussions which are required to maintain the character of the Observatory as a scientific institution are falling further and further behind. Amongst other matters which I should wish to take up, if leisure could be found, I may mention the determination of proper motions of stars from the observations made at Greenwich since Sir G. B. Airy's appointment in 1835, an investigation which appears to come within the terms of the Royal Warrant directing the Astronomer-Royal 'to rectify the tables of the motions of the heavens and the places of the fixed stars.'

"The appointment of a clerk, which has presumably received the sanction of the Admiralty, will, when it is made, provide for the increase of office-work which has taken place of late years in regard to chronometers, accounts, stores, stationery, printing, &c., and if the maintenance of the telegraph-wires, batteries, &c., for communication of time-signals were undertaken by the Post Office Telegraphs as part of the distribution of time to the public, there would be some further relief. But to enable me to give time to extraneous questions referred to the Astronomer-Royal by the Government, it appears necessary that the Chief Asssistant and I should be relieved of certain mechanical work which might be intrusted to computers, and that further responsibility should be delegated to the Assistants. Proceeding on the lines which have been laid down by my predecessor, I believe that the maximum of efficiency at the minimum of cost would be attained if an increase of work were met by an increase in the staff of computers, with due recognition of the position of two or three senior computers, and of the increased responsibility of the Assistants."

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—In Convocation on Tuesday, a grant of £4800, applied for by Prof. Clifton, for the extension of the Clarendon Laboratory by the erection of buildings for an Electrical Department, was refused by a large majority.

Twenty-seven men have entered for the final schools in Natural Science this year, of whom sixteen offer chemistry, four physiology, three animal morphology and physics, and one botany.

A course of medical teaching, including clinical demonstrations and elementary surgery, is to be given at the Radcliffe Infirmary during the first half of the Long Vacation.

Besides the lectures which we announced at the beginning of term, Mr. Arthur Evans, the Keeper of the Ashmolean Museum, is giving a course of lectures on "The Early Iron Age."

CAMBRIDGE.—The twenty-first Annual Report of the Museum and Lecture Rooms Syndicate states that during the year considerable progress has been made in arranging the various collections, but additional accommodation in the form of cases and cabinets is required in various departments, especially in botany and ornithology. Additional accommodation is urgently demanded for the teaching of physiology, pathology, and botany. It is also desirable that permanent arrangements for human anatomy and medicine should be taken into consideration without further delay, and that the work should be commenced as soon as possible after the present chemical laboratory is vacated.

Mr. J. W. L. Glaisher, F.R.S., and Mr. J. S. Nicholson, Professor of Political Economy in the University of Edinburgh, have been approved for the degree of Doctor in Science.

The University having been applied to by the Association for the Improvement of Geometrical Teaching to take some steps to give improved methods of teaching geometry fair play in their examinations, and the Association having sent a deputation to Cambridge to confer with the Board of Mathematical Studies, the latter Board have recommended that other proofs than Euclid's be accepted in the Previous Examination, no proof of any proposition occurring in Euclid being admitted in which use is made of any proposition which in Euclid's order occurs subsequently. They do not at present propose modifications in the syllabus of geometry for the Mathematical Tripos, because they are about to revise the schedule of Part I. as a whole.

The recent report on the local lectures scheme shows that a fair share of attention has been devoted to natural science—namely, thirty-five out of one hundred courses of lectures. The courses on "Work and Energy" by Mr. A. Berry, delivered at five centres in the Northumberland mining district, were very successful. There is distinct progress in the systematization of work, and the development of local centres; but there are many difficulties owing to lack of endowments. Attempts are being made to connect practical courses of instruction with the scientific lectures, but here again the lack of apparatus and laboratories is a serious disadvantage. An endowment fund of £1136 has been contributed, of which more than half is given by the Local Lectures and Examinations Syndicate. The chief purpose contemplated is the retention of the services of practised lecturers.

The class list of the Natural Sciences Tripos, Part I., just issued, contains the following names in Class I.: Anderson, Cai.; Barber, Chr.; Colbeck, Cai.; D'Albuquerque, Joh.; Dufton, S. F., Trin.; Dufton, A., non-collegiate; Elliott, Chr.; Francis, King's; Fry, King's; Grabham, Joh.; Groom, Joh.; Richardson, King's; Tennant, Cai.; Turner, F. M., Trin.; Waggett, Pemb.; Wagstaff, Sid.; Williams, Cai.

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society, May 28.—Prof. W. E. Ayrton, Vice-President, in the chair.—Dr. S. P. Thompson read a note on transformers for electric distribution. In the simple algebraic treatment of the dynamo several assumptions approximately true for well-made machines are made use of. The author finds that a similar set of assumptions for transformers greatly simplifies the algebraic theory:—(1) The iron, copper, and insulation are assumed good. (2) The reaction of the secondary on the primary (other than that desired) is small; thus, if the primary be

supposed to be supplied with constant mean current or constant mean potential difference, this is not to be altered by the current in the secondary. (3) No magnetic leakage; so that the coefficient of mutual induction is the geometric mean between their coefficients of self-induction. (4) The quantities of copper in the primary and secondary are to be equal. These assumptions are shown to be legitimate, and the ratios of the resistances, E.M.F.'s, currents, and coefficients of self-induction are expressed in terms of the ratio of the numbers of convolutions, which ratio is represented by $f = \frac{S_1}{S_2}$. From analogy with the dynamo it is shown that $E_2 = \frac{\omega M}{\sqrt{R_1^2 + \omega L_1^2}} E_1$, where $\omega = 2\pi n$, E_1 and E_2 the E.M.F.'s of the primary and secondary respectively, and R_1 and L_1 the resistance and self-induction of the primary coil. If R_1 be negligible, the above reduces to $E_2 = \frac{\omega M}{\sqrt{\omega^2 L_1^2}} = \frac{E_1}{f}$, $\frac{L_1}{L_2} = f^2$, and $M = \sqrt{L_1 L_2}$. The latter part of the paper contains a general investigation of two neighbouring circuits both having self-induction, and it is shown that the effective resistance of the primary is increased, and the self-induction decreased by closing the secondary circuit. Mr. Kapp said the investigations assumed the coefficients of induction to be constants, and that the phases of current in primary and secondary were opposite. The former being by no means true, he asked, What values were to be taken? and he believes the phases of current are not opposite in ordinary transformers. Mr. Swinburne protested against the use of formulæ to calculate the inductions when the required data could be obtained much more accurately from Dr. Hopkinson's curves on magnetization of iron. He also thought the curve of sines did not nearly represent the current curve for ordinary machines. Mr. Bosanquet thought the effective magnetization of a transformer would be different from that of a dynamo, for, in the former, permanent magnetism was not utilized. In reply to Mr. Kapp and Mr. Swinburne the author pointed out that as the coefficients of induction enter in both numerator and denominator, it would not matter which set of values were taken if the resistance was small compared with ωL; and that self-induction tends to smooth out irregularities in the current curve. Prof. Ayrton described a method of regulating a series transformer devised by himself and colleague some two years ago, based on analogy with a compound dynamo. Referring to the variation of L with current, he sketched a curve connecting them, obtained by Mr. Sumpner at the Central Institution, and mentioned that the E.M.F. curve of a Ferranti dynamo is an exact sine curve. He believes problems involving alternating currents would be greatly simplified by using a new set of measurable quantities, such as will render the equations as simple as possible. At Prof. Thompson's request, Prof. Ayrton exhibited a lecture experiment illustrating the action of transformers. The secondaries of two ordinary induction coils were joined in series through long fine wires, and an incandescent lamp placed in the primary circuit of one, lighted up on completing the primary of the other coil in which a battery was placed.—On magnetic torsion of iron wires, by Shelford Bidwell. This is an account of experiments made on the twisting produced by sending a current along magnetized iron wires, and the author shows that Wiedemann's explanation of these phenomena (by assuming a difference in molecular friction at the polar and lateral surfaces of magnetized molecules), is unsatisfactory. The wires were magnetized longitudinally by means of a solenoid in the axis of which the wires were suspended. To obtain consistent results it was found necessary to demagnetize the wire between the observations. This is done by reversed currents of gradually decreasing strength, and a simple arrangement of rheostat and commutator devised for this purpose was exhibited. Two sets of experiments were made, in one of which the current in wire or solenoid was kept constant whilst that in the other was varied. The amount of twisting does not increase continuously when the currents are increased, but attains a maximum when the inclination of the helix, representing the direction of magnetization, is inclined at about 33° to the axis of the wire. When the current in the solenoid was kept constant and that in the wire increased, permanent deflections remained on stopping the current. For small currents in the wire this deflection was diminished on starting the current, whilst stronger currents increased the deflection. For some intermediate value of the current, no change took place, and this value was dependent on the current in the solenoid. Experiments were shown illustrating these phenomena.

Anthropological Institute, May 24.—Mr. Francis Galton, F.R.S., President, in the chair.—Dr. George Harley, F.R.S., read a paper on the relative recuperative powers of man living in a rude, and man living in a highly civilized state; in which he brought forward a number of hitherto unpublished, though mostly well-known facts, demonstrating that the refining influence of civilization had not been altogether the unalloyed boon we so fondly imagine it to have been. For the cases cited went far to demonstrate the fact that while man's physique, as well as his mental power, had increased during his evolution from a barbaric state into a condition of *bienêtre*, his recuperative capacity, on the other hand, has materially deteriorated. In fact, it appeared from the examples cited that every appliance adding to man's bodily comfort, as well as every contrivance either stimulating or developing his mental faculties, while increasing his personal enjoyments materially diminishes his animal vitality; rendering him less able to resist the effects of lethal bodily injuries, or recover from them as well and as quickly as his barbaric ancestors, or his less favoured brethren.—Mr. G. L. Gomme read a paper on the evidence for Mr. McLennan's theory of the primitive human horde: and a communication by Mr. Samuel Gason on the Dieyerie Tribe of South Australia was also received.

Mineralogical Society, May 10.—Mr. L. Fletcher, President, in the chair.—It was reported that Mr. F. Pearce, of Maritzburg, Natal, and Prof. Albert Chester, of Clinton, N.Y., had been elected members in April.—The following papers were read:—Microscopical studies on some eruptive rocks from the Caucasus and Armenia, by Dr. Hjalmar Gylling, of Helsingfors.—Note on some specimens of glaucophane rock from the Ile de Groix, by Rev. Prof. Bonney, F.R.S.—On the crystalline form of kreatine, by Mr. L. Fletcher.—Note on francolite, by Mr. F. H. Butler.—On the meteoric iron seen to fall in the district of Nejed, in Central Arabia, in the spring of 1865, by Mr. L. Fletcher.—On a granite containing andalusite from the Cheesewring, Cornwall, by Mr. J. J. H. Teall.—Prof. J. W. Judd, F.R.S., exhibited some specimens and sections of tabasheer and other forms of opal, and made some observations thereon.

PARIS.

Academy of Sciences, May 31.—M. Janssen in the chair.—On the condition of stability in the movement of an oscillating system connected with a pendular synchronic arrangement, by M. A. Cornu. A solution is here offered of a problem which presents itself in the adjustment of certain apparatus of great precision employed in physics and astronomy: how to render the oscillations of a given mobile system, such as a pair of scales or a galvanometer, exactly synchronous with a corresponding periodical motion, such as that of a clock's pendulum, and the like.—On some crystallized metallic alloys of platina and tin, by M. H. Debray. Resuming his former studies of these alloys, the author here deals with those of platina and tin, with formula, $PtSn_4$; of rhodium, $RhSn_3$; of iridium, $IrSn_3$; and of ruthenium, $RuSn_3$. Osmium yields no alloy with tin, in which metal it crystallizes.—Progress of the Arago Laboratory, by M. de Lacaze-Duthiers. An account is given of the improvements lately introduced at this marine zoological station, which has been established at Banyuls. It is now fitted with a 7 horse-power steam-engine for supplying the aquarium with water, and with submarine electric lamps for studying the habits of the Mediterranean fauna.—On a fossilized tendril of *Nymphæa Dumasii*, Sap., by M. G. de Saporta. Although traces of rhizomes of Nymphæaceæ in various Tertiary formations are far from rare, the present fossil is specially remarkable for its great beauty and excellent preservation. Apart from the inner structure, which has been replaced by some amorphous substance, it retains all the exterior outlines of the organ down to the minutest superficial details.—Report on the velocities set up by the tides of the Pacific and Atlantic Oceans in a canal establishing free communication between these two basins, by M. Bouquet de la Grye. This is the Report of the Commission appointed last year at the request of M. de Lesseps to study the influence likely to be exercised on the Panama Canal now in progress by the regular rise and fall of the surrounding waters. It appears that the tidal currents, much stronger on the Pacific than on the Atlantic side, can

never exceed 2½ knots, and that this velocity will be reached only for a few hours at the equinoctial syzygies every year. It is incidentally stated that the Canal will be 72 kilometres long, 21 metres wide at bottom, with a slope of 45°, and a depth of 11·50 metres below the mean level at Panama, and of 9 metres below that of Colon.—Observations of Barnard's Comet (1887 *e*) made at the Algiers Observatory with the 0·50 m. telescope, by MM. Trépied and Rambaud. These observations give, in tabulated form, the apparent right ascension, the declination, and number of comparisons with other stars for the period from May 16 to May 24; also the positions of the stars and the apparent positions of the comet for the same period.—On simultaneous linear equations with partial derivatives of the second order, by M. Painlevé. Some remarks are offered in connexion with M. Goursat's recent paper on this subject, including the explanation of a different method for obtaining the same results.—On a melograph, by M. J. Charpentier. The apparatus here described and presented to the Academy have been devised and constructed for the purpose of offering a solution of the problem relating to the fixation of musical improvisations, and are applicable to the piano type of instruments.—On the vapour-tensions of liquid cyanogen, by MM. J. Chappuis and Ch. Rivière. While studying the compressibility of cyanogen the authors have had occasion to measure some maxima tensions of this gas, with results differing considerably from those obtained by Faraday and Bunsen. The discrepancies are attributed partly to the great difficulty of introducing cyanogen free from nitre into the barometric chamber; but chiefly to the manometric methods employed by those physicists, these methods being much inferior in accuracy to the open air manometer adopted by the authors.—On the reproduction of a carbonate of soda known as urao and trona, by M. Paul de Mondésir. These remarks are intended to throw some light on the subject of sesquicarbonate of soda, under which title are grouped various more or less unsatisfactory data and observations.—Action of selenious acid on the bioxide of manganese, by M. P. Laugier. During the course of his researches to discover an oxygenated product Se_2O_5 corresponding to S_2O_5, obtained by the action of sulphurous acid on the bioxide of manganese, the author has obtained some new compounds, here described, resulting from the combination of selenious acid with the sesquioxide of manganese.—On a simplified calcimeter, by M. A. Bernard. For the apparatus here described it is claimed that it possesses several advantages over that of Scheibler, although based on the same principle.—Researches on the relations existing between the spectrum of the elements of inorganic substances and their biological action, by Mr. James Blake. The author's further researches with over forty inorganic elements confirm his previous conclusions; all except nitrogen and potassium showing a definite relation between their biological action and their conditions of isomorphism.

BERLIN.

Physical Society, May 20.—Prof. Du Bois-Reymond, President, in the chair.—Dr. Gross spoke on the electrical condition of magnets during their magnetization. His experiments were made with Joule magnets. A cylindrical piece of iron was split along its axis, and the lower half of the cylinder surrounded lengthways by the spiral wire which conveyed the magnetizing current, completely insulated from it; the ends of the upper half of the cylinder were perforated by copper spikes, which were then connected by means of copper wires with a galvanometer so as to form a closed circuit. After this circuit, which included the upper half-cylinder, had been brought into electrical equilibrium, the magnetizing current (in the spiral surrounding the other half of the cylinder) was reversed, and the galvanometer gave a throw. The direction of the current thus indicated was always opposite to that of the magnetizing current passing along the inner surface of the half-cylinder. The speaker thought himself justified in excluding the possibility of this result being due to a simple inductive action of the magnetizing current on the galvanometer circuit, inasmuch as when the iron half-cylinder was replaced by one of copper the galvanometer then gave no throw. (In the discussion which followed it was remarked, in opposition to this view, that the resistance of the galvanometer was too great to admit of its indicating a simple induced current when experimenting with the copper half-cylinder.) Similarly, Dr. Gross is inclined to exclude as an explanation any induction of the magnet upon itself, and thinks that the cause of the current is the difference of potential between the inner and outer side of the cylindrical magnet. This point he proposes to investigate carefully in a future series of experiments.—Prof. Lampe criticised two papers which appeared last year in the *Repertorium für Physik*, of which one contained an explanation of gravitation, the other treated of the motion of a Foucault pendulum. The speaker pointed out very fully the mathematical and physical mistakes which had made it possible for the author of the first paper to regard gravitation as due to the rotation of the earth.—Prof. von Bezold gave an extremely lucid description of Sprung's balance-barograph.—Prof. C. W. Vogel communicated the most recent discovery in connexion with instantaneous photography, by which it is now possible to obtain instantaneous photographs not only at night but also in the darkest places. Messrs. Goedicke and Miethe have prepared a mixture of pulverized magnesium, chlorate of potash, and sulphide of antimony, which when ignited produces an explosive lightning-like illumination of such intensity that by means of it an instantaneous photograph can be taken. The speaker then gave a demonstration of the discovery by taking photograph[illegible] several persons present; he used the artificial light, of [illegible] each flash lasted one-fortieth of a second, and in a few mi[illegible] produced a picture during the meeting. The powders, a[illegible] pared by the discoverers, cost only a few pfennigs each, and hence readily come into general use.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Papers and Proceedings of the Royal Society of Tasmania for 1886.—Guide to the Science of Photo-Micrography: E. C. Bousfield (Kent).—Questions on Physics: S. Young (Rivingtons).—Encyklopædie der Naturwissenschaften, Erste Abth. 51 Lief., Zweite Abth. 42 and 43 Lief. (Trewendt, Breslau).—Elements of Physiological Psychology: G. T. Ladd (Longmans).—Les Pigmées: A. de Quatrefages (Baillière, Paris).—Official Record, New Zealand Industrial Exhibition, 1885.—Report of the Metropolitan Board of Works, 1886.—British Dogs, No. 7: H. Dalziel (Gill).—Bees and Bee-keeping, vol. ii. Part 8: F. R. Cheshire (Gill).—Reports of Experiments with various Insecticide Substances (Washington).—Our Shade-Trees: C. V. Riley (Washington).—Bulletin of the Iowa Agricultural College, November 1886 (Iowa).—Report of the Felsted School Natural History Society, 1886.—Diseases of the Hair, &c.: J. Startin (Harrison).—International Journal of the Medical Sciences, April (Cassell).—Journal of the College of Science, Imperial University, Japan, vol. i. Part 2 (Tokyo).

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THURSDAY, JUNE 16, 1887.

THE JUBILEE.

BEFORE our next number appears, most of the celebrations connected with the fiftieth anniversary of the Queen's accession will have taken place; and in London, at all events, the gorgeous ceremonials which are now being prepared for next Tuesday will have been the admiration of hundreds of thousands of Her Majesty's loyal subjects. It is therefore quite right and fitting that in a journal devoted to the progress of science, which the history of the last fifty years has shown to be the main basis of modern civilization, we should for a moment turn aside from our true function—that of fostering and recording the progress of natural knowledge—and dwell for one moment on the subject now uppermost in all minds, and dear to most British hearts. We know that in loyalty the students of Nature in these islands are second to none; and their gladness at the happy completion of the fifty years' reign, and their respect for the fifty years' pure and beautiful life, are also, we believe, second to none. But the satisfaction which they feel on these grounds is tempered when they consider, as men of science must, all the conditions of the problem.

The fancy of poets and the necessity of historians have from time to time marked certain ages of the world's history and distinguished them from their fellows. The golden age of the past is now represented by the scientific age of the present. Long after the names of all men who have lived on this planet during the Queen's reign, with the exception of such a name as that of Darwin, are forgotten; when the name of Queen Victoria even has paled; it will be recognized that in the latter half of the nineteenth century a new era of the world's history commenced. Whatever progress there has been in the history of any nation during the last fifty years—and this is truer of England than of any other country—the progress has been mainly due to labourers in the field of pure science, and to the applications of the results obtained by them to the purposes of our daily and national life.

Space utterly forbids that we should attempt to refer to the various memoirs, discoveries, and inventions which at once are suggested to the memory when one throws one's self back fifty years and compares the then condition of England with the present one; and we do not suppose that the most Philistine member of any community in our land, from the House of Lords downwards, will urge any objection against the statement.

It is quite true that some men of science take a pride in the fact that all this scientific work has been accomplished not only with the minimum of aid from the State, but without any sign of sympathy with it on the part of the powers that be.

We venture to doubt whether this pride is well founded. It is a matter of fact, whatever the origin of the fact may be, that during the Queen's reign, since the death of the lamented Prince Consort, there has been an impassable gulf between the highest culture of the nation and Royalty itself. The brain of the nation has been divorced from the head.

Literature and science, and we might almost add art, have no access to the throne. Our leaders in science, our leaders in letters, are personally unknown to Her Most Gracious Majesty. We do not venture to think for one moment that either Her Majesty or the leaders in question suffer from this condition of things; but we believe it to be detrimental to the State, inasmuch as it must end by giving a perfectly false perspective; and to the thoughtless the idea may rise that a great nation has nothing whatever to do either with literature, science, or art—that, in short, culture in its widest sense is a useless excrescence, and properly unrecognized by Royalty on that account, while the true men of the nation are only those who wield the sword, or struggle for bishoprics, or for place in some political party for pay.

The worst of such a state of things is that a view which is adopted in high quarters readily meets with general acceptance, and that even some of those who have done good service to the cause of learning are tempted to decry the studies by which their spurs have been won.

If literature is a "good thing to be left," as Sir G. Trevelyan has told us, if Mr. Morley the politician looks back with a half-contemptuous regret to the days when he occupied a "more humble sphere" as a leader of literature, if students are recommended to cultivate research only "in the seed-sowing time of life;" are not these things a proof that something is "rotten in the State," even in this Jubilee year? It surely is well that literature, science, and art should be cultivated by men who are willing to lay aside vulgar ambition of wealth and rank, if only they may add to the stock of knowledge and beauty which the world possesses. It surely is not well that no intellectual pre-eminence should condone for the lack of wealth or political place, and that as far as neglect can do it each scientific and literary man should be urged to leave work, the collective performance of which is nevertheless essential to the vitality of the nation.

We venture to think that our view has some claims for consideration when we note what happens in other civilized countries. If we take Germany, or France, or Italy, or Austria, we find there that the men of science and literature are recognized as subjects who can do the State some service, and as such are freely welcomed into the councils of the Sovereign. With us it is a matter of course that every Lord Mayor shall, and every President of the Royal Society shall not, be a member of the Privy Council; and a British Barnum may pass over a threshold which is denied to a Darwin, a Stokes, or a Huxley. Our own impression is that this treatment of men of culture does not depend upon the personal feelings of the noble woman who is now our Queen. We believe that it simply results from the ignorance of those by whom Her Majesty is, by an unfortunate necessity, for the most part surrounded. The courtier class in England is—and it is more its misfortune than its fault—interested in few of those things upon which the greatness of a nation really depends. Literary culture some of them may have obtained at the Universities, but of science or of art, to say nothing of applied science and applied art, they for the most part know nothing; and to bring the real leaders of England between themselves and the Queen's Majesty would be to commit a *bêtise* for which they would never be forgiven in their favourite *coteries*. No subject—still less a courtier—should be compelled to demonstrate his own insignificance. That this is the real

cause of the present condition of things, which is giving rise to so many comments that we can no longer neglect them is, we think, further evidenced by the arrangements that have been made for the Jubilee ceremonial in Westminster Abbey. The Lord Chamberlain and his staff, who are responsible for these arrangements, have, we are informed, invited only one Fellow of the Royal Society, as such, to be present in the Abbey; while with regard to literature we believe not even this single exception has been made. It may be an excellent thing for men of science like Prof. Huxley, Prof. Adams, and Dr. Joule, and such a man of literature as Mr. Robert Browning, that they should not be required to attend at such a ceremonial, but it is bad for the ceremonial. The same system has been applied to the Government officials themselves. Thus, the Department responsible for Science and Art has, we believe, received four tickets, while thirty-five have, according to Mr. Plunket's statement in the House on Tuesday, been distributed among the lower clerks in the House of Commons. Her Gracious Majesty suffers when a ceremonial is rendered not only ridiculous but contemptible by such maladministration. England is not represented, but only England's paid officials and nobodies.

While we regret that there should be these notes of discord in the present condition of affairs, there can be no question that Her Majesty may be perfectly assured that the most cultured of her subjects are among the most loyal to her personally, and that they join with their fellow-subjects in many lands in hoping that Her Majesty may be long spared to reign over the magnificent Empire on which the sun never sets, and the members of which Science in the future will link closer together than she has been able to do in the past.

IMPERIAL GEOLOGICAL UNION.

NO one interested in geological science could fail to be impressed with the evidence afforded by the Colonial and Indian Exhibition, in its display of natural products, in the conferences connected with it, and in the number of scientific men collected from all parts of the Empire, of the amount of geological work represented by Great Britain and its dependencies, and the commanding position of the Empire with reference to the geology of the world. The same fact was apparent in the importance attached to Colonial and Indian geology and geography at the meeting of the British Association at Birmingham. Influenced by these facts, I was induced to speak somewhat strongly in the address which I had the honour of delivering at Birmingham on the position of Britain and its colonies and the English-speaking world in general with reference to scientific progress. On my return to Canada, and more particularly after the (temporary, as I hope) failure of the project to hold a meeting of the British Association next year in Australia, it seemed desirable to give the matter some definite form; and after correspondence and consultation with friends, I was induced, in February last, to address a letter on the subject to Prof. Stokes, the President of the Royal Society. The reasons for this course were that both Prof. Huxley and his successor in the Presidential chair of the Royal Society had suggested an Imperial Scientific Union, and the subject was understood to be under the consideration of the Council of the Society, which from its central and commanding position has a right to the initiative in any movement of this nature. In this letter geological science is alone directly referred to, as being that with which the writer is more immediately connected and that which in some respects has already the best organization; but without excluding other departments of science. Special reference is also made to Canada, as affording an apt illustration of the extent and value of the geological domain of the Empire. I need scarcely add that the present year, distinguished as it is by many movements in the direction of Imperial Union, in connexion with its being the fiftieth year of the reign of Her Gracious Majesty Queen Victoria, seems especially auspicious for such a project. The following are extracts from the letter referred to

"It is, I think, evident from the report of the last meeting of the International Congress of Geologists, that great, if not insuperable, difficulties lie in the way of any general agreement as to geological classification, nomenclature, and mapping. These difficulties, however, depend so largely on difference of language and of habits of thought, that they would not affect a union for scientific purposes on the part of the geologists of the British Empire, and ultimately of all English-speaking countries. It therefore appears that such a more limited union might with advantage be undertaken in the first instance, and with the view not of obstructing but of aiding the wider movement.

"The British Empire also possesses exceptional facilities for taking the lead of other nations in so far as geology and physical geography are concerned. The British Islands, as is well known, are remarkable for the great variety of their formations and the excellence of their exposures, and much of the present classification and methods of representation in geology has originated in Great Britain, and has been adopted with slight variation in all English-speaking countries, and to a considerable extent in other countries as well. In Canada we have the larger half of North America, and much of this very satisfactorily explored. We have also the advantages of the best exposures of the older crystalline rocks, of a development of the Palæozoic series in the Eastern Provinces, more closely allied to that of Europe than to that of the interior American plateau, and of Pleistocene deposits so extensive and complete that they must ultimately decide many of those questions of glacial geology which have been so much agitated. In India, Australasia, and South Africa, with the western districts of Canada and various smaller dependencies, we hold a controlling influence in the geology of the great Pacific and Indian Ocean areas. Arctic and Antarctic geology and modern oceanic deposits have been worked principally by English observers, and English-speaking geologists have been and are exploring in many countries not under the British flag. More especially the large amount of geological work done in the United States is based on English methods, and is published and discussed in the English language, and the most intimate and friendly relations subsist between the geologists of the United States and those of Great Britain and the colonies.

"In these circumstances it would seem that a union of British and English-speaking geologists might overcome the difficulties which appear so formidable as between the different European nations, and might lay a broad foundation of geological fact, classification, nomenclature, and representation, which would ultimately be adopted by other countries as far as local diversities and differences of language might permit. Such a geological union would naturally be accompanied or followed by similar co-operation in other departments of investigation in natural science.

"It seems probable that the Geological Survey of Great Britain and the Geological Surveys of the Colonies and of India, with the British Association and the Geological Societies and geological sections of Societies in all parts of the Empire, would be willing to co-operate in such a movement under the auspices of the Royal Society, and that the Council might usefully invite communications on the subject from public departments and Societies, beginning with those of the mother country and its colonies and dependencies, but looking ultimately to union with those of the United States also.

"In the meantime, I propose to mention the subject to the Council of the British Association, to the English and American Committees of the International Congress of Geologists, and to the Council of the Royal Society of Canada, and shall be glad to have your permission to regard this communication as an open letter to be used in any way likely to promote the object in view."

Copies of the above letter were sent to representative men in every part of the Empire, and a large number of replies have been received, expressing an interest in the proposal and readiness to aid in carrying it out. In so far as Canada is concerned, Lord Lorne, the founder of the Royal Society of Canada, and his successor as Patron of that Society, Lord Lansdowne, have signified their hearty concurrence, and the Council of the Society appointed a Committee on the subject, consisting of Dr. Selwyn, F.R.S., Rev. Prof. Laflamme, and the writer, whose report was adopted at the recent meeting of the Society in Ottawa. The following are the conclusions and recommendations of this report:—

"(1) That the objects referred to seem of the greatest importance to the advancement of geological science, and deserve the consideration of this Society, and more especially of its Geological Section.

"(2) That the present year, when all the subjects of the British Empire are united in a common desire to celebrate the fiftieth year of the reign of Her Most Gracious Majesty, when the public mind is impressed with the recent gathering of the resources of the Empire in the Colonial and Indian Exhibition, when plans for Imperial Federation are before the public, and when a Conference of delegates from the colonies, for the purpose of promoting a more intimate connexion, is being held in London, appears eminently favourable to the realization of the idea of an Imperial Geological Union.

"(3) It would appear that the first steps towards such union should be taken by scientific bodies in London, and that the Royal Society of London should be requested to begin the movement by inviting in the first instance to a Conference, representatives of the Geological Survey of Great Britain and of the various Societies and Associations in Great Britain and Ireland prosecuting geological work, with representatives from similar bodies in the colonies. Such Conference might define the objects to be attained, might prepare a constitution and arrange for subsequent meetings and for reports to be sent in on important questions.

"(4) It appears to your Committee that when thus organized, the work of the 'Imperial Geological Union' might be carried on by local and general conferences and conventions: by regular reports from local branches for publication annually by the Officers or Council of the Union; by correspondence and conference with geological bodies abroad, and possibly by other methods which would develop themselves.

"(5) In so far as Canada is concerned, this work might be aided by the Geological Survey of the Dominion, by this Society and the Societies affiliated with it, and possibly also by the Universities.

"(6) The Director of the Geological Survey of the Dominion has intimated his willingness to co-operate in sending representatives of the Survey to any conference or convention, and also by furnishing information as to the work and methods of the Survey.

"(7) It appears to your Committee that this Society might co-operate by empowering the Council to continue its Committee and to select delegates to represent the Society in the event of a preliminary conference being called in London, and by inviting all the affiliated Societies which prosecute geological work in the Dominion to take similar action.

"Your Committee would therefore recommend that this report, with the letter appended, be printed and circulated to the different local Societies connected with this Society, and to such other bodies as may be interested in the matter, and that their aid and countenance be solicited in carrying out the scheme, and that the Society empower the Council, or a committee appointed for the purpose, to represent the views of the Society by correspondence, or by attending any conference on the subject which may be summoned. It will, however, be understood that no expense shall be incurred without consent of the Council of the Society.

"It appears to your Committee that while the usual language of the Union would necessarily be English, communications should be received in any language used within the Empire, and that in this Dominion the English and French languages would be recognized as in this Society."

It will be seen that we hope the initiative will be taken by the Royal Society, and the present communication is intended to aid in securing that general co-operation throughout the Empire which is essential to success. With the same object I have asked the Council of the British Association to throw its influence on the side of union; and propose, in resigning the office with which the Association has honoured me, to make it a personal request that this great Society, which, by its meeting in Canada and its proposed meeting in Australia, has assumed an Imperial character, will take a leading part in the promotion of Imperial union both in reference to geology and to other sciences.

I need scarcely add that the project is not intended to interfere with the operations of the International Congress of Geologists, which is to meet in London in 1888; but it would appear eminently desirable that the contemplated Imperial Geological Union should be organized before that meeting, so as to enable British geology to present a united front, and to assume the importance to which it is entitled.

J. Wm. Dawson.

SOCIAL HISTORY OF THE RACES OF MANKIND.

Social History of the Races of Mankind. Second Division: "Papuo and Malayo Melanesians." By A. Featherman. (London: Trübner, 1887.)

MR. FEATHERMAN does not improve. Those who have read the severe criticisms evoked by previous volumes, and still more those who have read the volumes themselves, will understand how much is implied in these few words, which could be justified only by a stern sense of duty, and regard for the interests of scientific truth. But, as the huge work grows under his hands, it becomes more and more evident that he has undertaken a task entirely beyond his strength. The present volume brings especially into painful evidence the

inherent defects of his method, his inadequate grasp of the subject-matter, and his many shortcomings betrayed at every step in the treatment of details.

And first as to the method. A "social history of the races of mankind," which, as he is careful to tell us, eschews both anthropology and ethnology "in the technical sense of these words," necessarily resolves itself into a history of social progress, such as, for instance, is presented in Mr. E. B. Tylor's "Primitive Culture," or his "Researches into the Early History of Mankind." But Mr. Featherman's work is in no sense a "history," that is, a systematic and orderly treatise on the various phases through which mankind has passed, or is passing, in its upward development from the crude beginnings to the highest aspects of human culture. Any such broad and philosophic exposition of the subject is at once excluded by his method, which consists of a disconnected and more or less accurate account of the habits and customs, social usages, language, religion, and tribal or national organization of the various races and their subdivisions, classified according to a system peculiar to the author. Here we have an interminable series of minute ethnographic pictures, involving endless repetitions, without unity, without point, without those comprehensive generalizations which are essential to give coherence to the whole, and which would flow of themselves from a systematic treatment. These *disjecta membra* may to some extent supply the raw material, but they never can "be considered as a manual of sociology," as is claimed for them by the author.

But owing largely to his inadequate grasp of the subject-matter, this raw material itself is often of a highly unsatisfactory nature, and is so arranged as to be almost worthless to the ordinary student, or in fact to any except those few anthropologists who have the leisure and knowledge needed to re-arrange it for themselves. When Mr. Featherman passed from the "Nigritians" (African Negroes) of the first to the "Melanesians" of this second division, he was at once confronted by one of the most tremendous difficulties in the whole range of anthropology; but of that difficulty, turning upon some rational or at least working classification of the Oceanic peoples, he seems to be absolutely unconscious. Hence in his grouping of these peoples he has fallen into an abyss out of which there is no redemption. It is all very well for him to protest that "it is not the object of this work to discuss contested ethnological questions"; but he himself feels the necessity of some kind of grouping, in establishing which he is fain to discuss some very abstruse questions touching the origin of mankind, the nature of species, the value of language as a racial test, and the like. In general he professes to base his classifications "principally upon physical characteristics and language" ("Nigritians," p. xv.), and this leads him to a classification in the present volume, which confounds the yellow and dark races, which identifies the Malays with the Papuans, which ignores the presence not only of the fair Indonesians, but of the pygmy Negritoes in the Eastern Archipelago, and which, as shown on the very title-page, recognizes in that region, and in fact in the whole of Australasia, eastwards to Fiji, one stock only—the "Melanesian." Of this stock there are two groups, the "Papuo-Melanesians," and the "Malayo-Melanesians," which is like saying the "Black-Blacks" and the "Yellow-Blacks," the latter comprising the Malay race in its widest sense, the former all the rest—that is, the Melanesians proper of Melanesia, the Papuans of New Guinea and neighbouring islands, the natives of New Britain and New Ireland, the Negritoes of the Philippines, of the Malay Peninsula, and Andaman, the Nicobarese, the Australians and Tasmanians. Certainly the Negritoes are nowhere mentioned by name, being ignored as such; but they are nevertheless described as Papuans or Melanesians under other names, such as Ayetas (in the Philippines), Semangs (in the Malay Peninsula), and Mincopies (in the Andaman Islands). On the last-mentioned he quotes somewhat disparagingly (p. 227) Mr. E. H. Man, to whom we are indebted for the very best memoir on this race. Yet even from him he might have learnt that the Andamanese "are Negritoes, *not* Papuans" (Journal of the Anthropological Institute, August 1882, p. 70), just as from the photographs taken by Mikluho-Maclay, and Dr. A. B. Meyer, whom he does not quote, he might have seen how profoundly the Negritoes of the Malay Peninsula and the Philippines differ from the Melanesians. This term Melanesian, which here receives such a prodigious extension, is nowhere very clearly defined, and from its free application to the yellow Malays, one is tempted to ask whether Mr. Featherman is aware that it is Greek for "black."

Of these Malays, again, it is dogmatically asserted (p. 420) that they "did not originate in Asia," although nearly all anthropologists regard them as true Asiatics, a branch of the Mongolic stock, who migrated southwards to the Archipelago while it possibly still formed part of the mainland. But Mr. Featherman has a curious theory about migrations, denying, in fact, "that either animals or plants ever migrate." Hence, for him, the Malays cannot be a branch of the Mongolic race, which they closely resemble, but must be "an island people," a branch of the Melanesians, whom they do not resemble at all. With the Melanesians they constitute one of his six stock races, which, although "zoologically varieties of the same species," nevertheless originated in six different centres, and are consequently not genetically connected. This inference he doubtless seems to repudiate in the present volume (p. viii.). But it is clearly and unequivocally stated in the passage in the previous volume, which he omits to quote in his reply to the critics who had, as he now says, "erroneously if not purposely" affirmed this of him. The omitted words run thus: "The peculiar physical characteristics and the *habitats* of the existing races tend to show that they sprang from distinct individual pairs, developed under a variety of surrounding conditions in different parts of the world" ("Nigritians," xxii.). In fact, the assumption is that like conditions inevitably produce like results, that "the same causes must necessarily produce the same effects under any given circumstances," hence that "plants and animals must have been produced and evolved not by a single pair, but by an indefinite number of pairs in different parts of the world" (xiv.). It follows that crocodiles, for instance, have not migrated, but have been independently evolved under like surroundings in the Old and New Worlds; and so with the "six" human types, "zoologically varieties of the same species," but nevertheless independently evolved

(from what lower types it is not stated) in different centres. So it is argued that "the Darwinian theory of transformism" is entirely wrong, and is caricatured by being compared to the Australian theory of the evolution of man from the lizard, which Mooramoora enabled to walk erect by striking off its tail (p. 181). "A weighty argument against the sweeping transmutation theory of Mr. Darwin" is elsewhere drawn from the Australian quadrupeds, hardly any of which are found in any other country, and it is triumphantly asked, "Why did they not advance beyond the marsupial type?" (p. 112). Mr. Featherman evidently still thinks that under given conditions the marsupial should "advance" to a higher or placental type, unaware that Marsh has shown that there is no such evolution, but that the marsupial and placental mammals descend in independent lines from a common undifferentiated prototype (*American Journal of Science* for April 1887).

We come, lastly, to Mr. Featherman's many shortcomings in the treatment of details, of which it may be said, without any exaggeration, "*Che formicolan d'errori.*" Blunders and unaccountable inaccuracies in geology, history, geography, zoology, ethnology, seem to accumulate at almost geometrical ratio with each succeeding volume. But, as a previous critic is here said (p. xviii.) to have charged him with making mistakes of this sort without pointing them out, it will be only fair to specify at least a few of the more glaring errors occurring at almost every other page of the present volume. In the very first sentence of page 1, Borneo is connected geologically and biologically with the Australian instead of the Asiatic world, to which Wallace and others have conclusively shown that it undoubtedly belongs. A little further on "Borneo, Sumatra, Java, Celebes, and the smaller islands of the Archipelago," are said to have "formed a continuous peninsular dependence of Papua" (p. 1), with which the three first were certainly, and Celebes most probably, never connected. But this re-grouping of the Eastern Archipelago, and the removal of the Indo-Malayan to the Austro-Malayan region was necessary for the author's peculiar views regarding migrations and the "Melanesians," so the results of Wallace's labours in this field are quietly shelved. The members of the animal kingdom are shifted about in the same reckless way, and apparently for no purpose at all, unless it be to show the author's incompetency for the work he has undertaken. Thus the hippopotamus is transferred from Africa to Sumatra (p. 286); birds of paradise from New Guinea to the same region (p. 286), and to Borneo (p. 3); the babirusa from Celebes to "the islands nearest to Malacca" (p. 2), and even to New Guinea (p. 9), where it is described as the *Sus papuensis!* the gazelle from Africa and South-Western Asia to the Eastern Archipelago generally (p. 2); the emu from Australia to Java (p. 361); the orang-utan from Borneo to "Malacca" (p. x.); humming-birds from America to the Philippines (p. 469), after which long flight it was at least courageous to deny that "animals ever migrate" (p. ix.). Topography and geography fare no better, for we have Quettah transported from Baluchistan to the Malay Peninsula (p. 13). On the same page the Ayetas are said to be "found more especially on Alabat Island, where they inhabit the coast as well as the mountain regions." Think of "mountain regions" in Sheppey, for instance, at Thames mouth, for that is about the size of the islet of Alabat, on the east coast of Luzon! And think of this rock being the chief home of the Ayetas, who are scattered over tens of thousands of square miles in the Philippine Archipelago! Is Mr. Featherman poking fun at his readers, when he writes such stuff as this; or is it that he has not the remotest idea of the significance of the terms which he blindly copies from his mostly antiquated authorities? The latter alternative seems forced upon us, when we again read that the islet of Amboyna and the Sulus "are distinguished for their alluvial lands, their navigable rivers, &c." (2). Then the large Solomon Archipelago is reduced to "Solomon's Island" (11), while, by way of compensation, Palawan develops into "the Palaonans" (p. 491). Australia is divided at p. 114, into "five provincial States," which, however, are further on reduced to "four provinces" (p. 181), Queensland being here forgotten. So with the population of Fiji, given correctly at p. 183, and wrongly at p. 187; and of the Philippines, nearly right at p. 470, but entirely wrong (4,290,000) at p. 480; the laborious compiler, with no information of his own, being thus everywhere at the mercy of the authority he happens at the moment to be quoting. A glaring instance is his treatment of the Malay Peninsula and its inhabitants, for which he appears to have seen nothing more recent than Favre's "Wild Tribes" (1852), and an early edition of Wallace, quoting, however, Rosenberg's "Malayische Archipel" (1879), which has nothing at all about the peninsula. The result is ludicrous, the area of this region being given at "about 45,000 square miles" (p. 420), instead of 75,000, and the population at 374,266 instead of 1,200,000. Here, also, "the chief rivers" are said to be "the Lingie, the Malacca, and the Cassang" (p. 419), and the mountains —but without wearying the reader it will suffice to say that the mountains are worse than the rivers. Similar wild statements are made about the Malay language (p. 300) about the population of Java (p. 362), the Javanese language (p. 376), the "Kanaks" of New Caledonia (p. 77), and, to make an end of it, about the Bughis of Celebes, of whom we are gravely informed that their "commercial activity is extremely limited" (p. 447), these Bughis being far and away the most enterprising and commercial people in the whole Eastern Archipelago.

One word in conclusion. If Mr. Featherman sees good to continue this wearisome compilation on the old lines, let him at all events abstain from sneering at specialists like Mr. Man (p. 232, 235), Mr. Taplin (not *Tarplin*, p. 135), Messrs. Fisson and Howitt (p. 141), and others who have done such admirable ethnological work in this Oceanic domain. But above all let him respect the august name of Charles Darwin (pp. 112, 181). A. H. KEANE.

THE FAUNA OF LIVERPOOL BAY.

First Report on the Fauna of Liverpool Bay and the Neighbouring Seas. By Members of the Liverpoo Marine Biology Committee, edited by W. A. Herdman, D.Sc., F.R.S., Professor of Natural History in University College, Liverpool. (London: Longmans. Green and Co., 1886.)

IN this volume are published the results of investigations carried on by a Committee of Naturalists belonging to Liverpool and its neighbourhood. The

inquiries were suggested by Prof. Herdman, and his energy and influence have evidently contributed largely to the success of the work. It is intended that the Committee shall endeavour to found a sea-side laboratory and form a permanent organisation for marine biological research, but its first operations in the summer of 1885 were limited to expeditions for obtaining invertebrate specimens, by dredging, trawling, and tow-netting from steam tugs, and collecting on the shore at low-tide.

The volume consists of a number of reports by the members of the Committee and other naturalists on separate portions of the collections made. The greater number of these reports are lists of species, with a record of the places where each occurred; one or two of the papers deal with matters of more general scientific importance. Prof. Herdman himself identified the Alcyonaria, the Echinodermata, the Nudibranchiata, and the Tunicata, and also is jointly with two other gentlemen responsible for the Hydrozoa. Mr. Hoyle records the Cephalopoda. The experience of these naturalists is a sufficient security for the correctness of their work. In the list of Vermes given by J. A. Harvey Gibson, there are one or two errors which lessen its value. *Cirratulus borealis*, Lamarck, and *C. cirratus*, O. F. Müller, are set down as separate species, and it is stated that the latter, of which a single specimen was dredged, has not previously been recorded from the locality. The two names are synonyms, and to what species the single specimen "in a rather mutilated condition" belonged remains an open question. *Nephthys hombergii*, And. and M. Edw., is given as a synonmyn of *N. longisetosa*, Oersted, but the two names undoubtedly refer to distinct species, and it follows that the specimens of Nephthys examined were not accurately discriminated.

Mr. Harvey Gibson contributes another paper on the structure of some of the Polychæta, in which he gives some interesting notes on certain anatomical points, and gives reasons for concluding that *Pectinaria belgica*, Pallas, and *P. auricoma*, Müller, are synonyms. A short paper by Prof. Herdman, on variation in the Tunicata, discusses the value of different characters in these animals as diagnostic marks, and points out the necessity of thorough anatomical examination in describing species, or even identifying individuals. A species of Sycandra which could not be identified with any already known, and which is therefore probably new, is described by Mr. Harvey Gibson under the name *S. aspera*.

Three introductory papers precede the more special part of the book: one in which Prof. Herdman gives a history of the origin and work of the Liverpool Marine Biology Committee; one by the Rev. H. H. Higgins, containing a review of previous work in the domain to which the volume refers; and one by Prof. Milnes Marshall on shallow-water faunas. In this last a short but interesting comparison is made between the peculiarities of the physical conditions of the littoral region and features commonly occurring in the life-cycle of its inhabitants. Prof. Herdman, in summing up the results of the first year's work of the Committee, gives the following figures:—913 species of invertebrates have now been recorded from the district under examination, of which 235 are new finds made by the Committee: 16 of these are new to the record of the British marine fauna, and 7 species and 3 varieties are new to science. These additions to zoological knowledge are illustrated by ten lithographic plates, which, with the exception of Plate II., containing coloured figures of Anthozoa, and Plate IV., devoted to small crustacean forms, do not attain a very high standard. There are also two maps showing the district explored.

OUR BOOK SHELF.

Oberpliocän-Flora aus den Baugruben des Klärbeckens bei Niederrad und Schleuse bei Höchst a M. T. Geyler und F. Kinkelin. (Frankfort, 1887.)

As a general rule, the more recent the fossil flora the more satisfactory the determinations of the plants comprised in it will appear, though the work of Williamson and others has made an exception of those of the Carboniferous period. In the late Tertiaries the species are so closely allied to those still living that comparisons are relatively easy; but as we go back in time they diverge more and more, and there is less to guide us. The Pliocene floras especially show us that innumerable species that are now exotic were indigenous probably down almost to glacial times, and their study sheds an immense light on the more problematical floras which preceded them.

This work describes a Pliocene flora recently discovered, and regarded as newer in age than those formerly described from the valley of the Maine. It deals chiefly with the fruits of well-known existing genera of north temperate regions. A remarkable exception is an Australian type of Callitris, *Frenèlites*, which appears to be correctly determined. The pines are numerous, among them being *Pinus montana*, and two varieties which are raised to the rank of species—*P. cembra*, determined on part of a cone, *P. strobus* on a scale, and some perfect examples named *P. cortesii*, Ad. Brong. Other conifers are the larch, the silver fir, and the Norway spruce. The American swamp or deciduous cypress, so prevalent in Europe from the Eocene age onward, is represented by foliage. Among the rest are leaves and supposed seeds of the hornbeam, the cup of an acorn, an abundance of beech-nuts, described as *Fagus pliocænica*, and the horse-chestnut, representing the Old World; and fruits of *Liquidambar*, *Nyssa*, a walnut, *Juglans cinerea*, and another nearly allied to *J. nigra*, and three hickories, representing the New. The European and American forms thus appear about equal in number, and there is one Asiatic, the horse-chestnut, and one Australian form.

The data are more trustworthy than are ordinarily obtainable from fossil floras, and they bring into prominence one significant fact—namely, that whenever we get the oak, hazel, walnut, or chestnut in strata so recent as the Pliocene, or even as true Miocene, there is no uncertainty about the genera, for fruits and other organs besides leaves are present; but in the older Tertiaries no distinct fruits of the kind are ever associated with the leaves ascribed to these genera. The evidence I have personally collected in the field seems to show that the early Eocene and pre-Eocene Dicotyledons had small clustered fruits, like *Platanus*, *Alnus*, *Liquidambar*, &c.; that leguminous plants were an Eocene development; while the larger-seeded oak, beech, walnut, hazel, are of later origin. The reliance placed on the mere similarity in the outward appearance of leaves of common types has not been justified by later discoveries, and an immense amount of revision is requisite before the botanist and geologist can safely put his trust in the descriptions of the older Tertiary floras.

J. STARKIE GARDNER.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

British Association Sectional Procedure.

As the time for holding the Manchester meeting of the British Association approaches, it seems natural to inquire whether any action will be taken by the Council of the Association toward carrying out the important suggestions made in the columns of NATURE (vol. xxxiv. p. 495), by Prof. Oliver Lodge, immediately after the late meeting at Birmingham. I can vouch for the fact that many of the active workers in the Section meetings of the Association can heartily indorse the expression of discontent which fell from Prof. Lodge as to the inadequacy of the present arrangements. The effect of the attempt to shirk holding Section meetings on the Saturday, and on the succeeding Wednesday, has been to cause a most undesirable pressure upon the time available on other days, and has rendered serious and effective discussion of the subjects of the papers almost impossible. It is understood that at Manchester, thanks to the generous hospitality of the local leaders, the Association will be graced by the presence of an unusual number of foreign men of science, including some of the most distinguished of chemists, physicists, and biologists. This fact is in itself an additional reason for expecting earnest and lively discussions to arise in the Section meetings,—discussions such as add greatly to the interest of the meetings, and are of extreme value to those who are actual workers in science. It would indeed be cause for regret if the anticipated discussions were to be burked or spoiled by want of due attention to the arrangements of the meetings. The suggestions of Prof. Lodge are indeed so timely that I fear to weaken their force by adding to them or emphasizing any of them. Yet I cannot refrain from urging two points: one the extreme undesirability of scamping the Wednesday sitting; and the other the advisability of reconsidering the hours of holding Committee meetings. Why should not the Sectional Committees meet from 3 to 4 o'clock, and the Sections at 10.30? A clear half-hour would be gained; Committee-men might slip out for lunch instead of attempting to sit out a dwindling meeting in a famished state; and they would continue their attendance to the end of the Section meeting because of the Committee meeting at its close.

Further, much good would accrue if the Council would cause to be published from the first the days and hours appointed for the reading of papers or the holding of discussions on the various topics. Last year I succeeded in inducing the Sectional Secretaries to begin this practice, in spite of the cold water thrown upon my suggestion by more than one of the ancient lights of the Council. If the Council would only, as a matter of good business-like arrangement, issue instructions that this should be done in No. 1 of the Journals, the benefit would be double. As an instance I will only mention that many of the members of the Committee on Electrolysis, of which Prof. Lodge is Secretary, are looking forward to a full and interesting discussion of their report, in which discussion they especially anticipate that an important part will be taken by their distinguished Continental visitors. Knowing this to be the case, why cannot the Council fix beforehand a day and hour for this matter, which is to many of the physicists and chemists the most important event of the meeting, more important than the addresses of Presidents of Sections, more important than the set evening discourses, more important even than the address of the President himself?

SILVANUS P. THOMPSON.

20 Arundel Gardens, W., June 4.

The Recent Earthquakes in Mexico and Turkestan.

IN vol. xxxiv. p. 570 of NATURE you kindly allowed me to bring forward some facts in support of a view advanced by me and mentioned in your review of the "Catalogue of European Earthquakes" which appeared in your number of September 16, 1886 (vol. xxxiv. p. 465), that earthquake localities lie on or are connected by great circles representing main lines of fissuring and therefore coast-line directions. Since then I have observed and noted two or three other remarkable cases, but the earthquakes recently reported (May 30) from Mexico, and June 9 from Turkestan, are so interesting in this respect that I venture to ask you for permission to point out how a great circle connects them.

This great circle is a coast-line direction which I had laid down and called "Coast of Coromandel Great Circle." It passes through or near the following localities and points. Parting from the mouth of the Musi River on that coast it takes in the coast-line to Pulicat; traverses the Indian and Southern Oceans and South Polar region (passing not far from the South Magnetic Pole); traverses the South Pacific and cuts the coast of Mexico at Talipa; passes at Oaxaca (the province of the same name is named as having been affected by the recent earthquake), also between Puebla and Vera Cruz (also similarly affected); runs parallel to the west coast of the Mexican Gulf; traverses the United States, about 200 miles west of the boundary shown in Major Powell's map of the earthquake of August 31, 1886 (see NATURE, vol. xxxv. p. 31), and roughly parallel to it; cuts the west coast of Hudson's Bay at the mouth of the Nelson River; passes at about 1° east of the North Magnetic Pole; traverses the North Polar region; crosses Nova Zembla, and the promontory to the north of the Sea of Obi and Siberia; and passes at about fifty-two miles to the west of Vernoje.

It may be of interest to remark that a great circle representing the Riviera coast-line, so lately and so disastrously shaken, passes in a north-west and south-east direction about 4° to the north-east of this point, and as the Turkestan earthquake has evidently extended beyond Vernoje, the actual distance between this great circle and the district affected may be less than 4°. In any case it is an interesting relation, and all the more so as this Riviera great circle cut New Zealand in the vicinity of the earthquake district of June 10, 1886, itself antipodal to that of Andalusia of December 25, 1884.

J. P. O'REILLY.

Dublin, June 11.

The Late Earthquake on the Riviera, February 23, 1887.

HAVING been at Nice during the late earthquake, I was much interested in the accounts published in NATURE (vol. xxxv. pp. 419 and 442), from which I have drawn up the following table:—

Earthquake of February 23, 1887.

Local time.	Greenwich M.T.	Duration.	Distance, miles. (From	Time, minutes. Nice.)	Velocity miles per minute.
Nice— h. m. s.	h. m. s.				
(1) 5 59 0 a.m.	5 50 0	55 secs. 25 intense.			
(2) 6 10 0	5 41 0	5?			
(3) 8 30 0	8 1 0	10?			
(4) 11 15 0 p.m.	22 46 0				
Marseilles—					
(1) 5 55 0 a.m.	5 33 40	30 secs.	100	3½	30
(2) 6 5 0	5 43 40	15 ,,	100	2½	37
Turin—					
(1) 6 22 0	5 32 0		100	2	50
(2) 6 31 0	5 41 0		100	? simul	taneous.
(3) 8 53 0	8 3 0		100	2	50
Basle—					
(1) 6 4 7	5 34 5		270	4	67
Paris—					
(1) 5 45 0	5 35 30		420	5½	76
Greenwich—					
(1) 5 38 0	5 38 0	20 secs.	650	8	81
(2) 5 45 0	5 45 0		650	4?	? 160
6 0 0	6 0 0				
7 40 0	7 40 0				
7 50 0	7 50 0				

I am indebted to M. Perrotin, of the Nice Observatory, for some useful information. He tells me that "the first shock lasted *nearly one minute*; it began by being very slight at first, and then became *very intense*: this latter phase lasted from 20 to 30 seconds."

We were all accused of great exaggeration in our accounts of the earthquake (I put the first shock at half a minute), but this more than confirms our estimates. A gentleman from South America, accustomed to earthquakes every week, told us that it was "a pretty good shake up."

According to Lyell, Mallet, and others, we at Nice being on alluvial deposits—gravel, clay, &c.,—felt not only the original shock, but also the rebounds from the rocks on either side; this would account for the very violent shaking that we had. I have compared notes with dozens of people, and feel sure that it was quite different from the sort of shock they felt at Cannes, Monte Carlo, and other places on rock, even the east bay at Mentone (the west bay suffered more than Nice). What saved us from being knocked down was, I suppose, that the amplitude of the vibrations was small, probably only a few inches. In the Italian Riviera (Diano Marina, &c.) they must have been more severe. Most people think that one more shock of the same strength would have brought half the houses down. A railway carriage going at 60 miles an hour gives the best idea of what our rooms were like during the first shock; it was impossible to stand on the floor without holding on to something, like a landsman on board a ship in a storm.

It would appear from the times given in the table that the velocity of this earthquake was high: 76 miles a minute to Paris, and 81 to London—a curious case of velocity increasing with distance.

The second shock seems to have gone faster than the first. The ordinary rate of earthquake-shock velocity is (according to Prestwich's "Geology"):—

1857. Neapolitan earthquake ...	...	9 miles per minute.	
1843. United States ,,	... ...	32	,, ,,
1869. Cachar (India) ,,	... ...	83	,, ,,

The centre of the shock was somewhere in the Gulf of Genoa, near Savona. The second shock was slight. The third was strong, but short.

The noise before the first shock was very loud, like a large steam blast. There were more than half a dozen other shocks in the two following days, but they were slighter, and chiefly oscillatory; curiously enough, we did not mind them so much as the vibrations, though I believe they are much more dangerous, if severe.

The night before the earthquake some horses were nervous and refused food, and dogs howled, but I naturally supposed that it had something to do with the Carnival which was being celebrated at the time. J. E. H. PEYTON.

108 Marina, St. Leonards-on-Sea, May 19.

The Shadow of Adam's Peak.

I HAVE recently seen a paper, read before the Physical Society by the Hon. Ralph Abercromby, which apparently shatters an explanation proposed by me to the same Society of the phenomena of the shadow of Adam's Peak in Ceylon. Whilst not anxious to support my own theory, if one more consistent with the phenomena has been discovered, I venture to think that there are certain considerations which militate against the new theory, and render it incomplete; and, with your permission, I will enumerate them.

(1) Mr. Abercromby says that it is the intervention of near and moving mist which produces the apparent uprising of the shadow. Is it possible that such a simple explanation could have escaped the notice of the hundreds of observers who have witnessed the phenomenon, and returned with the impression that there was something inexplicable about the shadow? It is difficult to imagine observing and reasoning faculties so rudimentary as not to be able to observe that a shadow was on mist, and reason from that to an explanation of the apparent approach and uprising of the shadow.

(2) Mr. Abercromby's theory depends on the intervention of near and moving mist rising from the Maskeliya Valley. This valley stretches away behind the observer in a south-east direction as well as to the north-west, and mist rising from it would be quite as likely to intercept the sun's rays behind as to form a curtain in front for the shadow to be projected on, and it would be only on very rare occasions, such as Mr. Abercromby describes, that the mist would keep entirely to the north-west of the Peak. Why it should do so is not explained. Therefore the uprising of the shadow could only be seen on such very rare occasions.

(3) Mr. Abercromby says: "Our fortune was in the unsettled weather, which made the mist so coarse and close that the unequivocal bow left no doubt as to the true nature of the cause;" "the sky was covered with a confused mass of nearly every variety of cloud;" "below and around us cumulus and mist;" "a pale moon with an ill-defined *corona*;" "sometimes masses of mist coming up from the valley enveloped us with condensed vapour;" "driving condensed vapour was floating about, and a fragment of rainbow-tinted mist appeared near the top of the shadow." Under such conditions, what else could Mr. Abercromby have seen than what he describes, the shadow on the mist, a circular rainbow, spectral figures like those of the Brocken, the rising and falling of the shadow as the mist intervened or passed away? Instead of "fortunate" in his conditions, I think Mr. Abercromby was the very reverse. To be "fortunate" he should also have seen the shadow in a clear atmosphere, and noted the *absence* of any appearance of uprising. Mr. Whymper, in his famous descent of the Matterhorn after the accident, saw in the evening a fog-bow very similar to that described by Mr. Abercromby, and the presence of mist was noticed in that case. But I ask, and I am willing to rest my theory on the answer, Is not the phenomenon of the apparent uprising of the shadow, witnessed when no mist is visible, and the atmosphere to the north-west is clear? This furnishes a simple *crux* of the two theories; for any observer can notice whether mist is visible or not, and if not, whether there is any appearance of the uprising of the shadow or not. Until corrected by future observers, I maintain that the phenomenon is seen when there are not "around us cumulus and mist" and "masses of mist coming up from the valley;" in fact, when the air is so calm and clear that the coast-line can be traced at a distance of seventy miles or more. If I am proved to be correct in this opinion, the new theory has not advanced the explanation by a single step. My theory of total internal reflection depends on the difference of temperature between the air in the low country and on the Peak, which is most marked in clear calm weather, ice forming at such times on the Peak, while a fall of the thermometer to 70° F. in the low country is commented on as noteworthy by the newspapers. The conditions described by Mr. Abercromby render the idea of mirage absurd; but they also suggest, if the new theory be correct, the absurdity of there ever having been any mystery about the phenomena of the Shadow of the Peak.

May 30. R. ABBAY.

Upper Wind Currents near the Equator and the Diffusion of Krakatão Dust.

I REGRET that Mr. Abercromby, before writing his interesting and suggestive article under the above heading, had no opportunity of making himself acquainted with the conclusions arrived at by the Krakatão Committee regarding the rate at which the finest ejecta were carried round the world. The velocity he ascribes to the material, viz. 120 miles an hour, deduced apparently from the few observations he quotes, is quite 40 miles an hour in excess of that deduced from the numerous cases treated by Mr. Russell and myself. In one or two cases in the Indian Ocean the velocity does apparently approach to that given by Mr. Abercromby, but these are both exceptional and doubtful, since they were probably due to minor outbursts antecedent to that which gave rise to the grand stream which encircled the globe at an average pace of 80 miles an hour.

Mr. Abercromby has thus accidentally made the problem appear far more formidable than it really is. A constant velocity of 120 miles an hour right round the world, though not outrageous to anyone who reflects on the great mobility of the atmosphere at the height of 100,000 feet or more, certainly makes a considerable demand upon our powers of scientific imagination, while a velocity of only 80 miles an hour, even though constant over the entire equatorial belt, does not appear, at such a height, to be opposed to what is already known of the motions of the atmosphere at the far inferior elevation of the cirrus clouds.

The height of the stratum is certainly a factor which cannot be overlooked, for if we find the average velocity of the wind continually increase as we ascend to the cirrus, it is reasonable to conclude that it rises beyond this limit, and if so a constant

wind of 80 miles an hour at an elevation of 100,000 feet (less than the height deduced by Verbeek for that reached by some of the ejecta) might theoretically co-exist with a trade wind of ordinary velocity at the earth's surface.

It is not so much with reference to the velocity as to the direction of the upper currents near the equator that Mr. Abercromby's itinerary observations are valuable, since they correspond both normally and exceptionally with what might be expected from the laws of aero-dynamics. Theory is naturally perhaps, though still somewhat singularly, silent as to what is supposed to be the motion of the air in the upper regions of the belt bounded by 15° on either side of the equator. Ferrel's equations are not very satisfactory for this space, owing to the smallness of the term $2v\omega \sin\theta$ representing the deflecting force of terrestrial rotation (*ablenkungskraft*), and close to the equator fail altogether at the surface. That the wind there, however, still maintains its westward component under the normal conditions which accompany the north and south trades is plain both from Mr. Abercromby's and other observations. Higher up, owing to the absence of friction, the air tends to move in the "inertia curve" corresponding to its motion at the surface, whose radius of curvature is $\frac{v}{2\omega \sin\theta}$; and since near the equator $\sin\theta$ is very small this curve is very nearly a straight line parallel to the equator. Whatever therefore happens to the surface wind through local influences such as latitudinal shift of thermal equator or doldrums, or the establishment of a local heat maximum on a land surface causing a deflection of the normal trade wind into a local monsoon, ought not to interfere sensibly with *the general tendency of the upper air to stream from east to west for a considerable space on either side of the equator*. I may just remark, *en passant*, that the belt bounded by 15° N. and S. latitude embraces an area of more than one-quarter of the entire surface of the globe.

The apparent anomalies as well as rules exhibited by Mr. Abercromby are thus seen to be in complete accordance with the above principle. It is only when we get some distance away from the equator that the gradient towards the poles in the upper atmosphere becomes large enough to change the westward into an eastward motion. As the air slides down this slope the radius of the "inertia curve" becomes smaller, and it veers through S.E. and S. to S.W., the normal direction of the upper current at the boundaries of the trade zones.

That the barometer gradient at a height of 13,000 feet over the equator is very small either from or towards the poles may be gathered from the following extract from a table given by Dr. Sprung in his "Lehrbuch der Meteorologie" (Hamburg, 1885):—

	Height 13,123 feet. Mean pressure in inches.
Lat. 20° N.	18·504
10°	18·532
0	18·543
10° S.	18·547
20°	18·547

Above this height the gradient towards the poles would increase, but theoretically there might be no change in the direction of the wind near the equator.

June 3. E. DOUGLAS ARCHIBALD.

Mammaliferous Gravel at Elloughton, in the Humber Valley.

I WAS informed a short time ago that a large bone had been found in a gravel-pit near Brough, on the Humber, and went at once to examine the place. I found the "bone" to be a mammoth's tusk of large size, and learnt that other teeth and bones had not infrequently been exhumed in the pit. As this seems to be a new locality for mammalian remains, I think a short description of the deposit may be found useful.

The excavation was commenced about twelve months ago on the top of a small isolated hill known as Mill Hill, which rises out of the Humber Flat to a height of about 90 feet, close to the village of Elloughton, and since that time there has been a constant and steady removal of the material, so that a good section is now exposed. The hill forms an outlier of the Wold Range, from which it is separated by low ground nearly a mile in width, the north shore of the Humber lying about one mile to the south of it. It is composed of Oolitic rocks overlain by gravel. The section at present shown is as follows:—

A. Top-soil, &c.... ...	2½ feet.	A British burial found in this layer, on the west side of the pit.
B. Rough stony gravel, with sand...	about 9 feet.	Contains pebbles of flint, sandstone, red chalk, Oolitic limestone, and other local rocks, along with a few well-worn erratic pebbles of felstone, quartzite, &c.; also rolled lumps of clay and streaks of carbonaceous matter like decayed vegetation.
C. Yellow sand, with stony layers	about 5 feet.	The mammoth's tusk and other bones were found in this bed.
D. Hard gray clay, forming floor of pit		Of doubtful age, but probably belonging to the Estuarine Oolites.

In the rough gravel, B, there are some boulders of local rocks so large as to suggest the idea that floating ice has been the agent of their transportation, especially as it seems as though the blocks must either have been raised from a lower level, or floated over the depression intervening between this hill and the Oolitic exposures in the flanks of the adjacent Wolds.

The junction of B with C is very well marked, and there are signs of erosion, and unconformity between them; but as the whole of the beds are current-bedded and irregular, this line of separation may be of no importance. On the other hand, since fossils seem only to be found in the sand, C, this may be the remains of an older deposit which has been denuded during the deposition of the overlying unfossiliferous gravel, B, and this latter bed may be a continuation of similar rough unfossiliferous gravels seen on the lower ground to the westward.

If the clay exposed on the bottom of the pit really forms part of the Oolites, I see no means of determining the age of these gravels; but my impression is that at any rate they are not older than the oldest boulder-clay of Holderness, and are probably not later than the newest. At Hessle, six miles to the eastward, bones have been found in a chalky rubble underlying boulder-clay, which Prof. Phillips regarded as pre-Glacial. At Bielbecks, seven miles to the northward, similar remains were obtained in 1829 from a fresh-water deposit which I think was regarded as post-Glacial. It may be that these deposits will eventually prove all to be of one age.

The size and condition of the tusk were such that I do not think it can have been carried hither by water-currents alone. It has more probably either been dropped from the floating or living carcase of the animal or from a mass of floe-ice. Its length, as it lay exposed on the floor of the pit at the time of my visit, was 90 inches, but the workmen said they had broken up about two feet of the "thick end" before they were aware; and as the apex was also blunted and badly preserved, I think its length when first deposited cannot have fallen short of 10 feet. Its diameter was 6 inches at a distance of 10 inches from the apex; 7½ inches at 20 inches; 8 inches at 30; 8½ at 40, beyond which it did not seem perceptibly to thicken. It lay in a water-logged gravel, and was in a very friable state; and though I was enabled, through the kindness of Mr. H. Lyon, the owner of the pit, to strengthen the specimen with cement, it crumbled into small splinters when an attempt was made to remove it, and was irretrievably ruined. Its curvature was not great, and would lie within a breadth of about 20 inches.

The only other remains I have yet obtained from the pit are some portions of the teeth of the mammoth and a few irrecognizable fragments of bone.

In the top-soil on the west side of the pit a British burial has been cut through, wherein lay the bones of a human skeleton, together with a fragmentary vase with the characteristic ornamentation. G. W. LAMPLUGH.

Bridlington Quay, June 6.

Fall of Peculiar Hailstones in Kingston, Jamaica.

SHORTLY after midday on the 2nd inst. a thunderstorm visited this city; the rain began with the wind from the east, as is usual with our May seasons, but it speedily changed to the

west, accompanied with much lightning and thunder. Immediately hailstones became mingled with the rain, attention being drawn to their advent by the sharpness with which they struck on the shingled roofs. The west door of the laboratory being open to the air, the hail came in freely, nearly covering the floor for more than 12 feet. The hailstones were of clear ice, inclosing a few bubbles of air, varying from mere points to bubbles of the size of a split pea. The shape of the stones



was singular. Suppose a shallow and very thick saucer to have a shallow cup, without a handle, inserted in it, and you will have a good idea of the form of the hailstones when unbroken. Many had more or less lost the "saucer" by violence, while some were entirely without it, presenting the appearance of a double convex lens with faces of different curvature.

By actual measurement the hailstones were found to vary from one-quarter to three-quarters of an inch in diameter, and from one-eighth to one-quarter of an inch in thickness at the thickest part. I observed that in very many of the larger stones the air-bubbles could move about, showing the interior to be still liquid; as melting proceeded the bottom of the "saucer" would suddenly give way and become concave. The storm lasted about 15 or 20 minutes, hail falling for the greater part of the time. The hail which fell on grass remained unmelted for ten or fifteen minutes after the rain ceased. The fall of hail was very local, none falling at my house a mile away. I am informed that hail last fell in Kingston in 1839.

JAMES JOHN BOWREY.

Government Laboratory, May 12.

Singular Nesting-place of Linnets

IT may be interesting to some of your readers to know of the recurrence of a strange freak on the part of a pair of linnets. Last year they selected, as the scene of their nest-building and other parental operations, the interior of a Maltese water-bottle, hung against a brick wall, at the back of the house of Capt. G. Wood, and in a sort of half yard, half garden. The bottle is of porous ware, 10 inches high, 7 inches wide at its broadest part, which is mid-way between the bottom of the neck and the base, and having an upright constricted neck 4 inches long and only 1¼ inches in diameter on the inside. In this singular receptacle the birds contentedly built, laid their eggs, and successfully reared their brood.

This year, strange to say, the same pair, or one identically like them, have returned to the old haunt, deftly repaired and slightly added to the old nest, laid their eggs, and now have a vigorous progeny of five or six unfledged youngsters.

How the birds came, in the first instance, to select such a shelter, seeing that they could only pass in or out with folded wings, and by a sort of dart, and that to enter the neck from within in this way must have been a task of considerable skill and no little difficulty, is a mystery; but that they should have retained such a happy memory of their first sojourn as to lead them to return to their old quarters, is more interesting still.

H. VIAN-WILLIAMS.

3 Waterloo Place, North Shields, June 2.

A Brilliant Meteor.

YESTERDAY I saw a very brilliant meteor with train, resembling a firework in shape, colour, and other features. It was coming from Ursa Major, and vanished midway between α Lyræ and δ Cygni. Motion very slow; 21h. 19m. mean Turin time.

Turin, June 11. F. PORRO.

ELECTRICITY AT OXFORD.

IT is with very great regret that we learn that the study of natural science in the University of Oxford received last week a blow which is all the more to be deplored in that it was, in part at all events, delivered by those from whom such an onslaught was least to have been expected. Professed hostility or indifference to the great scientific movement of the day, injudicious economy,—these are obstacles which promoters of that movement must be prepared to face, and will in the long run overcome. It is not, however, to be expected that progress will be made if each forward step is checked by those who have themselves enlisted on the side of science.

The cardinal point which the University had to decide was whether it should or should not provide itself with a laboratory for the development of the teaching of electricity. The Clarendon Laboratory was, we believe, the first building in this country which was planned and erected for the study of experimental physics alone. It was designed about twenty years ago by Prof. Clifton, and, if we except the provision made for electricity, nothing better or more complete is to be found within the four seas.

Rooms were, it is true, originally set apart as electrical laboratories. The rapid growth of the science would have sufficed to render them inadequate now, but we gather from a statement circulated by Prof. Clifton that other causes have combined to strengthen the case for an extension of the building.

Optics has been a favourite subject among students of physics at Oxford, and optical apparatus now occupies the space intended for electrical instruments. Thus it has come to pass that "the important branches of electricity and magnetism are," in the words of the Professor, "necessarily excluded from the practical course."

In consequence of this unsatisfactory condition of affairs, Prof. Clifton has for some years lectured almost exclusively on electricity, and has been compelled to discuss methods of manipulation and details as to instruments which are usually mastered in a laboratory. The Lee's Reader in Physics, Mr. R. Baynes, has also established a practical course on electrical measurements, in Christ Church. Although the work he has thus done is excellent, we believe that it is not contended that Christ Church is in a position to make a permanent provision for instruction in electricity on a scale adequate to the requirements of the University.

For some time past, therefore, the University has been urged to add a wing for electrical work to the Clarendon Laboratory.

The necessity of providing for other University requirements has caused a long delay, but at length the turn of physics seemed to have come. Plans prepared by Prof. Clifton were submitted to the Hebdomadal Council. Mr. Henry Wilde, F.R.S., generously promised a gas-engine, dynamos, and an electric lamp. The Delegates of the Museum (who superintend the laboratories of the University), the Curators of the Chest (who have charge of its financial affairs), approved the scheme. It was adopted by the Council, and nothing remained but for the graduates in Convocation assembled to give their assent.

At the last moment, however, unexpected opposition arose. Balliol and Trinity Colleges have for some years combined their provision for the teaching of natural science, and the President of Trinity, acting for these Colleges, issued a pamphlet hostile to the grant for the proposed new laboratory. This step was taken on two grounds, both of which appear to us mistaken.

In the statement above referred to, Prof. Clifton had mentioned as an advantage incidental to the erection of the new laboratory that he would be able to abandon the lecture course of electrical demonstrations, as the instruction given in them would be better provided for in laboratory work. He proposed to substitute a general course on physics, addressed not only to the comparatively few students who aim at high honours in that subject, but to the larger body who enter for the first or preliminary stage of the honour examination. To this

the authorities of Trinity objected that instruction of this kind was already given by one of their lecturers.

Into the merits of a dispute on a question of organization of this kind it is difficult, and perhaps unnecessary, to enter. The main fact is that, even if Balliol and Trinity are right in claiming as against the University something like a monopoly of general lecture instruction in physics, they have enforced that claim by placing, for an indefinite period, the Oxford school of physics at a serious disadvantage. Not a penny of the grant asked for was to be expended on apparatus for elementary lectures. It was all required for a lodge, for expenses connected with Mr. Wilde's installation, and for an electrical laboratory such as other Universities have and the University of Oxford has not. The President of Trinity no doubt thought that he was striving to prevent the University incurring an unnecessary expense. Could not some of his scientific advisers have informed him that the questions as to whether an electrical laboratory should be built, and as to whether Prof. Clifton should spend the time which its erection would place at his disposal in delivering a particular course of lectures, are separate and distinct? Are there no Boards or Faculties in Oxford in which the arrangement of lectures can be discussed without the friends of progress obstructing progress in Convocation? Opposition to the extension of the Clarendon Laboratory (the necessity for which they did not deny), lest as a secondary result of that extension a course of lectures should be given, which would involve no cost to the University, but which they feared might infringe their own real or supposed rights, is not an attitude for which the combined Colleges can expect much sympathy.

The second point which was raised by the President of Trinity was dealt with in an equally unsatisfactory manner. In 1886, Trinity College built and opened the Millard Laboratory for instruction in theoretical and practical mechanics and engineering. The Laboratory contains a steam-engine and three dynamos. It is about to be further extended, and it is claimed that it contains all the apparatus required for technical work in electricity. The President recited these facts in his pamphlet, and then added: "But with the question of advanced work I must leave others, who have more knowledge, to deal."

We venture to think that before describing the Millard Laboratory in detail in a pamphlet opposed to the Clarendon Laboratory grant, it would have been well for the President to have obtained from experts such information as would have enabled him to make up his mind as to what the two laboratories had or had not in common.

If it is really intended to concentrate the teaching of electricity in Balliol and Trinity, and, while placing it in the hands of College lecturers, to prevent the University Professor of Physics from acquiring the facilities for teaching it properly himself, we can only say that a most mistaken policy has been adopted. Physics, on account of the cost of the apparatus required, is a subject in which centralization is desirable, and, considering the place which electricity now occupies among the physical sciences, it would be absurd to exclude it from the University Laboratory, and from the curriculum of the only teacher of physics whom the University herself appoints. To do them justice, the combined Colleges did not directly make any such proposal; but, if they did not mean to make it, why was the Millard Laboratory imported into the controversy? As far as we can judge from the description given of it by the President of Trinity, it is a technical laboratory which may develop into something analogous to that of Prof. Stuart at Cambridge. If so, it does not—and those connected with it ought to have known that it does not—occupy the gap which the new building was to fill. "Theoretical and practical mechanics and engineering," coupled with electrical technology, afford plenty of scope for the energies even of such active Colleges as Balliol and Trinity. It is a pity that, with all this zeal, they have yet to learn that pure science is an ally and not a rival, that a dynamo is useful in a physical laboratory in which no technology is taught, and that the way for a young institution like the Millard Laboratory to earn respect is to do good work, and not to signalize its appearance on the field of labour by preventing others from doing it.

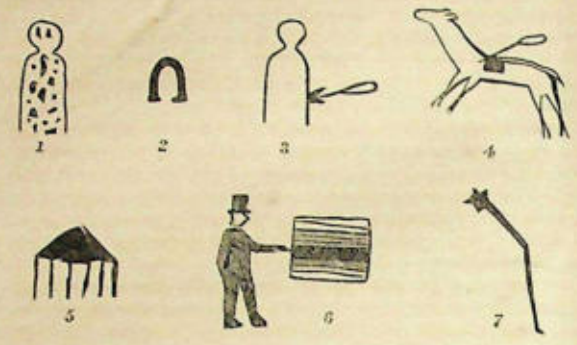
NORTH AMERICAN PICTOGRAPHS.[1]

THIS remarkable volume contains no fewer than 83 lithographed plates, and 209 separate woodcuts, and is an admirable compendium of the curious pictographs of the North American Indians. Large as it is, it professes to be only the forerunner of a still larger work that shall treat of pictographs generally. The author, Colonel Garrick Mallery, has already published an almost equally interesting memoir on "Gesture Language," in the first Annual Report of the Bureau of Ethnology.

One of the most striking features of the present work is the account it gives of the newly-discovered custom of the Sioux, or, more correctly speaking, of the Dakota Indians (for Sioux is some barbarism, repudiated by the natives), to keep national calendars. The custom is sufficiently ancient to have become generally established among this great branch of the Indians, but it is not old enough to have spread to the west of the Mississippi. One of the most important of the calendars begins with the year 1800; its historiographer was a man, still living in 1876, yclept "Lone-Dog." His calendar is painted on a buffalo hide, which appears to have been exhibited and explained to Indian audiences from time to time, and greatly admired by them, for four copies at least have been made from it (with variations of arrangement), and every intelligent adult Dakota knows its contents, and can read them in part. One of these copies is imitated in a beautiful plate, which is the most effective of all the many illustrations of this volume. The process of making the calendar is inferred to have been as follows:—During the dreary periods of their six winter months, certain elders of the tribe amused themselves with talking over the events of the past year, and Lone-Dog discussed with them which of those events should be selected by general suffrage as the representative of that period. Suppose it was an outbreak of the small-pox: then Lone-Dog drew the outline of Fig. 1 on one part of his buffalo robe, and dabbed it with red spots. Then that year became ever after known as the small-pox year, and the Dakotas would say so-and-so happened in the small-pox year, just as we should say in the year 1801. Or, again, the event might be that for the first time horses were seen by them that had been shod with iron: then the symbol of the year became a horse-shoe, Fig. 2. Lone-Dog's calendar is particularly graphic. Its earlier entries are probably derived from preceding chroniclers or from tradition; anyhow it covers the entire period from 1800 to 1871. The first entry is made in the middle of the robe, and the others are arranged year after year successively in an oblong spiral, the whole series being included in three turns and a half. They are drawn in black and red, the latter usually representing blood, of which plenty seems to be spilt in murder or in hunting. Thus Fig. 3 is a case of murder; Fig. 4 is a year in which a vast number of elk were killed, identified in the rude drawing by their cloven feet. Fig. 5 celebrates the erection of a trader's station; and Fig. 6 tells us that striped Spanish blankets were first introduced in that

[1] "Pictographs of the North American Indians." A Preliminary Paper by Garrick Mallery. Extract from the Fourth Annual Report of the Bureau of Ethnology. (Washington: Government Printing Office, 1886.)

year by a trader. Fig. 7 is the year of a great aërolite. Lone-Dog's system is not the only calendar. Others have recently been found by Dr. Corbussier which are drawn more elaborately, though not more intelligibly. The most important of these is only described, and not reproduced in this volume. It is by Battiste Good, and professes to date from prior to the year 1700. Being



drawn in five colours, it would require much cost to imitate, and is withheld for the present.

Other curious features of the work are the pictorial censuses that it contains. One consists of eighty-four heads of families in the band of "Big-Road." Each is represented with the symbol expressive of his name attached to his head, after the manner of Fig. 8. Another



census is of the 289 adherents of Red-Cloud, who are for the most part portrayed on a similar principle.

Some of the more symbolic representations are amusing and instructive. Those for various diseases are as follow:—We have already seen the representation of small-pox, and that of measles is much the same. A whooping-cough year is typified by Figs. 9 and 10, in



different calendars, Fig. 10 showing the broken and explosive expiration with much effect. Craziness is expressed by a wavy line; thus the name of the chief in Fig. 8 being Crazy-Horse, the animal has wavy lines drawn on his body. Starvation is shown, in Fig. 11, by a thin belly, and a black line across it; and gripes are excellently expressed by a scroll, Fig. 12, something like a figure 3, only more twisted and tortured, scrawled over the abdomen.

The question is fully discussed whether this calendar-making was in any way due to the influence of the whites, but is decided on good grounds in the negative. The whole conception and the way of carrying it out seems to be thoroughly Indian, but it is not every Indian who is born with the historiographic capacities of Lone-Dog. The author testifies to the variety of individual aptitudes when speaking of the inhabitants of Queen Charlotte's Islands, who are beautifully tattooed. He says, "nor is it everyone who can tattoo. Certain ones, almost always men (let Mr. Romanes make a note of it), have a natural gift which enables them to excel in this kind of work."

The events that a group of persons are most apt to associate with an epoch during which they have lived together, are not necessarily the most important ones. They are those occurrences which are simple and well defined, and have struck the fancy on that account, as well as from their unlikeness to former experiences. Such events are recalled with ease, and a partial or symbolic act of recollection suffices to identify them.

When pictorial nick-names are given to each successive year in council, as in the case of the Dakotas, the process must be very like that of giving verbal nick-names to new boys at school. This used to be a far more prevalent custom than it is now, and I have a vivid recollection of two old Etonians describing how it was done in their time. When the new boy made his appearance, he was of course well looked over and watched. Then, as the fancy took them, first one lad and then another addressed him with tentative nick-names. At the beginning, these trial names were apt to fall flat; at length one stuck; other lads adopted it, and usually in a few days the new boy was fitted with a generally-accepted name, by which he was afterwards known almost exclusively during the whole time he was at school. The appropriateness of the nick-name was by no means always obvious to strangers; it might even be due to some passing event with which by pure accident the boy was in some indirect way associated. I think this giving of nick-names is an excellent illustration of the manner in which many common words must have arisen.

The process of determining the most typical event of a year, and then of portraying it by a simple and bold design of a higher order of art than was known to Lone-Dog, and introducing no more detail than is necessary for identification, is well worth trying as an experiment. I tested it myself by attempting to construct such pictographs for the last few years of my life, under the condition that each should be included within a circle of the size of a shilling, and at last I succeeded fairly well, in my own, but probably too partial, judgment. I may add that, having done this, I laid a florin over my drawing, and traced a second circle round the florin. In the ring that lay between the two circles there was space for fully twenty-five bold capital letters, which I distributed among words that referred to other leading events of the year. The whole formed a by no means inartistic series of designs suitable for medallions.

I soon became so absorbed in my pictographs that I think others might interest themselves in the same way. It would be an amusing test of skill in a round game, to try who could make the most artistic and vigorous design within the compass of a circle traced, say, round a half-penny—that is, of exactly one inch in diameter—to commemorate some recent event known to all. What a capital prize subject for art students it would be, to refer them to some brief register of events during the fifty years of Her Majesty's reign, and to ask for fifty such medallions, one for each year. Then, again, many persons carve in wood or paint on china, and want designs; let them take episodes in their own histories, and make friezes

that should illustrate the events in families, schools, houses, &c., such as the stained-glass windows in churches do those in the history of the Bible. How prettily girls might design pictographs to record notable events in a pleasant tour, and interchange them with their fellow-travellers as presents. Such designs as these could be made subjects of embroidery, or, if on a larger scale, of that brass *repoussé* work which is, or was, so much in fashion. It would be by no means difficult to convert them into actual medallions. First the wax model, then the plaster cast, then the cast in white fusible metal, then the covering with an electrotyped coating of silver, just in the way that the ancient coins are reproduced at the British Museum, at the cost of about three shillings each, which are now so frequently used in rows for necklaces. What a delightful memorial of twenty-five years wedded history might be given by a husband to his wife, in the form of a necklace of such medals. It would be a pleasant labour to make a set of designs, which an electrotypist could afterwards put into better forms, and construct from them the wax medallions for the electrotypist to cast and turn into metal. I commend this idea of commemorative pictographs and *glyptographs* (as works in relief ought to be called) to the notice of amateur artists, whether they work in pencil, ink, colour, carving, embroidery, *repoussé* work, china painting, or in modelling.

This volume is an excellent example of the growing variety and wealth of material now available to inquirers into the origin of language. We meet in it with abundant evidence of the rapidity with which pictographs become abbreviated into conventional symbols, and are thereby adapted to play the same important part in reasoning that is usually played by words. I cannot see that it makes any fundamental difference in the use of symbols whether they appeal to the ear or to the eye, though I fully grant that on many grounds, not worth entering into here, the former is more generally convenient, and best suits the idiosyncracies of the majority of persons. The unassisted sense of touch, as we have learnt from the case of Laura Bridgeman, may afford an adequate basis for the exercise of a considerable amount of reasoning. And for aught I can see to the contrary, a dog who "ponders," to use a dog-trainer's expression, may occasionally be carrying out some real act of thought by the aid of imagined and symbolic odours.

FRANCIS GALTON.

COCOA-NUT PEARLS.

THE following letter has been sent to us by Dr. Sydney J. Hickson :—

"During my recent travels in North Celebes I was frequently asked by the Dutch planters, and others, if I had ever seen a 'cocoa-nut stone.' These stones are said to be very rarely found (1 in 2000 or more) in the perisperm of the cocoa-nut, and when found are kept by the natives as a charm against disease and evil spirits. This story of the cocoa-nut stone was so constantly told me, and in every case without any variation in its details, that I made every effort before leaving to obtain some specimens, and eventually succeeded in obtaining two.

"One of these is nearly a perfect sphere, 14 mm. in diameter, and the other, rather smaller in size, is irregularly pear-shaped. In both specimens the surface is worn nearly smooth by friction. The spherical one I have had cut into two halves, but I can find no concentric or other markings on the polished cut surfaces.

"Dr. Kimmins has kindly submitted one half to a careful chemical analysis, and finds that it consists of pure carbonate of lime without any trace of other salts or vegetable tissue.

"I should be very glad if any of your readers could inform me if there are any of these stones in any of the Museums, or if there is any evidence beyond mere hearsay for their existence in the perisperm of the cocoa-nut."

On this letter Mr. Thiselton Dyer, to whom we sent it, has been good enough to make the following remarks :—

Dr. Hickson's account of the calcareous concretions occasionally found in the central hollow (filled with fluid—the so-called "milk") of the endosperm of the seed of the cocoa-nut is extremely interesting. It appears to me a phenomenon of the same order as tabasheer, to which I recently drew attention in this journal.

The circumstances of the occurrence of these stones or "pearls" are in many respects parallel to those which attend the formation of tabasheer. In both cases, mineral matter in palpable masses is withdrawn from solution in considerable volumes of fluid contained in tolerably large cavities in living plants—and in both instances they are Monocotyledons.

In the case of the cocoa-nut pearls the material is calcium carbonate, and this is well known to concrete in a peculiar manner from solutions in which organic matter is also present.

In my note on tabasheer I referred to the reported occurrence of mineral concretions in the wood of various tropical Dicotyledonous trees. Tabasheer is too well known to be pooh-poohed; but some of my scientific friends expressed a polite incredulity as to the other cases. I learn, however, from Prof. Judd, F.R.S., that he has obtained a specimen of apatite found in cutting up a mass of teak-wood. The occurrence of this mineral under these circumstances has long been recorded; but I have never had the good fortune to see a specimen.

Returning to cocoa-nut pearls, I send you a note which the *Tropical Agriculturist* for April last quotes from the *Straits Times*:—

"A trade journal appearing in Java gives the following particulars regarding a peculiar kind of pearl found in this part of the world:—It is well known that pearls have been met with within oysters and mussels. Sometimes even trees yield pearls. In the Proceedings of the Boston Society of Natural History, there is a paper by Mr. J. Bacon regarding the kind of pearls often found within cocoa-nuts. The specimens shown have been bought at Singapore. They are said to be so rare in the East Indies as to be highly prized by the native rajahs, and worn by them as precious stones. Mr. Bacon himself possessed a small pearl of this sort. It is said that when allowed to grow, they will reach the size of cherries. This pearl resembles the common variety in smoothness, whiteness, and scant lustre of surface. It is harder than it, and almost as hard as feldspar or opal. The common pearl varies in hardness, but is never harder than feldspar. The cocoa-nut pearl consists of carbonate of lime, with very few organic substances remaining after treatment with acid solutions. This organic matter is insoluble, shows no trace of vegetable substances after microscopical examination, and seems to be akin to albumen in structure. In the common pearl there is also found an albuminous substance, but the latter remains unchanged in appearance and lustre even after the calcareous constituent parts have been dissolved away. In other respects microscopical research has brought out the fact that the cocoa-nut pearl is formed of concentric layers without any nucleus. The whole mass is made up of layers of fine crystalline fibres. Prof. Bleekrode, in commenting on the former in a Dutch scientific periodical, says that Rumphius, the famous botanist, had in his 'Herbarium Amboinense,' given full particulars of this petrifaction in the cocoa-nut. Rumphius has even illustrated his account of it by accompanying drawings of the two forms in which this kind of pearl is met with—pear-shaped and round, either of uniform appearance or with red edges. Hardly one

in a thousand cocoa-nuts on the average displays this strange peculiarity. The formation of the latter is always a remarkable phenomenon, hard to account for, from the water in the nuts generally lacking the chemical substances favouring abnormal growth of the kind. Rumphius states for a fact that cocoa-nuts from Macassar yield more pearls than those from other places. This scientist, in 1682, sent, as a present to the Grand Duke of Tuscany, a ring in which a cocoa-nut pearl had been set. Similar pearl-like formations are met with in other East Indian fruits, such as the waringin, the pomegranate, and the kechubong."

To this may be conveniently added two brief extracts from the long and admirable account given by Rumphius:—

"*Calappites*, Belgis *Calappus-Steen*, Malaicensibus *Mestica Calappa*, albus est lapillus instar marmoris seu silicis albi, durus, planus, ac glaber, cujus putaveram alio loco inter lapides ac mineras descriptionem dedisse, quum vero in *Calappa nuce* inveniatur, ac sollicitus sim, opus illud a me forte non absolutum iri, animo induxi hic loci ejus exhibere descriptionem. Est itaque albus ac politus, seu glaber lapillus in interiore *Calappæ nucis* parte concrescens, nunc putamini fixus, nunc vero media in lympha natans, diversæ ac duplicis potissimum formæ" (Rumphius, "Herbarium Amboinense," vol. i. pp. 21, 22).

"Incolæ plurimum omnes *Mesticas* amant, quarum quasdam tanti æstimant, ut optimis etiam præferant gemmis; plurimas enim ipsis tribuunt immo sine dubio superstitiosas etiam virtutes, gestant enim has ad nudum corpus, in annulis, et armis, ad prosperum conatuum successum obtinendum. Elegantissimos ac rotundissimos hujus Calappi lapillos, seu *Calappites* imponunt annulis suis, vel etiam telis adpendent, non auro, sed argento circumdatos, dicentes melius hoc cum natura *Calappites* convenire" (p. 22).

If Dr. Hickson would present one of his pearls to the Kew Museum, it would, I am sure, interest a great many persons who would be glad to see an authentic specimen of so interesting a curiosity.

NOTES.

THE Annual Meeting of the Royal Society for the election of Fellows was held at the Society's rooms in Burlington House on Thursday last, when the following gentlemen were elected into the Society: John Young Buchanan, M.A., John Theodore Cash, M.D., Sir James Nicholas Douglass, M.I.C.E., Prof. James Alfred Ewing, B.Sc., Prof. George Forbes, M.A., William Richard Gowers, M.D., Prof. Alexander B. W. Kennedy, M.I.C.E., George King, M.B., Sir John Kirk, M.D., Prof. Oliver Joseph Lodge, D.Sc., Prof. John Milne, F.G.S., Rev. Octavius Pickard-Cambridge, M.A., George James Snelus, F.C.S., Thomas, Lord Walsingham, William Whitaker, B.A.

THE Council of the London Mathematical Society have awarded the second De Morgan medal to Prof. Sylvester, F.R.S., for his numerous and brilliant contributions to pure mathematics. The medal will be presented at the Council meeting in November next.

THE preparations for the forthcoming meeting of the British Association in Manchester are progressing very favourably. A strong Local Committee has been formed, and a guarantee fund of over £10,000 has been raised to meet the necessary local expenses. The reception-room will be in the recently-built Natural History Museum of the Owens College, and the Section rooms in the College or its immediate neighbourhood. A prominent feature of the meeting will be the presence of a large number of eminent foreign men of science, of whom more than a hundred have already accepted invitations to attend.

ARRANGEMENTS for the dinner to Prof. Tyndall are progressing satisfactorily under the direction of the Executive Committee consisting of Prof. Stokes (Chairman), Sir F. Abel, Sir W. Bowman, Sir F. Bramwell, Dr. Evans, Prof. Frankland, Dr. Hirst, Prof. Huxley, and Sir Henry Roscoe. Circulars announcing the dinner have been largely issued. It is, however, for obvious reasons impossible to send notices to all those who might wish to attend, and applications for tickets are daily made by gentlemen who have received no special notification of the event. There is no doubt that a body of scientific men will meet at the dinner such as has seldom or never been brought together on a similar occasion. Nor will the gathering be confined to scientific men alone. Among others, the following have also expressed their intention of being present: Lord Derby, Lord Lytton, Earl Bathurst, Sir F. Pollock, Sir F. Leighton, Lieut.-General Smyth, Prof. Bonamy Price, and Messrs. Leslie Stephen, W. Lecky, and Wemyss Reid.

THE Ladies' *Soirée* at the Royal Society, as we stated last week, was largely attended. Careful preparations had been made for it, and it was a great success. At intervals, in the Principal Library, a cornet solo was telephoned from Brighton. A large number of objects of great scientific interest were exhibited. Photographs of clouds, and photographs of the Firth of Forth Bridge, were shown with the lime-light; the former with demonstrations by the Hon. Ralph Abercromby, the latter with demonstrations by Mr. Baker. The microscopic structure of pearls was also shown with the lime-light, by Dr. George Harley. The Zoological Society of London exhibited a fine living specimen of the electric eel, from which shocks were taken. Prof. A. W. Rücker exhibited—(1) Colours of soap-films rotating under the influence of an air-current. A jet of air is directed on to the film so as to form a vortex, the colours of which change as the film becomes thinner. This experiment is due to Sir David Brewster. Attention has been recently called to it by Lord Rayleigh. (2) Artificial imitation of the colours of the setting sun. Light is passed through a glass cell containing a solution of sodium hyposulphite. If a little hydrochloric acid is added, the sulphur is deposited in fine particles which scatter the blue end of the spectrum. The transmitted light becomes redder, and colours like those of sunset are produced. This experiment is due to Capt. Abney. (3) Apparatus to illustrate the passage of light through lenses. An application on a large scale of the method of tracing the rays by passing them through air in a closed space charged with a small quantity of smoke. Chrysalides and living larvæ showing the influence of surroundings upon their colours were exhibited by Mr. E. B. Poulton; and Dr. E. Klein exhibited the following specimens of microbes under the microscope and in cultivation:—*Bacillus anthracis*; *Bacillus tuberculosis*; Bacillus of leprosy; Bacillus of swine fever; Bacillus of septicæmia; Bacillus found in typhoid fever; Spirillum found in Asiatic cholera; several other species of Spirilla; several species of *Bacterium termo*; Micrococcus of foot-and-mouth disease; Micrococcus of scarlet fever; Micrococcus of vaccine; different species of coloured microbes. Mr. Chichester A. Bell showed apparatus for reproducing audibly the vibrations of liquid jets. Vibratory motions of the orifice from which a liquid jet escapes, give rise to slight swellings, and constrictions of the liquid column. The swellings increase and the constrictions diminish as the jet travels downwards, finally causing it to break into drops. When the jet strikes upon a flat surface, the swellings are continued as waves in the thin sheet of liquid, which spreads out from the point of impact. The jet liquid being a conductor of electricity (acidulated water), and two platinum electrodes in circuit with a battery, and a telephone being immersed in the liquid sheet or nappe, the jet vibrations are reproduced as sound in the telephone.

A DEPUTATION consisting of Mr. Mundella, Mr. Joseph Chamberlain, Sir John Lubbock, Sir Henry Roscoe, Sir Lyon Playfair, Mr. John Morley, and others, will wait upon the Chancellor of the Exchequer on the 30th inst. to urge the claims of University Colleges upon the Government. Mr. Goschen has always taken so deep an interest in questions connected with education that he may be expected to consider carefully the arguments which will be submitted to him. It is almost certain that unless the University Colleges receive aid from the State some of them will have to be closed, for it has never been found that institutions of this kind can be maintained by fees alone. All that is asked is that the nation shall do for the University Colleges of England what is already done for like institutions in Wales, and for the Universities of Scotland.

THE foundation-stone of the new College of Science at Newcastle-upon-Tyne was laid yesterday by Sir William Armstrong.

THE Rev. J. E. Leefe has presented his botanical collections to Kew. Since the death of Borrer in 1862, Mr. Leefe has been universally recognized as the principal authority on British willows. In early life he lived in Essex and Yorkshire, but for the last generation he has held the living of Cresswell on the coast of Northumberland, opposite Morpeth. Here he got together a very fine collection of living willows, which had been obtained from Borrer, Darwall, the Duke of Bedford's collection at Woburn, and the Botanic Gardens of Kew and Cambridge. His sight having failed, he has retired to live at Coatham, near Redcar, and has given to Kew the collections he is no longer able to use. His principal publication was issued in 1842 under the title of "Salictum Britannicum." This contains ninety specimens, with printed tickets, and has been the recognized standard, ever since its publication, by which British willows have been named. His principal published papers are in the *Journal of Botany* for 1871—one entitled "An Arrangement of the British Willows," and another "On Hybridity in Salix, and the Growth of Willows from Seed." The collection he has now presented contains his own copy of the "Salictum," accompanied by a quarto manuscript; a valuable set of types from Hoch, the author of the classical "Flora Germanica"; a great many specimens dried from his living collection at Cresswell; and American types received from his correspondents in the United States. The general herbarium is of a miscellaneous character, principally British, but containing also a number of plants from Central Europe, Abyssinia, America, and other parts of the world. Amongst the British plants, the collection contains a curious *Ammophila*, gathered near Cresswell in 1872, with the glumes of ordinary *A. arenaria*, but with the decidedly tropical inflorescence of *A. baltica*, for which one of the only two known British stations is in Ross links, also on the Northumbrian coast, and which has by some botanists been regarded as a hybrid between *A. arenaria* and a *Calamagrostis*.

Apropos of our note last week on the invitations to the ceremony at Westminster Abbey, a correspondent writes to us from Dublin:—"We have the same state of things here. Neither the President of the Royal Irish Academy, nor the President of the Royal Dublin Society, as such, have got invitations. Invitations have been sent lavishly to Mayors, all of whom, save in three cases, have refused them, thus leaving, as one would have thought, a chance for science coming No. 2."

IN a despatch received at New York from Mexico on the 12th inst. it was announced that shocks of earthquake had been felt throughout Guerrero State on the 29th ult. and on the 1st and 2nd inst., and that several of the smaller towns had been injured.

SEVERE shocks of earthquake were felt last week in some parts of Turkestan. At Vernoje they began about 5 o'clock on the morning of the 9th inst. Almost all the buildings in the town were destroyed, and much life was lost. Great damage was also done at Kashelensk, Tsharkent, and other places. The telegraph line in the neighbourhood of Vernoje was broken down for a distance of about 200 versts.

THE last number of the *Annuaire de la Société Météorologique de France* (February, 1887) contains an interesting article by M. Hervé-Mangon on the distribution of rainfall and its duration in Paris, from observations taken during the years 1860-70. These observations, which were made with Hervé-Mangon's pluvioscope, show that rain falls on an average 19 hours a month. The month with the shortest duration of rain was August, which had only 12½ hours, while March had 26, and October and November a little more than 22 hours each. An examination of the hours of the rainfall during the night and during the day shows that on an average there are fewer hours of rain during the night than during the day. The longest interval without rain was 26 days, from September 11 to October 6, 1865. The greatest number of consecutive days of rain was 18, from October 3 to 20, 1867. The month of March had, on an average, the greatest number of rainy days, viz. 21·2, and the month of June the least, viz. 13·1. The months of greatest and least amount of rainfall do not correspond with these months, the maximum being 2·21 inches in September, and the minimum 1·00 inch in February.

THE *Monatsbericht der Deutschen Seewarte* for the whole year 1886 has been issued simultaneously with the Report for January 1887. The delay in the issue of the Reports is owing to some important alterations in the form of the work, especially the extension, considerably to the west, of the chart showing barometric minima. The above Report takes the place of the *Monatliche Uebersicht der Witterung*, which completed its tenth volume with the year 1885. It is proposed to issue it regularly in the third month after that to which it refers, and to include in it (1) a review of the atmospheric conditions over Central Europe, (2) preliminary communications respecting the weather in the North Atlantic, and (3) meteorological tables for Europe generally, and charts of the paths of the barometric minima over ocean and continent. This monthly report will be supplemented by a more complete quarterly review of the weather, which will appear after a lapse of about two years, and will serve as the explanatory text of the daily synoptic charts for the North Atlantic Ocean and adjacent continents lately referred to (May 26, p. 88). This text will be issued separately by the German Admiralty, and will be of great value to all interested in meteorological investigations.

FROM a recent report by Dr. Hellmann on statistics of lightning-damage in Schleswig-Holstein, Baden, and Hesse, it appears that the danger from lightning in these parts (unlike the case of other parts of Germany) has been decreasing of late years. Soft roofed houses are fired about 7 times oftener than those with hard roofs. Windmills are struck 52 times, and church and clock towers 39 times, oftener than ordinary houses with hard roofs. The marshy regions in Schleswig-Holstein are the most dangerous; and the land about inlets of the east coast the safest. With like conditions, the relative danger decreases the more houses are grouped together. In Baden the danger varies more than in any part of Germany (about Heidelberg it is 24, and in Waldshut 265 per million houses). In Hesse, the low plain of the middle Rhine is the most dangerous part. In the fifteen years 1869–83, there were killed by lightning for every million men, in Prussia, 4·4; in Baden, 3·8; in France, 3·1; and in Sweden, 3·0. The geological nature of the ground, and especially its capacity for water, has important influence. Thus, calling the danger on lime 1, that for sand is 9, while for loam it is 22. This is partly why most of South Germany and Austria is less dangerous than North Germany.

There are four factors affecting the lightning-danger to buildings; two physical—unequal frequency of storms, and geological character; and two social—variable population, and mode of building. Of all trees, oaks are most frequently damaged, beeches most rarely (in the ratio 54 to 1).

An electric trumpet has been recently devised by M. Zigang (*La Nature*, June 4). It consists of a short brass tube mounted on wood and containing an electro-magnet whose ends face a vibrating plate, on which is fixed a small piece of soft iron. Against this plate-armature rests a regulating screw with platinum point, which serves for automatic interruption, by vibration of the armature. With two Leclanché elements a musical sound is had, which may be varied in pitch, intensity, and timbre by means of the screw. This instrument may be usefully employed in signalling on ships, railways, tramways, &c.; it may also serve as a receiver for signals of the Morse type.

Prof. Christensen, of Copenhagen, has recently (*Journal für praktische Chemie*, 1887, No. 11) made a redetermination of the atomic weight of fluorine, with the satisfactory result that this element is to be added to the already large list of those whose atomic weights are whole numbers and simple multiples of that of hydrogen. The determination was based upon the analysis of a double fluoride of ammonia and manganese, $4NH_4F \cdot Mn_2F6$, the extreme precautions displayed in the preparation and purification of which show the peculiar difficulties attending work upon this singular element. It is very interesting to read of the filtrations through platinum gauze placed in gutta-percha funnels, of the drying of the beautifully crystalline red salt spread out upon wide expanses of platinum-foil, and of the skilful manner in which all traces of silicon were eventually eliminated. The results of the numerous analyses show that, if Stas's value for oxygen be taken as the standard, the atomic weight of fluorine is 18·94, but if, as Mendelejeff concludes, oxygen be 16, then the atomic weight of fluorine becomes 18·99, or, in round numbers, 19·0.

It will probably be remembered that, early in the year 1883 (*Ber. der Deut. Chem. Ges.*, xvi. 324), a number of chemical reactions, especially the formation of arsenides from mixtures of metals and arsenic, were brought about, by Dr. W. Spring, by subjecting the powdered mixtures to the immense pressure of 6000 atmospheres. A still more striking experiment, entirely unique in its way, has just been made by Dr. Spring, in conjunction with Dr. Van't Hoff (*Zeitschrift für physikalische Chemie*, i. 5). In the course of a study of chemical dynamics these workers found that the blue-coloured double acetate of copper and calcium, $(C_2H_3O_2)_4CaCu \cdot 8H_2O$, is perfectly stable at atmospheric pressure as far as 75°; above this temperature it is decomposed into its constituent acetates, three-quarters of its water of crystallization being set free. This decomposition is attended with contraction in volume, and the salts dissolve in the liberated water. The idea was at once suggested, Could this decomposition be effected by means of Dr. Spring's powerful compressing machinery? The idea was carried out, and no sooner was the pressure upon the solid double acetate increased to 7000 atmospheres, at a temperature of 40°, than the solution of the separated constituent salts spurted from every joint of the apparatus, and on releasing the pressure the resolidified mass was found to consist of a mixture of the white calcium and the green copper salt.

Last week we referred to the fact that the Council of the Meteorological Society are anxious to obtain photographs of flashes of lightning. The *Photographic News*, dealing with the conditions under which such photographs should be taken, notes the following points as important:—"First, the exact position of the camera. In many countries, ordnance maps can be obtained on such a scale that a minute dot will indicate the position of the camera within a foot or two, and it will often be easy to record the position of the apparatus with far greater exactness, as, for example, when the camera is placed at a window. A thread with a plummet should be allowed to range from the optical centre (say the diaphragm in case of a doublet) to the floor, where a mark should be made. Second, the time at which the exposure was made. Third, the aspect of the camera. When the locality is exactly recorded, this datum may be approximate, as there will generally be the means of exactly determining it upon the plate itself. Fourth, the equivalent focus of the lens, but the determination of this may well be left until it it is found that something valuable may be deduced from the photograph. Fifth, the distance of the flash. The recording of this is a very important matter, as, when the focus of the len[s] is known, it will be easy to determine the actual dist[ance] between cloud and earth, also the horizontal angle subtended [at] the observer at the camera. To determine the distance, [the] observer should note as accurately as possible the time elap[sed] between the flash and the report, and in doing this, even suc[h] chronograph watch as may now be had for five or six pounds wi[ll] be found of great service."

At a meeting of the Middlesex Natural History and Science Society, at the Natural History Museum, South Kensington, on the 11th inst., Prof. W. H. Flower, F.R.S., gave an address on the teeth of the Mammalia, especially referring to those specimens exhibited in the case in the Index Museum. Details of the structure, growth, and disposition of the teeth in the jaw were given, and the peculiarities of vestigial and rudimentary teeth pointed out. Prof. Flower referred to the value of these index museums, calling special attention to that of mineralogy, arranged by Mr. Lazarus Fletcher, and which for greater convenience was placed in the mineral gallery.

This evening, Prof. A. W. Williamson will deliver an address, in the Chemical Theatre, to the London University College Chemical and Physical Society. He has chosen as his subject, "Atomic Motion." Sir Henry Roscoe will take the chair.

"My Microscope, and Some Objects from My Cabinet," a simple introduction to the study of "the infinitely little," by a Quekett Club man, is announced for immediate publication by Messrs. Roper and Drowley. The little volume is dedicated to the President and Members of the Quekett Microscopical Club.

Messrs. Whittaker and Co. will publish early next week Mr. E. C. Robin's book on "The Design and Construction of Applied Science and Art Buildings, and their Suitable Fittings and Sanitation."

The Thuringian Fisheries Union held their tenth meeting at Jena on May 26. One of the members stated that 64,000 young salmon had been placed in the Saale last year. The Grand Duke of Saxe-Weimar was present at the meeting, and took part in the debates.

Dr. Moritz Wagner, Professor at the Munich University, died at Munich on May 31. He was well known as a scientific traveller, and author of some excellent works of travel.

During the five months ended May 1887 the total value of the fish landed on the east coast of Scotland was £335,366; on the west coast, £75,290; in Orkney and Shetland, £34,516; the total value for five months being £445,172. As compared with the corresponding period of last year, this was a decrease of £4,113. The last month, however, showed an increase of £6,478 over the corresponding month of the year 1886.

Artificial clouds for the protection of vines from frost were produced in a vineyard at Pagny on the Franco-German frontier during the night of May 13. About 3 a.m., when the thermometer had gone down to −1°·5 C., the signal was given to ignite

liquid tar, which had been poured into tin boxes, and pieces of solid tar which had been placed in the ground near the vines. Large clouds of smoke quickly enveloped the vineyard. The fires lasted for about two hours, but the smoke did not clear off till a considerable time after. The object of the experiment was completely gained, as not one young shoot was destroyed by the frost.

THE American Institute of Electrical Engineers, organized three years ago, is making arrangements for the purchase of a suitable building in New York. It is proposed that there shall be an electrical library and museum, and, if space permits, an experimental laboratory. Suitable accommodation will be provided for council and general meetings, and the entertainment of members and their guests, and the house will be open "at all reasonable hours."

The additions to the Zoological Society's Gardens during the past week include a Squirrel Monkey (*Chrysothrix sciurea*) from Guiana, presented by Miss Grace Williams; a Negro Tamarin (*Midas ursulus*) from Guiana, presented by Miss Julia Neilson; a Rhesus Monkey (*Macacus rhesus*) from India, presented by Miss R. M. Hurt; a Common Marmoset (*Hapale jacchus*) from South-East Brazil, presented by Mrs. Constance Hoendorff; a Common Raccoon (*Procyon lotor*) from North America, presented by Mr. G. F. Van Zandt; two Lanner Falcons (*Falco lanarius*), European, presented by Mr. William Thomson; two Scaly Ground Doves (*Scardafella squamosa*) from Brazil, presented by Mr. William de Castro; a Cockateel (*Calopsitta novæ-hollandiæ*) from Australia, presented by Mr. H. H. James; a Ring-necked Parrakeet (*Palæornis torquatus*) from India, presented by Mrs. Hill; a Yellow-billed Sheathbill (*Chionis alba*) from Cape Town, presented by Mr. R. C. Ashton; nine Barbary Turtle Doves (*Turtur risorius*) from Africa, presented by Mr. E. L. Armbrecht; a Red Brocket (*Cariacus rufus*), a Great American Egret (*Ardea egretta*) from Brazil, deposited; three Sandwich Island Geese (*Bernicla sandvicensis*) from the Sandwich Islands, a Wryneck (*Iynx torquilla*), European, purchased; a Wapiti Deer (*Cervus canadensis*), a Barbary Wild Sheep (*Ovis tragelaphus*), a Variegated Sheldrake (*Tadorna variegata*), nine Summer Ducks (*Æx sponsa*) bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

THE GREAT SOUTHERN COMET (1887 *a*).—Dr. J. M. Thome, of the Cordoba Observatory, has published in the *Astronomical Journal*, No. 156, some interesting particulars as to the appearance and observed positions of the great comet which he discovered on January 18. On the 21st it became evident that the comet was, in effect, all tail, the head being much the fainter part of the object, and being at least 15′ in diameter, very thin, and without nucleus or condensation of any kind. After various attempts at determining its co-ordinates, Dr. Thome adopted the plan of moving the telescope along the axis of the tail, until reaching a point beyond which nothing of a nebulous character could be distinguished, and determining its position. These points were approximately half a degree in advance of the true centre of the nebulosity, and nearly in its axis. The observations of position extend from January 21 to January 27. With regard to the appearance of the comet to the naked eye, Dr. Thome remarks that it was a beautiful sight—a narrow, straight, sharply-defined, graceful tail, over 40° long, shining with a soft starry light against the dark sky, beginning apparently without a head, and gradually widening and fading as it extended upwards.

The same number of the *Astronomical Journal* contains a discussion of the orbit of the comet by Mr. S. C. Chandler, Jun. The observations extend from January 20 to 29, and were made at Melbourne, Cordoba, the Cape, and Windsor, N.S.W. Two sets of elements—which do not materially differ, considering the extreme uncertainty of the observations—have been obtained; the first by taking the Cordoba observations as they stand, the second by attempting to determine the true centre of the nebulosity from Dr. Thome's statement that the recorded positions are 30′ in advance of the true centre and nearly in its axis. The elements are:—

		I.		II.
T (G.M.T.)		1887 Jan. 9·080		Jan. 8·730
ω	...	173° 36′·2	...	174° 48′·6
Ω	...	130 46·2	...	132 48·6
i	...	61 48·9	...	57 52·1
log *q*	...	8·30484	...	8·36280

Mr. Chandler points out that these elements are very unlike those of comet 1880 I., with which this comet was at first associated. In fact the orbit found resembles more those assigned to the comets of 1680 and 1689, than that of the group 1843-80-82.

NEW MINOR PLANETS.—A new minor planet, No. 267, was discovered by M. Charlois at Nice on May 27. Another, No. 268, was discovered by M. Borelly at Marseilles on June 9.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1887 *JUNE* 19-25.

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on June 19.

Sun rises, 3h. 44m.; souths, 12h. 0m. 58·8s.; sets, 20h. 17m.; decl. on meridian, 23° 26′ N.: Sidereal Time at Sunset, 14h. 8m.

Moon (New on June 21) rises, 2h. 48m.; souths, 10h. 20m.; sets, 18h. 1m.; decl. on meridian, 15° 57′ N.

Planet.	Rises. h. m.	Souths. h. m.	Sets. h. m.	Decl. on meridian. ° ′
Mercury ...	5 21	13 39	21 57	23 39 N.
Venus ...	7 21	15 9	22 57	19 11 N.
Mars ...	2 50	11 2	19 14	22 50 N.
Jupiter...	14 28	19 47	1 6*	8 50 S.
Saturn...	5 43	13 47	21 51	21 41 N.

* Indicates that the setting is that of the following morning.

June.	h.	
21 ...	18 ...	Sun at greatest declination north; longest day in northern latitudes.
23 ...	5 ...	Saturn in conjunction with and 2° 26′ north of the Moon.
23 ...	10 ...	Mercury in conjunction with and 3° 27′ north of the Moon.
23 ...	19 ...	Jupiter stationary.
25 ...	0 ...	Venus in conjunction with and 2° 1′ north of the Moon.

Variable Stars.

Star.	R.A. h. m.	Decl. ° ′		h. m.	
U Cephei	0 52·3	81 16 N.	June 23,	0 14	*m*
R Virginis	12 32·8	7 37 N.	,, 21,		*M*
δ Libræ	14 54·9	8 4 S.	,, 25,	1 0	*m*
U Ophiuchi	17 10·8	1 20 N.	,, 20,	1 46	*m*
		and at intervals of		20 8	
W Sagittarii ...	17 57·8	29 35 S.	June 25,	2 0	*m*
U Sagittarii... ...	18 25·2	19 12 S.	,, 25,	1 0	*m*
η Aquilæ	19 46·7	0 43 N.	,, 20,	1 0	*M*
S Sagittæ	19 50·9	16 20 N.	,, 24,	23 0	*m*
R Capricorni ...	20 5·0	14 36 S.	,, 23,		*M*
δ Cephei	22 25·0	57 50 N.	,, 21,	23 0	*m*

M signifies maximum; *m* minimum.

Meteor-Showers.

	R.A.	Decl. °
Near β Ursæ Majoris ...	168 ...	55 N.
α Cephei	315 ...	60 N.

GEOGRAPHICAL NOTES.

EMIN PASHA contributes to the Scottish Geographical Society's Journal an account of an exploration he made recently of part of Lake Albert Nyanza, which contains some data bearing on the probable origin and the physical geography of

the lake. Off the station of Mabagi, on the north-west shore of the lake, Dr. Junker found a long, low, sandy island, which he recognized as of quite recent formation; for in 1879 he noticed that the spot where it now lies was covered with shallow water. Its length is 1067 yards, and maximum breadth 99 yards. Tall grass and weeds grow at the water's edge, and a species of acacia (*A. mellifera*) on the higher parts. The island, Emin Pasha states, is due to the deposition of the detritus brought down by the two rivers which enter from the south-west. From what he observed on the lake, he is inclined to believe that the foreshore on the west is gradually encroaching on its waters; in other words, the lake in this part is gradually filling up. As for the lake itself, Emin Pasha attributes its origin solely to erosion. He thinks it more than probable that formerly a large stream may have made its way from between the two ranges to east and west of the lake, so that its erosive action, combined with that of inundations, heavy rains, caving-in, and the influence of the sun and weather, are quite sufficient to account for the result. The geological formation of both ranges is the same; their altitudes differ but little, and the terrace-like formation of their descent lakewards is in each case exactly alike. Emin Pasha hoped to examine the problem much more minutely. He landed at Kibiro, on the opposite side of the lake, and gives an interesting description of the valuable salt-mines of the region. Emin Pasha afterwards made two other journeys on the lake, during one of which he discovered what he believes to be a new river, called Kakibbi by the Wasongora, and Duéru by the Wamboga. It flows from the Ussongora Mountains, and is of considerable size, and enters the lake at the south, having a large island near its *embouchure*. It abounds with cataracts, and is therefore unnavigable. To the south-west, Emin Pasha was informed, there is a large river on the banks of which there is a colony of Akkas—called Balia by the Wanyoro people, but by themselves Betua; the latter a name suggesting the Batua recently discovered by Lieut. Wolf on the Sankuru, to the south of the Congo. Is it not possible that the Kakibbi is the same as the "red river" discovered by Mason Bey in 1877, entering the south extremity of Lake Albert?

In the *Bulletin* of the Lyons Anthropological Society will be found an interesting paper by M. Bertholon on the "Arab Colonization of France," in which the author, mainly on the basis of place-names, seeks to identify the existing effects of the Saracenic invasion of France. Dr. Collomb has also a useful paper on the peoples of the Upper Niger, their manners and their history.

M. Édouard Dupont, Director of the Brussels Natural History Museum, is about to leave for the Congo, to make a geological investigation of the region along the south bank of the river, between Boma and Stanley Pool. He will endeavour especially to determine the epoch when the river broke through the coast range, and the age of these mountains. He will also explore any caves which may exist, in order to discover if there are any remains of a primitive population.

The new number of Petermann's *Mitteilungen* is one of special scientific interest. The first paper gives the results of a series of researches by Japanese botanists on the botanical zones of Japan, in which the relation of these zones is shown to the configuration of the surface of the country. A much longer and perhaps more important paper in the same department is Herr Ernst Hartert's account of the botanical results of the expedition to the Niger under the late Herr Flegel; it abounds with detailed information on the plants collected by the expedition. Dr. Alex. Supan, the able editor of the *Mitteilungen*, who takes a special interest in meteorology, contributes a carefully elaborated paper on the mean duration of the chief heat periods in Europe. Then we have a series of extracts from Emin Pasha's letters, from 1883 down to 1886, much of which has already been published.

THE NEPHRIDIA OF "LANICE CONCHILEGA," MALMGREN.[1]

SEVERAL accounts of the nephridia of *Terebella conchilega* have been given. H. Milne-Edwards (*Ann. d. Sci. Nat.* (2) *Zoologie*, x., 1838, p. 220), in a paper published in 1838, on the circulation in Annelids, describes the vascular system in a species to which he gives this name, and gives a figure of the animal opened along the dorsal median line. In this figure four looped nephridia are distinctly shown, situated behind the branchial region. The representation of the position and character of these organs is perfectly correct so far as it goes: they are the upper parts of the four nephridia belonging to somites 6–9. But the paper I refer to does not describe the nephridia, as it deals with another subject: they are shown in the figure, and that is all; and in the description of the figure the organs are referred to as organs of generation.

Keferstein (*Zeitschrift für wiss. Zoologie*, Bd. xii., 1862) mentions that the structure and number of the nephridia in *T. conchilega* are the same as in *T. gelatinosa*, Kef.: in both cases he says there are six pairs, each organ consisting of a tube bent on itself, of which one half is darker, the other lighter: the organs belong to segments 3–9.

Cosmovici[1] gives an erroneous description of the organs: he says there are two pairs without internal openings, which he calls "organs of Bojanus," one of these situated in front of the cephalic diaphragm, the other immediately behind it, each of them having an external opening; and two other pairs, each of which has an internal as well as external opening, and is shaped like an urn: the internal opening is large, and surrounded with a circular lip. The gonad is attached to the posterior part of each of these latter organs, which Cosmovici calls segmental organs, and which he says serve as efferent excretory ducts.

The species referred to by these three authors is the *Nereis conchilega* of Pallas, *Terebella conchilega* of Gmelin; and this is called *Lanice conchilega* by Malmgren. My specimens were identified from Malmgren's description, and there is no doubt of the identity of my specimens with the species of that author; but there is room for some uncertainty regarding the specific identity of the specimens referred to by the authors I have mentioned. For instance, Cosmovici identified his species by means of Quatrefages' "Histoire des Annelés," 1865, and there it is stated that the tube of *Terebella conchilega* possesses no hollow fringes at its mouth: these fringes are always present in the tube of *Lanice conchilega*, Malmgren. This species is distinguished by some marked characters: two of them are the presence of a large vertical lobe on the 3rd somite (second branchiferous) and the coalescence of the ventral scutes usually present into a continuous ventral plate.

The true relations of the excretory system are as follow:—Enumerating the somites from before backwards, and counting the buccal as the 1st, we find that the branchiæ belong to somites 2, 3, and 4: the first notopodial fascicle of capillary setæ is on the 4th somite, the third branchiferous; the first neuropodial uncinigerous torus is on the 5th: the neuropodial tori are repeated on every succeeding somite to the end of the body; the notopodial fascicles occur only on seventeen consecutive somites. There are traces of transverse septa behind the 1st, 2nd, 3rd, and 4th somites, but none in the rest of the thoracic region, which bears the notopodial fascicles. On dissection, four long double nephridial tubes are seen projecting dorsalwards with the body-cavity; the lower parts of these tubes are covered by strands of the oblique muscles which pass from the nerve cord to the neighbourhood of the notopodial bristles: careful examination shows that these tubes belong to somites 6, 7, 8, and 9. Their internal openings can be found immediately behind the fascicle of bristles belonging to somites 5, 6, 7, and 8 respectively, but their efferent tubes are seen to pass down beneath the fascicles of somites 6, 7, 8, and 9. The lower parts of these efferent tubes are very wide, and it is impossible to separate them from one another. Beneath the fascicles of the following four somites (10–13 inclusive) are seen membranous nephridial sacs, which externally at least are inseparable from one another. These sacs are simple, that is, they are not composed of a tube bent on itself like the anterior nephridia: they scarcely extend above the level of the oblique muscles, and no internal opening or nephrostome can be found in them. In front of the most anterior nephridium, that belonging to somite 6, are seen traces of a rudimentary nephridium. In order to trace out the relations of these nephridia more accurately, the anterior part of a specimen was cut into a series of horizontal longitudinal sections, commencing with the ventral surface, and the reason why the successive nephridia could not be isolated from one another was seen on examination of these sections: the lower parts of the efferent limbs of the four anterior normal nephridia, in somites 6–9, and the whole of the nephridial sacs in somites

[1] A Paper read before the Royal Society of Edinburgh by Mr. J. T. Cunningham, on Monday, May 16.

[1] "Glandes génitales et Organes segmentaires des Annélides polychètes" (*Arch. de Zool. Exp.*, t. viii., 1879–80).

liquid tar, which had been poured into tin boxes, and pieces of solid tar which had been placed in the ground near the vines. Large clouds of smoke quickly enveloped the vineyard. The fires lasted for about two hours, but the smoke did not clear off till a considerable time after. The object of the experiment was completely gained, as not one young shoot was destroyed by the frost.

THE American Institute of Electrical Engineers, organized three years ago, is making arrangements for the purchase of a suitable building in New York. It is proposed that there shall be an electrical library and museum, and, if space permits, an experimental laboratory. Suitable accommodation will be provided for council and general meetings, and the entertainment of members and their guests, and the house will be open "at all reasonable hours."

The additions to the Zoological Society's Gardens during the week include a Squirrel Monkey (*Chrysothrix sciurea*) from Guiana, presented by Miss Grace Williams; a Negro Tamarin (*Midas ursulus*) from Guiana, presented by Miss Julia Neilson; a Rhesus Monkey (*Macacus rhesus*) from India, presented by Miss R. M. Hurt; a Common Marmoset (*Hapale jacchus*) from South-East Brazil, presented by Mrs. Constance Hoendorff; a Common Racoon (*Procyon lotor*) from North America, presented by Mr. G. F. Van Zandt; two Lanner Falcons (*Falco lanarius*), European, presented by Mr. William Thomson; two Scaly Ground Doves (*Scardafella squammata*) from Brazil, presented by Mr. William de Castro; a Cockatiel (*Calopsitta novæ-hollandiæ*) from Australia, presented by Mr. H. H. James; a Ring-necked Parrakeet (*Palæornis torquatus*) from India, presented by Mrs. Hill; a Yellow-billed Sheathbill (*Chionis alba*) from Cape Town, presented by Mr. R. C. Ashton; nine Barbary Turtle Doves (*Turtur risorius*) from Africa, presented by Mr. E. L. Armbrecht; a Red Brocket (*Cariacus rufus*), a Great American Egret (*Ardea egretta*) from Brazil, deposited; three Sandwich Island Geese (*Bernicla sandvicensis*) from the Sandwich Islands, a Wryneck (*Iynx torquilla*), European, purchased; a Wapiti Deer (*Cervus canadensis*), a Barbary Wild Sheep (*Ovis tragelaphus*), a Variegated Sheldrake (*Tadorna variegata*), nine Summer Ducks (*Æx sponsa*) bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

THE GREAT SOUTHERN COMET (1887 *a*).—Dr. J. M. Thome, of the Cordoba Observatory, has published in the *Astronomical Journal*, No. 156, some interesting particulars as to the appearance and observed positions of the great comet which he discovered on January 18. On the 21st it became evident that the comet was, in effect, all tail, the head being much the fainter part of the object, and being at least 15′ in diameter, very thin, and without nucleus or condensation of any kind. After various attempts at determining its co-ordinates, Dr. Thome adopted the plan of moving the telescope along the axis of the tail, until reaching a point beyond which nothing of a nebulous character could be distinguished, and determining its position. These points were approximately half a degree in advance of the true centre of the nebulosity, and nearly in its axis. The observations of position extend from January 21 to January 27. With regard to the appearance of the comet to the naked eye, Dr. Thome remarks that it was a beautiful sight—a narrow, straight, sharply-defined, graceful tail, over 40° long, shining with a soft starry light against the dark sky, beginning apparently without a head, and gradually widening and fading as it extended upwards.

The same number of the *Astronomical Journal* contains a discussion of the orbit of the comet by Mr. S. C. Chandler, Jun. The observations extend from January 20 to 29, and were made at Melbourne, Cordoba, the Cape, and Windsor, N.S.W. Two sets of elements—which do not materially differ, considering the extreme uncertainty of the observations—have been obtained; the first by taking the Cordoba observations as they stand, the second by attempting to determine the true centre of the nebulosity from Dr. Thome's statement that the recorded positions are 30′ in advance of the true centre and nearly in its axis. The elements are:—

		I.		II.
T (G.M.T.)		1887 Jan. 9·080		Jan. 8·730
ω	...	173° 36′·2	...	174° 48′·6
Ω	...	130 46·2	...	132 48·6
i	...	61 48·9	...	57 52·1
log *q*	...	8·30484	...	8·36280

Mr. Chandler points out that these elements are very unlike those of comet 1880 I., with which this comet was at first associated. In fact the orbit found resembles more those assigned to the comets of 1680 and 1689, than that of the group 1843-80-82.

NEW MINOR PLANETS.—A new minor planet, No. 267, was discovered by M. Charlois at Nice on May 27. Another, No. 268, was discovered by M. Borelly at Marseilles on June 9.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1887 JUNE 19–25.

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on June 19.

Sun rises, 3h. 44m.; souths, 12h. 0m. 58·8s.; sets, 20h. 17m.; decl. on meridian, 23° 26′ N.: Sidereal Time at Sunset, 14h. 8m.

Moon (New on June 21) rises, 2h. 48m.; souths, 10h. 20m.; sets, 18h. 1m.; decl. on meridian, 15° 57′ N.

Planet.	Rises. h. m.	Souths. h. m.	Sets. h. m.	Decl. on meridian. ° ′
Mercury ...	5 21 ...	13 39 ...	21 57 ...	23 39 N.
Venus ...	7 21 ...	15 9 ...	22 57 ...	19 11 N.
Mars ...	2 50 ...	11 2 ...	19 14 ...	22 50 N.
Jupiter...	14 28 ...	19 47 ...	1 6* ...	8 50 S.
Saturn...	5 43 ...	13 47 ...	21 51 ...	21 41 N.

* Indicates that the setting is that of the following morning.

June.	h.	
21 ...	18 ...	Sun at greatest declination north; longest day in northern latitudes.
23 ...	5 ...	Saturn in conjunction with and 2° 26′ north of the Moon.
23 ...	10 ...	Mercury in conjunction with and 3° 27′ north of the Moon.
23 ...	19 ...	Jupiter stationary.
25 ...	0 ...	Venus in conjunction with and 2° 1′ north of the Moon.

Variable Stars.

Star.	R.A. h. m.	Decl. ° ′		h. m.	
U Cephei	0 52·3 ...	81 16 N. ...	June 23,	0 14	*m*
R Virginis	12 32·8 ...	7 37 N. ...	,, 21,		*M*
δ Libræ	14 54·9 ...	8 4 S. ...	,, 25,	1 0	*m*
U Ophiuchi	17 10·8 ...	1 20 N. ...	,, 20,	1 46	*m*
			and at intervals of 20	8	
W Sagittarii ...	17 57·8 ...	29 35 S. ...	June 25,	2 0	*m*
U Sagittarii... ...	18 25·2 ...	19 12 S. ...	,, 25,	1 0	*m*
η Aquilæ	19 46·7 ...	0 43 N. ...	,, 20,	1 0	*M*
S Sagittæ	19 50·9 ...	16 20 N. ...	,, 24,	23 0	*m*
R Capricorni ...	20 5·0 ...	14 36 S. ...	,, 23,		*M*
δ Cephei	22 25·0 ...	57 50 N. ...	,, 21,	23 0	*m*

M signifies maximum; *m* minimum.

Meteor-Showers.

	R.A.	Decl. °
Near β Ursæ Majoris ...	168 ...	55 N.
α Cephei	315 ...	60 N.

GEOGRAPHICAL NOTES.

EMIN PASHA contributes to the Scottish Geographical Society's Journal an account of an exploration he made recently of part of Lake Albert Nyanza, which contains some data bearing on the probable origin and the physical geography of

10–13, are in open communication, forming a wide continuous longitudinal tube extending from somite 6 to somite 13. Openings to the exterior from this tube were found in somites 6–9 inclusive, corresponding to the four large looped nephridia: each of these openings was close behind the upper end of an uncinigerous torus. The internal openings of the same four nephridia could be traced with ease and certainty: they are attached to the body-wall close behind the notopodial fascicles of somites 5–8. These openings are wide, and are overhung dorsally by a longitudinal lip furnished with a series of small ciliated digitate processes: lower down, the anterior and posterior lips of the opening are simple, thick-walled, and ciliated. The aperture leads into a thin tube, which passes inwards and backwards, curving round the inner end of the fascicle of bristles behind the aperture, and then, crossing the continuous tube, rises up on the inner or medial side of the loop, at the apex of which it is continued into the efferent wider limb of the loop, which passes down on the outer side to open into the longitudinal tube. Neither internal nor external openings could be found in that part of the longitudinal tube which is between the loops: it seems evident that this part of the tube represents four somewhat reduced nephridia which have coalesced, but whose openings have disappeared. Anteriorly to the four looped nephridia are traces of three others: the longitudinal tube extends forwards into somite 5 as if it included a nephridium belonging to that somite, but I could find no external opening in this somite: at the angle between the septum behind somite 4 and the body-wall is a very obvious nephrostome, which ought to lead into the longitudinal tube, into that part of it corresponding to somite 5, but the connexion could not be traced. Nephrostomes were also present attached to the anterior face of the septa behind somites 2 and 3 (the first and second branchiferous), and leading into tubes seen in somites 3 and 4, but I could find no external openings in these somites. I could find no nephrostome in somite 1 (the buccal) nor any trace of a tube in somite 2. Gonads are present in the form of clumps of deeply-staining small indifferent cells attached to the exterior of all the nephrostomata mentioned, seven in all. The germinal cells, when still quite undifferentiated, separate from the gonads, and undergo further development in the cœlome. But I found no reproductive elements in the cavity of the nephridial system, though the body-cavity contained them in quantity, and it is probable that at the right season they are expelled through the nephridial system. The body-cavity contains, besides the reproductive elements, a large number of spherical, vacuolated, nucleated cells. This is the first case in which a communication between successive nephridia has ever been discovered in any adult invertebrate. It is true that in the development of Polygordius, according to Hatschek, each nephridium gives off backwards a prolongation of itself, from which the next nephridium is formed, and the two remain in communication for a time; but the connexion is soon severed, and in the adult the successive nephridia are isolated and independent. In *Lanice conchilega* the nephridia have coalesced together after coming in contact from before backwards, the separating membranes having disappeared. The case is extremely interesting in the fact that we have in it an approximation to the condition of the excretory system in Vertebrata: the presence of a metameric series of nephrostomata in vertebrate embryos has long ago been seen to constitute a resemblance between them and Chætopoda, but hitherto no Chætopod was known which resembled the vertebrate in having a number of nephridia coalesced to form a continuous longitudinal tube.

It is surprising to find that, as far as I have been able to discover, no resemblance to the condition seen in *Lanice conchilega* occurs in any of its near allies. The only species of the genus Terebella as defined by Malmgren that occurs in the Firth of Forth is *Terebella Danielssoni*, but of this I have only one specimen, and have not examined its nephridia. Of Amphitrite there are two species in the Forth: *Amphitrite cirrata* I have not examined anatomically; in *Amphitrite Johnstoni* there are a large number (15–17) of nephridia forming long loops projecting dorsalwards into the body-cavity, in the anterior region: each has its own internal and external openings, and is isolated and independent. In *Terebellides Stroemii* there is one pair of large dark-coloured nephridia in the anterior end, and three pairs of small rudimentary ones posterior to this. In *Pectinaria belgica* there are three pairs: they are all independent. In *Melinna cristata* there are several pairs, all separate. Figures showing the interesting relations which exist in *Lanice conchilega*, together with a more complete description of the nephridia in other forms of Polychæta, will I hope shortly be published in a paper on the anatomy of Polychæta.

NOTES ON THE GEOLOGY OF PART OF THE EASTERN COAST OF CHINA AND THE ADJACENT ISLANDS.

SURGEON P. W. BASSETT-SMITH, R.N., has forwarded to the Hydrographical Department of the Admiralty a brief Report on this area, embodying the results of observations made in the course of last summer during the cruise of H.M.S. *Rambler*. Specimens of rocks were collected at certain points on the mainland and on the neighbouring islands, stretching from Chusan on the north to Ockseu Island, south of Hai-tan Strait, opposite the northern part of Formosa.

All the islands, with a single exception, appear to consist of crystalline rocks. They usually present sharp rugged outlines, with bold cliffs—more or less fissured and veined—rising, in many cases, vertically from moderately deep water. In the following notes, the stations from which the specimens were collected are described in succession from north southwards.

Tou-wah Island, the most northerly station, consists of an irregular range of hills trending in a north-west and south-east direction, and reaching an elevation of 1600 feet. A gray granitic rock was obtained from the summit. Thornton Peak, on the mainland in the province of Chi-kiang, separated from the Chusan group by a narrow sea, is composed of a pink granite. From Ta-fou Island, in San-moon Bay, a fine-grained purplish quartz-felsite was obtained. The group of Hae-shan Isles seems to be composed of a dark gray quartz-felsite, and a similar rock forms the Tai chow Islands.

Another group of stations visited by the *Rambler* lies off the coast of the province of Fu-kien. Fuh-yan Island consists of hills reaching a height of 1700 feet, and yielding a fine-grained greenish rock, apparently a diabase. Coney Island is composed for the most part of a coarse pinkish granite, with veins of quartz, and dykes which appear to consist of diabase and hornblende-porphyrite. The two islands known as Tung Yung are formed mainly of quartz-felsite; the specimens obtained from the larger of the two isles containing much opaque white feldspar, porphyritically distributed through the rock. In a cove at the south-west end of the latter island, the rocks split up into irregular columns, and in certain parts these columns exhibit considerable curvature.

The third group of stations is situated on the River Min, and in the neighbourhood of its mouth. Chang-chi is a large irregular-shaped island of red porphyrite. The island known as Matsou is particularly interesting, the principal rock being a white quartz-felsite, with a complicated network of basaltic dykes. In a small sandy bay, a deep water-course exposes a layer of dark earth, about a foot in thickness, crowded with land shells. Two small neighbouring islands known as White Dog consist of dark gray quartz-felsite.

On the north side of the mouth of the River Min is an island, termed Sharp Peak, about three miles in length, which culminates in a rocky peak 1500 feet high. The island is formed, for the most part, of a hard conglomerate, associated with slates and shales, and with a talcose schist penetrated by veins of quartz. A cliff at the north-east point of the island displayed a clear section, in which this schist was seen to alternate with beds of slate and conglomerate, inclined at about 45°.

A small low island off the south point at the entrance to the River Min, consists of granite, gneiss, and mica-schist. A specimen of red granite, with crystals of iron pyrites, was obtained from the rugged mountains of the neighbouring mainland. Temple Point, on the north side of the Min, a few miles from its mouth, yielded a greenish-yellow steatitic rock, with dendritic markings. At Pagoda Anchorage, up the river, a fine-grained pink gneiss was obtained, and this locality also yielded a fragment of a large crystal of smoky quartz. About twelve miles further up the Yuen Fu branch of the Min River are some hot springs having a maximum temperature, in November, of 114° F. The rock is here a quartz-felsite. An orthoclase porphyry occurs about five miles further up the river, and quartz-felsite again occurred ten miles higher. Here, in a curious recess in the hill-side, in which a temple has been built, are numerous stalactites, some of large size. The mountains all up

the Yuen Fu are very fine, presenting a succession of bold outlines and rocky peaks. A dark-gray quartz-felsite was obtained from a high peak in a range of hills bounding the water-shed of the Min on the south. From the base of the hills a stretch of low flat reclaimed land extends to the coast. The soil of the hills is of a bright red colour, contrasting with the dark tints of the felsitic rocks.

The fourth group of stations includes a number of localities around Hai-tan Strait. Here the hills present vivid colouring, which contrasts very markedly with the white sands of the shore, especially on Hai-tan Island itself. This consists of three ranges of hills, with intermediate barren plains. Near the north point is a group of reddish sand-cliffs, from 20 to 30 feet high, horizontally stratified, and presenting flat summits, which form a miniature plateau deeply trenched by numerous gullies. At the mouth of the strait is a small barren island—Tessara Island—composed of gneissose rocks, which carry iron pyrites. Slut Island, about 400 feet high, yielded a dark porphyritic felsite, and a weathered surface of the rock displayed evidence of fluxion structure. Syang Point, at Hai-tan, shows granitic rocks running up into high hills. Kiang-shan, on Hai-tan Island, is a hill 1800 feet high, composed of dark-gray quartz-felsite. Mount Bernie, on the mainland, at the south end of the strait, about 1400 feet in height, is composed of a similar rock, weathering to a reddish earth; and in Hungwah Sound the hills are of similar character. In Ockseu, a small rocky island, about twenty miles south of Hai-tan, is a dark-coloured rock, apparently dioritic, and certain masses of this rock when struck, emit a ringing sound, like that of a phonolite. There are here numerous veins of quartz, some showing rather bold crystals, and a good deal of schorl, or black tourmaline. It is notable that the island of Ockseu is especially subject to seismic disturbances.

THE METEOROLOGY OF INDIA[1]

IT is perhaps inseparable from the mode of issue of the "Indian Meteorological Memoirs" that their titles (*e.g.* Vol. III., Part I., I.—Rainfall, Part I.) are rather complex. It is stated that this memoir is to be in three parts, whereof the present part treats only of the normal rainfall of India; Part II. is to treat of its variations in past years; Part III. is to contain the tabular data: the whole to form Vol. III. of the series.

As India depends chiefly on agriculture, the investigation of the conditions affecting its rainfall is of the highest practical importance to it. The registers of rainfall available are, except a few private ones, all official work done under Government orders. Some few extend from 1844, but the most of those accepted as trustworthy, after a critical examination, date from about 1862; the discussion includes the data only down to 1883, *i.e.* covers pretty nearly a complete record for twenty-two years. Altogether, the registers of 424 stations are reviewed: for purposes of discussion these are grouped into twenty-five "rainfall districts," *i.e.* districts with similar rainfall.

From all these it appears that the average rainfall of the whole of India, excluding Burmah and the Himálya, is about 42 inches. The range of rainfall over this wide area is one of the most wonderful in the world, viz. from about 500 or 600 inches in Cherra Púnji to from 1 to 5 inches in Sindh. The average annual range over the whole of India (as above) is about 13 in the whole 42 inches. The rainfall is discussed under four heads:—

(1) Summer Monsoons. (2) Autumn Rains in South-East.
(3) Winter Rains. (4) Spring Storms.

The local distribution of 1, 3, and 4 is well shown by tints of various shades on three maps. For the connection with the state of air-pressure, twelve maps are given, showing the isobars for the mean pressure of each month; the discussion of this connection is complicated, and difficult to summarise.

(1) *Summer (South-West) Monsoon.*—By some, the south-west monsoon is considered to be an extension of the south-east trade-winds, but the author considers their connection to be very doubtful, and gives a rough calculation, showing that the evaporation from the Northern Indian Ocean, land of India, and Bay of Bengal is enough to account for the whole of this season's rain. This rainfall is far the heaviest of the four seasons, and the most important for agriculture for most part of India, being, in fact, popularly styled "the rains." On its sufficiency depend the lives of millions. The distribution is at once seen by the tinted map. The west coasts of India and Arakhan catch the first and heaviest fall of over 100 inches: this does not top the coast range of mountains. The next heaviest is from the head of the Bay of Bengal to the Himálya, thence all along the lower Himálya, of from 50 to 70 inches. The amount decreases thence steadily with distance from the head of the Bay of Bengal, and from the Himálya, dwindling to almost nothing on the south-east coast and north-west border.

The effect of a mountain-range in intercepting rain is clearly brought out, *e.g.* in the Western Ghâts this rainfall, coming from the south-west, decreases from 250 inches on the coast to 100 inches at 30 miles inland, and to 20 inches at 60 miles from the coast. Again, very little rain crosses the outer snowy range of the Himálya. In fact, it seems to be an established law that the precipitation of rain from damp air is greatest in an ascending current from the chill produced in the ascent, and is moderate in a horizontal current.

(2) *Autumn Rains in South-East.*—The author shows that these are not (as often stated) a part of the north-east monsoon, but are, in fact, a late part of the south-west monsoon, corresponding to the late and heaviest part of the same on the Arakhan coast.

(3) *Winter Rains.*—These are popularly styled the north-east monsoon, and are popularly said to be due to a reversal of the conditions of the south-west monsoon. Their distribution is, roughly speaking, the opposite of that of the south-west monsoon, and is well shown on the map given. The south-east coasts, which scarcely feel the south-west monsoon, catch the maximum of over 10 inches of this season, the North-West Himálya catch from 5 to 10 inches, the head of the Bay of Bengal from 3 to 5 inches, and the rest of the country less and less with increased distance from these places.

Small as these quantities are (compared to those of the south-west monsoon), they are of the greatest importance to some of the localities named, especially to North-West India, as on them depends the growth of the valuable crops of temperate climates, *e.g.* wheat, the staple of North-West India; indeed, in the extreme north-west the winter is the dampest season.

(4) *Spring Storms.*—This rainfall is distinguished by increasing with the advance of the season, *i.e.* with the rising temperature, and mainly restricted to the south and east provinces. It is often accompanied by hail and thunderstorms, and is common in the evenings. This rain is usually very local, of short duration, heavy, and frequently repeated.

Altogether, this is a most elaborate and valuable monograph on its subject—the normal rainfall of India.

Part I. of Vol. IV. of "Indian Meteorological Memoirs" contains three memoirs, each a short monograph on its own subject, by different authors: these will be dealt with separately.

I.—"Account of the South-West Monsoon Storm of May 12-17 in the Bay of Bengal and at Akyab," by J. Eliot (pp. 38, and 2 plates). The history of this storm has been worked out from the meteorological reports of fourteen coast stations, and the logs of fourteen vessels passing through the Bay of Bengal. The states of the barometer and wind are shown for four days on four charts, and the track of the storm-centre on another. The meteorological conditions seem to have been remarkably uniform over the Bay of Bengal for a fortnight preceding the storm; indeed, this seems to be the normal state of things before a cyclone. The south-east trade-winds seem to have extended north of the equator on May 10 and 11, and gradually advanced into the Bay of Bengal, as strong south and south-west squalls, with rain, increasing in violence within the Bay. In front of these, a barometric depression was formed about the 12th, round which, as a vortex, the wind became cyclonic. This cyclone advanced in a curved path north and east (whereas most cyclones advance north and west up the Bay), increasing from 6 miles per hour on the 15th to 15 miles per hour on the 17th, and broke up on the Arakhan Hills close over Akyab on the 17th, doing great damage to property.

II.—"On the Diurnal Variation of the Rainfall at Calcutta," by H. F. Blanford, F.R.S. (pp. 8, and 1 plate). This is a

[1] "Indian Meteorological Memoirs," Vol. III., Part I. I.—The Rainfall of India, Part I. Pp. 116, and 9 Plates. A Monograph by H. F. Blanford, F.R.S. (Calcutta: Government Printing Press, 1886.)
"Indian Meteorological Memoirs," Vol. IV., Part I. Pp. 57, and 4 Plates. Edited by H. F. Blanford, F.R.S. (Calcutta: Government Printing Press, 1886.)
"Report on the Meteorology of India in 1882," by H. F. Blanford, F.R.S. Pp. 305 and 3 Plates. (Calcutta: Government Printing Press, 1886.)

discussion of the hourly frequency and quantity of rain in a period of seven years (1878–84), derived from a self-registering Casella's hyetograph. The results do not seem of much practical importance. In the rainy season the rain is least frequent at the hour of maximum pressure, and most frequent at the coldest hour. At other seasons, dust-storms, with rain, are commonest in the evening. The greatest and least rainfall occur in general at the hours of greatest and least frequency.

III.—"The Meteorological Features of the Southern Part of the Bay of Bengal," by W. L. Dallas (pp. 11, and 1 plate). This is a discussion of the meteorology of a square district of 4° by 4° of the Indian Ocean, about half way between Ceylon and Sumatra, derived from the logs of ships. The air-pressure is at a maximum in January and at a minimum in May, with slight minima in July and October, which seem related to the occurrence of cyclones. The diurnal variation is extremely regular, the minima occurring about 3h. 30m. and 15h 40m., and the maxima about 9h. and 22h. The range is markedly largest in April and September, *i.e.* at the two great seasonal changes. The mean temperature is 80°·9, and the range of the mean monthly temperature is only 3°, which is smaller than at any coast station: the diurnal range of the year is about 2°·7, varying from 3°·75 in April to 1°·8 in May, the maximum and minimum being thus close together. In the summer (south-west) monsoon calms are rare. From April to September the wind is pretty steady from south-west to west-south-west, and, from December to March, generally from north to north-east. Only thirteen gales are recorded in twenty-five years, and none of them over force 9 of the Beaufort scale.

Mr. Blanford's "Report" for 1884 is a discussion of the meteorology of India in 1884, on the same general plan as adopted for the ten years preceding. The discussion rests on observations supplied from 134 reporting-stations. Each meteorological element is discussed separately, beginning with the solar radiation as being the prime cause of all meteorological change; next, earth-radiation, temperature, humidity, cloudiness; and, lastly, rainfall. The great extent of India, and its isolation by ocean and mountain from other countries, render it a country most favourable for meteorological study. One singular feature is, that most considerable variations are of a somewhat lasting character, sometimes lasting two seasons, *e.g.* heavy snow in the spring in the Himálya is followed by steady north-west winds over the plains of Northern India, afterwards turning into the hot west winds.

The year under review was in some ways peculiar. Perhaps the most striking feature brought out is that, ever since 1878, the temperature of insolation and of the air have both steadily fallen, and were lowest in 1884 (1°·2 less than in 1878), although the sky was slightly less cloudy than in 1883: it seems likely that this is part of a cyclic change connected with that of the sunspots, the temperature being highest at the sunspot minimum, and *vice versâ*. The mean air-pressure was slightly (0″·01) above that of past years, and also much steadier. The average humidity was rather lower, and the average clearness of sky somewhat greater than in the recent years, and yet the total rainfall was somewhat greater: this was chiefly due to excess of rain in North-West, Central, and South-East India. Heavy snow fell in the North-West Himálya early in the year, bringing rain to the North-West Punjab, and dry north-west winds in North India generally, followed by a hotter summer than usual. The south-west monsoon bringing the rain sets in in North India in June. The storms of the year were somewhat singular. From July to September a series of cyclones formed in the Bay of Bengal, and followed a north and west course far into the plains of India: this course seems to be the usual cyclone track of the Bay of Bengal. One of these, in July, crossed the entire breadth of India, and one, in September, lasted over a fortnight. Heavy snow fell in the outer Himálya in September and October, followed by north-west winds in North India, and by an unusually cool winter in India generally. Twelve charts accompany this Report, showing the mean monthly temperature, air-pressure, and wind; the isotherms, isobars, and wind-resultants being plotted in colours on each monthly chart. This annual Report, of which a very brief summary only is here given, is the outcome of an enormous amount of labour: the detailed tables of data covering 305 quarto pages, these tables being themselves mostly the result of laborious computation from the data furnished by the observatories.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The Mathematical Examiners have bracketed as Senior Wranglers Messrs. Baker and Flux of St. John's, and Iles and Michell of Trinity. It is unprecedented to have a bracketed Senior Wrangler. No women students have this year been placed as Wranglers.

The following women students have been placed in the first class of the Natural Sciences Tripos, Part I., E. E. Field, A. J. Flavell, and M. M. Smith, all of Newnham College.

The Honorary Degree of Doctor in Science has been conferred on Prof. Asa Gray, of Harvard.

SCIENTIFIC SERIALS.

Annalen der Physik und Chemie, No. 6, June.—R. Emden, on the vapour-pressures of saline solutions. Criticism of prior results, and fresh experiments conducted according to the method of Konowalow. Babo's law, that the vapour-tension of saline solutions is always proportional to that of pure water at the same temperature, is shown to be true between 20° C. and 95° C.—Max Planck, on the principle of increase of entropy. Application of this principle in the study of dissociation of gases.—C. R. Schulze, on the amount of water of crystallization held in various salts. Proves the existence of a new form of sulphate of magnesia having density 1·8981, containing six molecules of water, and therefore differing from Mitscherlich's salt of same composition of density 1·6151.—W. Voigt, on the theory of light for absorbing isotropic media. A development of the theory propounded by the author three years ago.—C. L. Weber, on the galvanic conductivity of amalgams. The amalgams examined were of tin, bismuth, lead, cadmium. Addition of tin increases conductivity of mercury; bismuth increases it until 10 per cent. of bismuth has been added, after which further addition decreases the conductivity; lead shows a maximum at about 25 per cent.; cadmium produces a steady increase in conductivity.—Adolf Koepsel, determination of magnetic moments and absolute strength of currents by means of the balance. The method is due to R. von Helmholtz, and is independent of the earth's magnetic field or its variations. The author has made by this method a new determination of the electro-chemical equivalent of silver, which he gives as 0·011740 ± 0·0000022 in C.G.S. measure. Lord Rayleigh's value was 0·011794.—Walter König, magnetic researches on crystals. A very careful research on magnetic susceptibility of quartz and calc-spar in magnetic fields of various degrees of intensity. The two principal permeabilities in calc-spar possess a constant difference in fields of various strengths up to 3000 C.G.S.; for quartz, the difference diminishes as the field is strengthened, and is less than that of calc-spar.—R. Clausius, reply to some remarks of Lorberg upon dynamo-electric machines.—A. Foeppl, electricity as an elastic fluid. A speculative paper: the author thinks the existence of the Hall effect a criterion of his theory.—K. Wesondonck, on the absence of polar difference in spark-potential.—G. Meyer, note on the index of refraction of ice; the value for sodium light is 1·3133.—E. Ketteler, on the dispersion of rock-salt. The author thinks he has established the law that the absorbing power of substances for heat-rays is proportional to the negative coefficient of the term in λ^2 in the formula which he uses in place of Cauchy's for the law of dispersion.—W. Voigt, reply to Wernicke's remarks on elliptic polarization.—F. Braun, on the diminution of the compressibility of solutions of sal-ammoniac with increase in temperature.—A. Overbeck, on the signification of the absolute system of measurement.

SOCIETIES AND ACADEMIES.

LONDON.

Geological Society, May 25.—Prof. J. W. Judd, F.R.S., President, in the chair.—The following communications were read:—On the remains of fishes from the Keuper of Warwick and Nottingham, by Mr. E. T. Newton; with notes on their mode of occurrence by the Rev. P. B. Brodie and Mr. E. Wilson.—Considerations on the date, duration, and conditions of the Glacial period with reference to the antiquity of man, by Prof. Joseph Prestwich. After showing how the discoveries in the valley of the Somme and elsewhere, twenty-eight years ago, led geologists who had previously been disposed to restrict the age of man to exaggerate the period during which the human race had existed, the author proceeded to

discuss the views of Dr. Croll on the date of the Glacial epoch. Dr. Croll, who had at first referred this to an earlier phase of orbital eccentricity, commencing 980,000 years ago, subsequently regarded it as coinciding with a minor period of eccentricity that commenced 240,000 and terminated 80,000 years since. This last estimate was chiefly supported by the amount of denudation that had subsequently taken place. The efficacy of the increased eccentricity of the earth's orbit in producing the cold of the Glacial epoch was shown to be very doubtful; for as similar changes in the eccentricity had occurred 165 times in the last 100 millions of years, there must have been many glacial epochs in geological time, several of them much more severe than that of the Pleistocene period. But of such glacial epochs there was no valid evidence. Another inference from Dr. Croll's theories, that each glacial epoch consisted of a succession of alternating cold and warm or interglacial phases, was also questioned, such alternations as had been indicated having probably been due to changes in the distribution of land and water, not to cosmical causes. The time requisite for such interglacial periods as were supported by geological evidence was more probably hundreds than thousands of years. Recent observations in Greenland by Prof. Helland, Mr. V. Steenstrup, and Dr. Rink, had shown that the movement of ice in large quantities was much more rapid, and consequently the denudation produced much greater than was formerly supposed. The average rate of progress in several of the large iceberg-producing glaciers in Greenland had been found to be 36 feet daily. Applying these data and the probable accumulation of ice due to the rainfall and condensation to the determination of the time necessary for the formation of the ice-sheet, the author was disposed to limit the duration of the Glacial epoch to from 15,000 to 20,000 years, including in this estimate the time during which the cold was increasing, or preglacial time, and that during which the cold was diminishing, or postglacial time. Details were then given to show that the estimate of 1 foot on an average being removed from the surface by denudation in 6000 years, on which estimate was founded the hypothesis of 80,000 years having elapsed since the Glacial epoch, was insufficient, as a somewhat heavier rainfall and the disintegrating effects of frost would produce far more rapid denudation. It was incredible that man should have remained physically unchanged throughout so long a period. At the same time, the evidence brought forward by Mr. Tiddeman, Dr. Hicks, and Mr. Skertchly of the occurrence of human relics in preglacial times, had led the author to change his views as to the age of the high-level gravels in the Somme, Seine, Thames, and Avon valleys, and he was now disposed to assign these beds to the early part of the Glacial epoch, when the ice-sheet was advancing. This advance drove the men who then inhabited Western Europe to localities such as those mentioned which were not covered with ice. Man must, however, have occupied the country but a short time before the land was overwhelmed by the ice-sheet. The close of the Glacial epoch, *i.e.* the final melting of the ice-sheet, might have taken place from 8000 to 10,000 years since. Neolithic man made his appearance in Europe 3000 to 4000 years B.C., but may have existed for a long time previously in the east, as in Egypt and Asia Minor civilized communities and large States flourished at an earlier date than 4000 B.C. After the reading of the paper there was a discussion, in which the President, Dr. Evans, Dr. Geikie, Prof. Boyd Dawkins, Dr. Hicks, and others took part. —Notes on some Carboniferous species of *Murchisonia* in our public museums, by Miss Jane Donald. Communicated by Mr. J. G. Goodchild.

Zoological Society, June 7.—Mr. E. W. H. Holdsworth, in the chair.—The Secretary read a report on the additions that had been made to the Society's Menagerie during the month of May, and called attention to a Tooth-billed Pigeon (*Didunculus strigirostris*) brought home from the Samoan Islands, and presented to the Society by Mr. Wilfred Powell; to two Red-spotted Lizards (*Eremias rubro-punctata*) obtained at Moses' Well, in the Peninsula of Sinai, and presented to the Society by Mr. G. Wigan; and to a small scarlet Tree-Frog (*Dendrobates typographus*) from Costa Rica, presented to the Society by Mr. C. H. Blomefield.—Mr. Sclater called attention to examples of two North American Foxes now living in the Society's Gardens, which he referred to *Canis velox* and *C. virginianus*.—A communication was read from Mr. A. O. Hume, containing some notes on *Budorcas taxicolor*, the Gnu-goat or Takin of the Mishmee Hills, and some remarks on the question of the form of the horns in the female of this animal.—A communication was read from Mr. E. Symonds, containing notes on various species of Snakes met with in the vicinity of Kroonstadt, Orange Free State, specimens of which had been forwarded to Mr. J. H. Gurney, and determined by Dr. Günther.—Mr. Martin Jacoby, gave an account of a small collection of Coleoptera obtained by Mr. W. L. Sclater in British Guiana.—Prof. G. B. Howes, read a paper on a hitherto unrecognized feature in the larynx of the Anurous Amphibians. This was the existence in many individuals of various species of a rudimentary structure, which appeared to correspond to the epiglottis of Mammals, and which in some instances attained a remarkable development as an organ of voice.

Institution of Civil Engineers, June 7.—Annual General Meeting.—Mr. Woods, President, in the chair.—The Report of the Council on the condition of the Institution, and the annual statement of the accounts, were received. The number of members on the roll of the Institution, on March 31, 1887, was 4347, of whom 20 were honorary members, 1568 members, 1[illegible] associate members, and 484 associates. This was a net increase of 173, or 4·19 per cent., on the 4174 members of all classes recorded last year. The elections had included 34 members, 234 associate members, and 6 associates, while the deaths, resignations, and erasures were 106. Many deaths had occurred among the older members of the Institution during the past twelve months, chief among whom must be placed Sir Joseph Whitworth, whose world-wide renown as a mechanician it was unnecessary to dwell upon. By his will he bequeathed to the Institution 80 shares, of £25 each, in the firm of Sir Joseph Whitworth and Company, Limited. During the twelve months under review, 211 candidates were admitted as students. On the other hand, 82 were elected into the corporation as associate members, and 106 ceased, from various causes, to belong to the class. The total number of students on March 31 last was 949, as against 926 at the same date in 1886. There were twenty-six ordinary meetings during the session, when twenty original communications were read and discussed. The Howard Quinquennial Prize had been adjudged to Dr. John Percy, in recognition of his researches on the uses and properties of iron. To the authors of some of the papers read and discussed at the ordinary meetings medals and premiums had been awarded, viz.: Telford Medals and Telford Premiums to Alexander B. W. Kennedy, Dr. J. Hopkinson, Colonel E. Maitland, and W. Willcocks; a Watt Medal and a Telford Premium to E. A. Clowes; Telford Premiums to W. J. Dibdin, W. S. Crimp, J. J. Webster, and J. Kyle; and the Manby Premium to L. H. Ransome. For papers printed in Section II. of the Proceedings, without having been publicly discussed, the following awards had been made: a Telford Medal and a Telford Premium to J. G. Gamble; a Watt Medal and a Telford Premium to W. J. Last, and Telford Premiums to J. Hetherington, K. W. Hedges, C. J. Wood, A. Leslie, and D. A. Stevenson. Twelve students' meetings had been held on alternate Friday evenings, at which thirteen papers were read and discussed.—The ballot for Council resulted in the election of Mr. G. B. Bruce, as President; of Sir John Coode, Mr. G. Berkley, Mr. H. Hayter, and Mr. A. Giles, M.P., as Vice-Presidents; and of Mr. W. Anderson, Mr. B. Baker, Mr. J. W. Barry, Sir Henry Bessemer, F.R.S., Mr. E. A. Cowper, Sir James N. Douglass, Sir Douglas Fox, Mr. C. Hawksley, Mr. J. Mansergh, Mr. W. H. Preece, F.R.S., Sir Robert Rawlinson, C.B., Sir E. J. Reed, K.C.B., F.R.S., M.P., Mr. W. Shelford, Mr. F. C. Stileman, and Sir William Thomson, F.R.S., as other Members of Council.

Chemical Society, June 2.—Mr. William Crookes, F.R.S., President, in the chair.—The following papers were read:—The equivalent of zinc, by Lieut.-Colonel Reynolds, late R.E., and Prof. W. Ramsay.—The magnetic rotation produced by chloral, chloral hydrate, and hydrated aldehyde, by Dr. W. H. Perkin, F.R.S.—Note on a new class of voltaic combinations in which oxidizable metals are replaced by alterable solutions, by Dr. C. R. Alder Wright and Mr. C. Thompson. It appeared to the authors probable that just as a liquid capable of parting with oxygen, chlorine, &c., can be used in conjunction with an electrode of unchangeable material at one side of a voltaic cell (as in Grove's nitric acid battery and analagous combinations), or may be replaced by a solid conducting electrode, itself capable of losing oxygen (*e.g.* a plate of strongly compressed peroxide of lead), so conversely might a conducting plate of oxidizable material (*e.g.* zinc) at the other side be replaced by an unchangeable electrode in conjunction with a liquid capable of taking up oxygen, chlorine, &c., without producing any fundamental change in the character of the actions

taking place in the cell whilst generating a current. The electrode immersed in this oxidizable substance, like the zinc of an ordinary cell, would acquire the lower potential, and the opposed plate the higher potential; *i.e.* the wire connected with the latter would be the "positive pole" of the construction in reference to the external circuit. On trial, it has been found that such is the case, and that in consequence a large variety of novel forms of cell becomes easy of construction. For example, sodium sulphite or potassium ferrocyanide solution opposed to chromic-sulphuric acid solution; preferably with an intermediate layer of some neutral salt solution, such as sodium sulphate, to prevent the direct action of the two fluids on one another. During the passage of a current, sodium sulphate or potassium ferrocyanide is formed in quantity proportionate to the electricity passing, *i.e.* to the amount of silver thrown down in a silver voltameter included in the circuit; whilst [illegible] sulphate is produced at the other side. Various [illegible]ous cells are described, in particular one where lead oxide [illegible]ed in caustic soda is opposed to alkaline hypobromite: [illegible] case lead dioxide is produced and separates out in the [illegible]orm; and one where chromium sesquioxide dissolved in [illegible]e soda is opposed to chromium trioxide dissolved in sul[illegible]ic acid; here sodium chromate and chromium sulphate are formed, an E.M.F. about equal to that of a Daniell cell being set up.—The composition of Prussian blue and Turnbull's blue, by Mr. Edgar F. Reynolds.—Phlorizin, by Prof. E. H. Rennie.—Further notes on the chemical action of *Bacterium aceti*, by Mr. Adrian J. Brown.—Note on the cellulose formed by *Bacterium xylinum*, by Mr. Adrian J. Brown.—The oxidation of ethyl alcohol in the presence of turpentine, by Mr. C. E. Steedman, Williamstown, Victoria.

Royal Microscopical Society, May 11.—Rev. Dr. Dallinger, F.R.S., President, in the chair.—Mr. Crisp called attention to a number of slides of hair which Dr. Ondaatje, of Ceylon, had forwarded to the Society with a request for information as to its peculiarities of structure; also to a donation by Mr. Deby of sixty-two slides, chiefly of Micro-Hymenoptera, which came from the collection of the late Mr. F. Smith.—Mr. J. Mayall, Jun., said that he took it for granted that the Fellows were interested in whatever concerned the history of the microscope, and would therefore be glad of any new facts which tended to throw light upon the subject. He had lately come across evidence which showed that magnifying glasses were used at least as early as 1513-20, for, in the celebrated portrait of Leo X., by Raphael, the Pope is shown holding one in his hand. The picture was painted between 1513 and 1520, as the Pope was elected in 1513 and Raphael died in 1520. He brought to the meeting a large volume (lent for the purpose by Mr. Quaritch) which contained an engraving of Raphael's portrait of Leo X. During a recent visit to Florence he also paid some attention to the microscopes which had been attributed to Galileo. It was of course rather difficult to say in such matters what was really authentic and what was not. He could not, however, help noting that all the telescopes made in 1660, or about that time, had cardboard tubes, and wood or horn cells for the lenses, whereas these microscopes were made with substantial brass body-tubes with strong and well-made screw threads and firm tripod support. He could only say, therefore, that if the microscope-makers had arrived at that stage of perfection in Galileo's time, they had reached a point not attained by his successors until many years afterwards.—Mr. J. Mayall, Jun., also exhibited a microscope which had come from Japan. It was made after one of the old upright tripod models and had a ring of inlaid silver ornamentation at both top and bottom.—Dr. Maddox's paper, on the different tissues found in the muscles of a mummy, was read.—Professor Bell gave an account of a recent visit which he had paid to M. Pasteur's laboratory in Paris.—Mr. Deby called attention to a series of double-stained sections of the rare parasitical plant, *Brugmansia Lowii*, one of the Rafflesiæ, but differing in its being hermaphrodite. It grows on the overground roots of a species of Cissus, and was collected by him in 1884 in the Raritau range of mountains in Central West Sumatra. The sections showed the development of the plant from the time it begins to raise the bark of its host as a minute tubercle up to the complete maturity of its ovules. The double staining allows of distinguishing between the tissues of the parasite and of its host, which in unstained sections cannot be determined. The formation of the loculi of the ovary is very remarkable, and partakes more of a fungoid growth than phanerogamic.

PARIS.

Academy of Sciences, June 6.—M. Janssen in the chair.—Researches on the density of sulphurous acid in the state of liquid and of saturated vapour, by MM. L. Cailletet and E. Mathias. Having already described the method employed by them for determining the density of ethylene, of the protoxide of nitrogen, and of carbonic acid as liquids and saturated vapours, the authors here generalize their method by applying it to the study of a substance (sulphurous acid), whose critical point, approaching 156° C., is much higher than that of the former gases. Their researches show that the densities of the liquid and of the saturated vapour have a common limit, which is opposed to the conclusion arrived at by Avenarius; also that the critical density is 0·520.—Heats of combustion, by MM. Berthelot and Recoura. Continuing their studies of the heats of combustion by the new calorimetric method, the authors have determined the mean for glucose at 3·762 calories; for quinone, 6·102; for napthalene, 9·688; for benzoic acid, 6·345; and for salicylic acid, 5·326. These studies are being continued with a view to determining the heat of combustion of liquid and volatile bodies, and the measure of the heat of combustion of pure carbon in its various states. Notwithstanding its fundamental importance for calculating the heats of formation of organic compounds, this element has been neglected since the time of Favre and Silbermann.—Heats of combustion, by MM. Berthelot and Louguinine. Mean determinations are given for several compounds, such as napthalene, 9·6961 calories; phenol, 7·8105; benzoic acid, 6·3221; cuminic acid, 7·5533; quinone, 6·0613; hydroquinone, 6·2295; pyrogallol, 5·0262.—A new endless tape odograph, by M. Marey. The ingenious instrument here described has been prepared for the purpose of automatically recording the velocity of men walking or running with or without burdens, and under the varying conditions of level or inclined, smooth or rugged track, with or against the wind, and so forth. It is especially applicable for determining the marching capacity of troops, as well as the velocity of locomotives and other engines, of water and atmospheric currents.—Action of oil on troubled waters, by Admiral Cloué. The author has studied the results of over two hundred experiments, made especially in England and the United States, and concludes that the question is now definitely settled. There can no longer be any doubt that oil has a most efficacious effect in calming storm-tossed waters, and thus saving vessels in danger of foundering at sea. Fish oils appear to be the best, mineral oils owing to their lightness the least effective, but kitchen refuse of all sorts and similar substances floating compactly on the surface, tend to produce the same result.—On the character and results of the improved methods of amputation lately introduced into hospitals, by M. Trélat. The author's observations for the Charité and Necker Hospitals in Paris show that since 1880, when the antiseptic methods came into general use, the mortality under all kinds of amputations has fallen from 50 and upwards to an average of about 15 per cent.—On the density of the celestial vault, in relation to the radiant-points, by M. Alexis de Tillo. According to their right ascensions the 1315 radiant-points of the northern hemisphere are shown to be disposed in such a way as to make it evident that the regions traversed by the Milky Way (0°-90° and 270°-360°) have a perceptibly greater meteoric density than the others (90°-180° and 180°-270°) which lie mainly beyond that stellar zone.—On the melotrope, a new musical apparatus, by M. J. Carpentier. This instrument is intended to serve as a complement to the recently described melograph, the automatic records of which it faithfully reproduces on any piano. But it may also be so adjusted as to constitute itself an independent instrument suitable for the performance of automatic music generally.—Action of an electro-static field on a variable current, by M. Vaschy. It is shown that in a magnetic field of varying intensity a closed conductor placed in this field is traversed by induced currents, and in general there arises in each point of the space an electric force capable of being calculated. In other words, the variations of the magnetic field develop a true electrostatic field exercising a mechanical action on the electrified bodies. In virtue of the principle of equilibrium between action and reaction, the latter must react on the magnets or variable currents to which is due the magnetic field.—On the conductibility of abnormal salts and of acids in extended solution, by M. E. Bouty. The author's previous conclusion is here confirmed, that in respect of their conductibility these acids differ greatly from each other, not even excepting sulphuric, nitric, and hydro-

chloric acids; further, that these varying degrees of conductibility are not directly comparable with those of the neutral salts.—On cyanoacetic acid, by M. Louis Henry. These researches show, as anticipated, that the hydrogen element (CH_2) in this acid, $CN-CH_2-CO(OH)$, has a basic character; also that the acid itself may be obtained in well-defined and perfectly white crystals, and that it dissolves, not at 55° C., as indicated by Van't Hoff, but at 65°-66° C.—On the periodicity of magnetic perturbations and solar rotation, by M. Ch. V. Zenger. A comparative study of observations recorded at the Parc Saint-Maur and Paulovsk Observatories shows that the dates of magnetic perturbations largely coincide either with the days of the solar period or with those of the periodic shooting-stars. This coincidence is observed at points far distant from each other on the surface of the globe, and in years of least (1878) as well as of greatest solar activity (1883-84).

BERLIN.

Physiological Society, May 27.—Prof. Munk, President, in the chair.—Dr. Loewy spoke on the respiratory centre in the medulla oblongata. His experiments were carried out on rabbits in the laboratory of Prof. Zuntz. He found that severing the medulla from the brain had no influence on either the frequency, depth, or rhythm of the respiration. On cutting one vagus in the animal operated upon as above, he observed a slight slowing of the respiratory movements; in order to produce any marked alteration of the respiration, he found it necessary to cut both vagi. After this operation the frequency of the movements was considerably lessened, the inspirations being very deep, while the expirations either did not take place at all, or were passive: in some few cases active expiration continued. The volume of the respired air was considerably diminished, while the rhythm was normal. By the above experiments it was shown that the centre in the medulla is able to maintain the rhythm of the respiratory movements after it is severed from both the brain and the peripheral parts of the vagi. Moreover the centre when thus isolated was found to be equally susceptible to stimuli, whether applied directly or arriving from the periphery, as when it was still connected with the brain and lungs. In one experiment after the medulla was separated from the brain and both vagi were divided, the spinal cord was cut through, and the muscles of the hind-limbs tetanized; this produced a quickening of the respiratory movements similar to that observed in normal animals, in accordance with the experiments of Zuntz and Geppert. (Muscular contractions lead to the formation of some product of their metabolism which has not yet been isolated, but which stimulates the respiratory centre when brought to it in the blood.) Similarly an excess of carbonic acid gas in the respired air had the same stimulating effect on the isolated respiratory centre as on the centre of normal animals. The irritability of the centre was not altered either qualitatively or quantitatively by its severance from the brain and lungs; thus equal percentage increments of carbonic acid gas in the respired air produced an equal increase of the respiratory movements in animals with isolated and unisolated respiratory centre. Dr. Loewy has also endeavoured to find experimentally an answer to another important question connected with respiration. The vagus, as is well known, is the only nerve that is in a state of continuous stimulation. Hering and Breuer have explained this as the result of the distension of the lung-alveoli during respiration, which acts as a stimulus to the endings of the vagus in the lungs. But inasmuch as they found that this continuous stimulation of the vagus does not entirely disappear when the lungs are no longer distended, after making an incision into the thorax, they assumed the existence of other unknown factors to explain the phenomenon. Dr. Loewy spoke against this view, pointing out that even in the collapsed lungs the alveoli are distended beyond their real size and that they are of normal size only in the atelectatic lung, and will then no longer stimulate the endings of the vagus. Experiments made by him confirmed this opinion: by occluding the bronchus of one lung, this lung became completely atelectatic, and then the vagus of the other side was severed. The immediate result of this was a considerable diminution in the frequency of the respiratory movements, greater in fact than is usually observed by section of only one vagus. Subsequent section of the vagus of the atelectatic lung produced no further effect on the respiration, thus showing that this vagus was not in a state of tonic stimulation.—Dr. Gad has carried on researches in his laboratory on the reaction-time for stimulation and inhibition. The experiments were made on the masseter muscle of man; the lower jaw was fixed so that the muscles antagonistic to the masseter did not come into play, and the contraction or relaxation of the muscle was graphically recorded on a Marey drum by means of a specially constructed muscle forceps. The experiments showed that as nearly as possible the same time elapsed between a given signal and the subsequent contraction of the muscle as between the given signal and its relaxtion. According to this, the will has an equally exact control of the inhibitory as of the stimulatory process.—Dr. Benda recommended the use of the kidney of mice for studying the structure of the glomeruli, and demonstrated this structure on a series of preparations which he exhibited.

BOOKS, PAMPHLETS, and SERIALS RECEIVED

A B C Five-Figure Logarithms: C. J. Woodward (Simpkin).—Elem... Microscopical Technology. Part 1: Dr. F. L. James (St. Louis).—Su... and Review of International Meteorological Observations, July to De... 1885 (Washington).—Histoire des Sciences Mathématiques et Phy... tome xi.: MM. Marie (Gauthier-Villars, Paris).—A Dictionary of ... sophy: J. R. Thomson (Dickinson).—Results of Observations of th... Stars made with the Meridian Circle at the Government Observatory, M... in the years 1862-63-64: N. R. Pogson (Madras).—Rustic Walking ... in the London Vicinity: W. R. Evans (Philip).—Encyclopædia Britan... 9th ed., vol. xxii (Black, Edinburgh).—Ocean Birds: J. F. Green (Porte... —Philips' Handy-Volume Atlas of the World (Philip).—Scala Naturæ: J. Cleland (Douglas, Edinburgh).—British Dogs, No. 8: H. Dalziel (Gill). —Annals of the Astronomical Observatory of Harvard College, vol. xvii. The Almucantar: S. C. Chandler (Cambridge, Mass.).—Higher Algebra: Hall and Knight (Macmillan).—Beiträge zur Biologie der Pflanzen, Vierter Band, Drittes Heft (Breslau).—Journal of the Liverpool Astronomical Society, vol. v.—Bulletin of the U.S. National Museum, No. 31—Synopsis of the North American Syrphidæ: S. W. Williston (Washington).

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THURSDAY, JUNE 23, 1887.

THE AGRICULTURAL PESTS OF INDIA.

The Agricultural Pests of India and of Eastern and Southern Asia, Vegetable and Animal, Injurious to Man and his Products. By Surgeon-General Edward Balfour, Author of "The Cyclopædia of India," &c. (London: Bernard Quaritch, 1887.)

CONSIDERABLE attention has been directed lately to agricultural pests of all kinds, and especially to insect pests, in various countries, because the injuries occasioned to crops by their agency have greatly increased, and in some instances altogether new disorders and diseases attributable to them have appeared. The universal international exchange of agricultural produce and other commodities has tended and must tend to distribute insects, fungi, and other sources of evil to mankind, animals, and plants, throughout the world. Thus the terrible scourge of the vine, the *Phylloxera vastatrix*, was first introduced into the French vineyards with plants, or cuttings, of vines imported from the United States. Very many insects most noxious to agricultural, fruit, and garden crops, in the United States were brought there with plants, cuttings, fruits, and seeds. The elm-leaf beetle, *Galeruca xanthomelæna*, which is now seriously damaging elm-trees, was not known in the United States until 1837, and came probably from France, or Germany, where it had been a troublesome pest long before that date. The hop fly, *Aphis humuli*, called the "barometer of poverty" by a Kentish historian of hop culture, has only recently visited the hop plantations of America; yet it caused almost a total blight last year in those of the Eastern States, upon an area of nearly 40,000 acres. Without any doubt this insect was conveyed from England in "hop-sets." The Hessian fly has been conveyed to Great Britain by some means or other not yet discovered, during the last year, and bids fair to be a dangerous and permanent scourge to the wheat and oat crops of this country.

It is the same with moulds, or mildews, or "blights," occasioned by fungi. The vine mildew, *Oidium tuckerii*, was not dreamed of in France until 1845. The potato mould, *Peronospora infestans*, had shown no important sign in Great Britain until 1844. The coffee mildew, *Hemileia vastatrix*, did no serious harm in the coffee plantations of Ceylon until after 1870; but during the last two years it has enormously decreased their yield.

Diseases of animals have also been greatly intensified during the past thirty years in Great Britain and in other countries. In India, as we gather from this little book of Surgeon-General Balfour, anthrax, pleuro-pneumonia, rinderpest, foot-and-mouth disease, are so rampant that the Madras Government has recently appointed an inspector of cattle diseases with a sufficient staff under him.

There is no doubt that the attacks of certain insects and parasitic fungi are more frequent and more fatal than formerly. Hop blights from aphides and mildew, *Spærotheca castagnei*, are far more common and destructive in England than they were fifty years back; and the orange-growers of Florida, California, and other places where oranges are cultivated, are at their wits' end to combat the ravages of scale insects, Coccidæ, which have greatly increased since 1870.

It is a moot point as to whether this is due, or not, to modern and more artificial systems of cultivation, which may be more favourable to the spread of insects and parasitic fungi. Or it may be that these new systems interfere with the balance of Nature by decreasing parasitic and other insects, and birds and other animals, which are the natural foes of injurious insects. It has been discovered by Prof. Forbes, of Illinois, that several species of the Carabidæ and Coccinellidæ eat the spores of fungi; therefore an unusual increase in the number of birds, or other foes of these insects, might occasion a serious spread of mildews.

The importance of the subject of agricultural pests cannot be overrated. It is now fully recognized by the Government of the United States, who have a distinguished entomologist upon the staff of the National Agricultural Department. Besides this, many of the States have their own entomologists, who furnish frequent and valuable reports and advice as to methods of treatment. In England the Agricultural Department of the Privy Council have lately issued a series of reports upon insects injurious to crops, written by Mr. Charles Whitehead; and Miss Ormerod, the entomologist of the Royal Agricultural Society, has published annual reports for upwards of ten years, which have been of the utmost value and practical benefit to agriculturists. And in India, as Surgeon-General Balfour tells us in this work, the serious injuries caused by insects and other animals, fungi, and bacilli, to mankind, animals, and plants, have at last attracted the attention of the Government of India, and it is proposed to invite communications from those engaged in agriculture, forestry, and horticulture in that country, to furnish matter for periodical reports like those issued from time to time by Miss Ormerod. These would of course be published in the vernacular, and should be illustrated by woodcuts, as Miss Ormerod suggests in her comprehensive letter in the preface of "Agricultural Pests of India." It is much to be hoped that a competent entomologist may be appointed in India to direct this work.

Surgeon-General Balfour, so far back as 1880, recommended the Secretary of State for India to obtain reports on the diseases of cattle and plants, and on creatures noxious to mankind and vegetation. In his admirable "Cyclopædia of India and of Eastern and Southern Asia," published in 1885, he gave a general view of the entomology of these regions, and described the losses sustained by agriculturists from these and similar causes. He has followed this up with the work now under review.

Though a small book, the "Agricultural Pests of India" is very ambitious in design, as it treats not only of insects and fungi and animals injurious to mankind and agricultural crops, but of all manner of birds, beasts, and fishes. Several of these cannot, even by the greatest stretch of the imagination, be classified as pests to agriculture, and seem to be altogether out of place in this category. Under the heading "Fish," sharks and siluroids are described, though it is not by any means clear in what way they are agricultural pests, except,

perhaps, that they might bite off the limbs of unwary agriculturists disporting in the sea. The book should have been styled the "Natural History of India," or "A Manual of the Natural History of India," rather than the "Agricultural Pests of India." But the fact that rather too many subjects are dealt with cannot be held to be a very serious fault in a compilation containing an immense amount of serviceable information arranged alphabetically, together with a good index, so that any head can be quickly found. The author had great opportunities of acquiring knowledge of the branches of natural history he has here discussed while he was engaged in forming the Government Central Museum at Madras, and other museums in various parts of India, as well as in the preparation of "The Cyclopædia of India" and his work on "The Timber Trees of India." He was therefore very well qualified to prepare this manual or dictionary of natural history, which will serve to show Indian agriculturists what are the principal foes of their crops and herds. No remedies or methods of prevention are given in detail. Some general instructions appear in the introductory chapters, such as to farm cleanly, and to use certain washes and powders in case of the attack of some insects. These, however, have evidently been taken from lists of remedies prescribed by American and English practical entomologists, and have not been actually tried in India. Now that Surgeon-General Balfour has demonstrated the dangers, and indicated general remedies which have been found advantageous in other climes, the farmers, the foresters, and fruit-growers of India should at once make experiments, and prove for themselves whether these are as efficacious in the fiery heat of the East as in the temperate climates of Great Britain and America.

This notice cannot be concluded without an allusion to some of the errors which have been carelessly allowed to remain in the book, having evidently escaped the notice of the eminent scientific man who "revised nearly the whole in manuscript, and the proofs as they passed through the press." It is not to be expected that Surgeon-General Balfour should be a skilled entomologist, but it is very unfortunate for him that those on whom he relied for assistance should have so signally failed him. He says that the *Cecidomyia tritici* is the Hessian fly of Europe and America. In reality the Hessian fly of Europe and America is *Cecidomyia destructor*, named so by Say long ago, and is completely and specifically distinct from *Cecidomyia tritici*, which is the true wheat midge of Great Britain. This is a mistake which appears unpardonable in a scientific reviser. On p. 45 it is stated that "the species of Necrophorus and Silpha are useful; they feed on carrion, and by scratching the ground from under dead animals they partially bury them." As a fact the *Silpha opaca*, and another species, the *Silpha atrata*, eat and seriously injure plants of beet and mangel-wurzel, as has been shown by Curtis and Miss Ormerod in England, by Guérin Méneville in France, and Taschenberg in Germany. It need hardly be said that correct information as to the habits of insects is as necessary as accurate nomenclature—at least to agriculturists.

Again, under the heading Buprestidæ and Elateridæ (click beetles) it is remarked that the larvæ feed on living wood, and are more or less injurious. The wire-worm, the larva of *Elater lineatus*, is fearfully destructive to the roots of crops of all kinds. In the description of Elateridæ, further on, this kind of mischief is attributed to their larvæ; so that there are two utterly conflicting accounts of the habits of these insects, calculated to puzzle the inquiring Indian farmers.

A sweeping statement that "all the weevil family insert their eggs in the stigma of the flower" cannot be supported, and is utterly opposed to the experience of observers. A few species do this, but others deposit their eggs in a variety of places. Of weevils it is also said that they "attack principally in their larval stage every part of vegetable tissues." As a fact, many weevils do incredible harm to vegetation in their perfect or weevil form, and it would be difficult for the larvæ—mere maggots—to hold on to leaves.

Sitonas, described as attacking stored grain and seeds, have been evidently mistaken for species of Bruchi.

These and other mistakes ought to be corrected before the work is put into the hands of the agriculturists of India as a text-book for their guidance.

CELL-DIVISION IN ANIMALS.

La Cytodiérèse chez les Animaux: Étude comparée du Noyau et du Protoplasme. Par T. B. Carnoy, Professor of Biology in the University of Louvain. (Louvain: A. Peeters, 1886.)

IN this work the learned biologist of Louvain has ably resumed and discussed the latest researches made concerning the phenomena of cell-division in arthropods and worms. It is, of course, impossible in a short article to do justice to the great labour and admirable patience here displayed by the distinguished author; nor can we discuss as fully as the subject deserves the several points on which Dr. Carnoy appears to differ essentially from other workers in the same field, as, for instance, from Prof. E. Van Beneden and from Mr. Nussbaum. But the questions raised by the Louvain Professor are of such importance that even a summary of his present views cannot fail to be of interest.

First, as regards cell-division in arthropods, Prof. Carnoy maintains that in them the direct mode of division may be observed in various tissues, young and adult, and must be admitted to have all the characters of what he terms "un processus normal."

This direct mode occurs either by "étranglement" or by the help of a partition, just as in vegetable cells, and this is verified for the protoplasm itself as well as for the nucleus.

Then, contrasting the direct with the indirect or karyokinetic mode of cell-division, he remarks that those two processes have in reality the same morphological significance and physiological value; that the characters of karyokinesis are inconstant, and that they may often be seen passing through many intermediate stages into the characters proper to the akinetic mode. Nevertheless, our author admits that karyokinesis is of considerable importance to cell-life, inasmuch as it affords an easier and surer method for making the cell dicentric; it also leads to the division of the nuclear element into two equal parts; it enriches the protoplasm with plastine; and,

lastly, it renders possible the total regeneration of the nucleus. In the present state of our knowledge, however, there is obviously much that is hypothetical in the respective importance of these consequences.

It is chiefly in his researches on the embryology of Nematoda that Prof. Carnoy has reached conclusions which are totally at variance with those already arrived at on the same subject by Messrs. Nussbaum and E. Van Beneden. We allude especially to the mode of formation of the polar bodies in the egg of *Ascaris megalocephala*. For the Louvain Professor, the two successive divisions which take place in the germinal vesicle assume the following characters:—

(1) The nuclear element ("élément nucléinien typique") of the egg of *Ascaris megalocephala* becomes at an early stage broken up into eight nearly equal rod-like portions; these at once separate into two groups of four rods ("bâtonnets"), thus constituting the Wagnerian spots.

(2) When a spermatozoid has made its way into the egg, sometimes very soon afterwards, occasionally later, an alteration of the germinal vesicle becomes visible; its membrane dissolves away, and subsequently, by a process of true karyokinetic division accompanied by the formation of asters of remarkable variety and complexity, the first polar body is expelled. This he finds to consist of four nuclear rods and a portion of the protoplasm of the egg. At this stage, therefore, according to Dr. Carnoy, four rods only remain within the egg.

(3) Now the same process begins again, in all essential respects resembling that which has just been described; finally, the second polar body is expelled in its turn. It consists of two nuclear rods, so that only two rods remain now in the egg for the formation of the female pronucleus. We are thus in a position to calculate accurately the amount of nuclein lost by the germinal vesicle during the expulsion of the polar bodies. According to Prof. Carnoy, the loss, for *Ascaris megalocephala*, would amount exactly to three-fourths of the nuclein originally present in the egg.

We are not sure whether Prof. E. Van Beneden's views on this delicate question may not be to a certain extent reconciled with those of the eminent biologist of Louvain, especially as regards the number of nuclear portions contained in the first polar body. But respecting the constitution of the second polar body the views of the two Belgian observers are certainly difficult, if not impossible, to reconcile.

Prof. Carnoy's book reads easily, and his statements are always clear and definite. The text is illustrated by a large number of figures, beautifully executed, which greatly enhance the value of this most interesting and important work.

L. Martial Klein.

OUR BOOK SHELF.

The Climatic Treatment of Consumption: a Contribution to Medical Climatology. By J. A. Lindsay, M.A., M.D. (London: Macmillan and Co., 1887.)

Dr. Lindsay does not profess to have written a systematic and exhaustive treatise upon the climatic treatment of consumption. He holds that we are only on the threshold of climatological investigation: and "for its exhaustive discussion," he says, "prolonged inquiry will be necessary, and more exact methods than those hitherto generally employed." He has made, however, an important contribution to the study of a very difficult subject, and his book ought to be of much service not only to physicians but to many sufferers who may still hope to find in climatic treatment a powerful adjunct to hygienic and medical measures. Having discussed the causes of consumption and the general principles of climatic treatment, Dr. Lindsay presents a general view of the chief sanatoria for consumption. He then describes mountain sanatoria and the ocean voyage, and gives a full and trustworthy account of sanatoria he himself has visited, including Australia, Tasmania, New Zealand, California, the Cape, Algeria, Southern France, and the home sanatoria. The value of the book is, of course, greatly increased by the fact that he has relied for his information mainly on personal observation.

Illustrations of the British Flora. Drawn by W. H. Fitch, F.L.S., and W. G. Smith, F.L.S. Second Edition. (London: L. Reeve and Co., 1887.)

When the illustrated edition of Bentham's "Hand-book of the British Flora" was exhausted, the wood engravings of that work were reproduced in a volume intended to serve as a companion to the "Hand-book" and other British Floras. The volume has been so popular that the publishers have found it necessary to issue a second edition; and they have taken pains to secure that it shall be more useful than ever to students of botany, and especially to beginners. Five cuts have been added, and the arrangement of all the illustrations has been brought into accordance with Bentham's "Hand-book" as it has been revised by Sir J. D. Hooker. To facilitate reference from other Floras, the index has been greatly enlarged, and there is a new index of English and popular names.

Sketches of Life in Japan. By Major Henry Knollys, R.A. With Illustrations. (London: Chapman and Hall, 1887.)

In this book Major Knollys undertakes to tell us something of "the minor lights and shades" of the social life of Japan. He is a careful observer, and writes brightly and pleasantly; and no doubt the lively record of his impressions will interest a good many readers who would not have cared to study a more elaborate and systematic account of the Japanese people. The substance of the book was written "on the spot," but all statements with regard to matters of fact have been carefully revised.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Thought without Words.

There appears to be some ambiguity about this matter as discussed in the correspondence which has recently taken place in your columns. In the first instance Mr. Galton understood Prof. Max Müller to have argued that in no individual human mind can any process of thought be ever conducted without the mental rehearsal of words, or the *verbum mentale* of the Schoolmen. Now, although this is the view which certainly appears to pervade the Professor's work on "The Science of Thought," there is one passage in that work, and several passages in his subsequent correspondence with Mr. Galton, which express quite

a different view—namely, that when a definite structure of conceptual ideation has been built up by the aid of words, it may afterwards persist independently of such aid; the scaffolding was required for the original construction of the edifice, but not for its subsequent stability. That these two views are widely different may be shown by taking any one of the illustrations from the NATURE correspondence. In answer to Mr. Galton, Prof. Max Müller says, "It is quite possible that you may *teach* deaf-and-dumb people dominoes; but deaf-and-dumb people, left to themselves, do not *invent* dominoes, and that makes a great difference. Even so simple a game as dominoes would be impossible without names and their underlying concepts." Now, assuredly it does "make a great difference" whether we are supporting the view that dominoes could not be *played* without names underlying concepts, or the view that without such means dominoes could not have been *invented*. That there cannot be concepts without names is a well-recognized doctrine of psychology, and that dominoes could not have been invented in the absence of certain simple concepts relating to number no one could well dispute. But when the game has been invented, there is no need to fall back upon names and concepts as a preliminary to each move, or for the player to predicate to himself before each move that the number he lays down corresponds with the number to which he joins it. The late Dr. Carpenter assured me that he had personally investigated the case of a performing dog which was exhibited many years ago as a domino-player, and had fully satisfied himself that the animal's skill in this respect was genuine—*i.e.* not dependent on any code of signals from the showman. This, therefore, is a better case than that of the deaf-mute, in order to show that dominoes can be played by means of sensuous association alone. But my point now is that two distinct questions have been raised in your columns, and that the ambiguity to which I have referred appears to have arisen from a failure to distinguish between them. Every living psychologist will doubtless agree with Prof. Max Müller where he appears to say nothing more than that if there had never been any names there could never have been any concepts; but this is a widely different thing from saying what he elsewhere appears to say, *i.e.* that without the mental rehearsal of words there cannot be performed in any case a process of distinctively human thought. The first of these two widely different questions may be dismissed, as one concerning which no difference of opinion is likely to arise. Touching the second, if the Professor does not mean what I have said he appears in some places to say, it is a pity that he should attempt to defend such a position as that chess, for instance, cannot be played unless the player "deals all the time with thought-words and word-thoughts." For the original learning of the game it was necessary that the powers of the various pieces should have been explained to him by means of words; but when this knowledge was thus gained, it was no longer needful that before making any particular move he should mentally state the powers of all the pieces concerned, or predicate to himself the various possibilities which the move might involve. All these things he does by his specially-formed associations alone, just as does a draught-player, who is concerned with a much simpler order of relations: in neither case is any demand made upon the *verbum mentale*.

Again, if the Professor does not mean to uphold the view that in no case can there be distinctively human thought without the immediate and direct assistance of words, it is a mistake in him to represent "the dependence of thought on language" as absolute.[1] The full powers of conceptual ideation which belong to any individual man may or may not all have been due to words as used by his ancestors, his contemporaries, and himself. But, however this may be, that these powers, when once attained, may afterwards continue operative without the use of words is not a matter of mere opinion based on one's own personal introspection, which no opponent can verify: it is a matter of objectively demonstrable fact, which no opponent can gainsay. For when a man is suddenly afflicted with aphasia he does not forthwith become as the thoughtless brute: he has lost all trace of words, but his reason may remain unimpaired.

June 4. GEORGE J. ROMANES.

[1] *e.g.* "I hope I have thus answered everything that has been or that can possibly be adduced against what I call the fundamental tenet that the science of language, and what ought to become the fundamental tenet of the science of thought, namely that language and thought, though distinguishable, are inseparable, that no one truly thinks who does not speak, and that no one truly speaks who does not think."—"Science of Thought," pp. 63-64.

I HAVE postponed offering you any remarks on Prof. Max Müller's "Science of Thought," until I had read the book through.

I think Prof. Muller is on the whole right, that language is necessary to thought, and is related to thought very much as organization to life. The question discussed by some of your correspondents, whether it is possible in particular cases to think without language, appears to me of little importance. I can believe that it is possible to think without words when the subjects of thought are visible things and their combinations, as in inventing machinery; but the intellectual power that invents machinery has been matured by the use of language.

But Prof. Müller has not answered, nor has he asked, the question, on what property or power of thought the production of language depends. He has shown most clearly the important truth that all names are abstract—that to invent a name which denotes an indefinite number of objects is a result of abstraction. But on what does the power of abstraction depend? I believe it depends on the power of directing thought at will. Prof. Müller lays stress on the distinction between percepts and concepts, though he thinks they are inseparable. I am inclined to differ from him and to think that animals perceive as vividly as we do, but have only a rudimentary power of conception and thought. I think the power of directing thought at will is the distinctively human power, on which the power of forming concepts and language depends. JOSEPH JOHN MURPHY.

Belfast, June 19.

AFTER reading the correspondence published in NATURE (vol. xxxvi. pp. 28, 52, and 100) on this subject, it has occurred to me that the difficulties anthropologists find in Prof. Max Müller's theory are connected chiefly with his peculiar definitions.

In his letters to Mr. Galton, Prof. Müller narrows the domain of his theory to a considerable extent. By defining thought as the faculty of "addition and subtraction," and by taking language as composed of "word-thoughts" or "thought-words," Prof. Müller excludes from his theory all those processes which are preliminary to the formation of concepts. Thus narrowed, I do not see that his doctrine in any way touches the wider question, whether reasoning, as generally understood, is independent of language. If we keep to the terms of this theory, thoughts and words are undoubtedly inseparable. But this does not in the least imply that all thought is impossible without words.

When we enlarge the scope of our terms, it is at once evident that thoughts and words are not inseparable. It is all very well to join together "thought-word" and "word-thought." Yet the thought is something quite distinct from the mere sound which stands as a word for it. A concept is formed from sensations. Our thoughts are occupied with what we see, and feel, and hear, and this primarily. Thus it is that, in the wider sense of thinking, we can think in pictures. This is the mental experience which Prof. Tyndall so highly prizes. He likes to picture an imaginary process, not in words, not even by keeping words in the background, but in a mental presentation of the things themselves as they would affect his senses. Surely, then, if the mind can attend to its own reproduction of former sensations, and even form new arrangements of sensations for itself quite irrespective of word-signs, as Mr. Galton and most other thinkers have experienced, it is evident that thought and language are not inseparable.

All this is, of course, somewhat apart from Prof. Müller's restricted theory. But the question follows, how from these wider thoughts do we become possessed of the faculty of abstraction. Does not the one shade imperceptibly into the other? Prof. Müller answers no, and here I think he is at fault. It is at this point that anthropologists part company with him. If he be right, how do people learn? According to his theory, new thoughts when they arise, start into being under some general concept. I do not deny that they are placed under some general concept, but it seems to me that something entirely independent of the general concept has, for convenience, been placed under it, and this something must be called a thought. No doubt the thought is at first vague and indefinite, and only when it becomes definite does it require a name. But here one can plainly trace the genesis of a thought, and the adaption of a word as a symbol for it. The new concept and its sign do not arise simultaneously. There are two distinct growths, not one only, as Prof. Müller's theory presupposes. The connexion may be

subtle and close, but the two elements can be easily separated. It avails nothing to say that until the thought is placed under a concept, it is not a thought. This is a mere question of definition, not of actual fact.

I would point out one other consideration. If Prof. Müller's theory were true for all kinds of thinking, development would be impossible. If man could not think without language, and could not have language without thinking, he would never have had either, except by a miracle. And scientific men will not accept the alternative. We can conceive shadowy thoughts gradually shaping to themselves a language for expression, and we can understand how each would improve the other, until by constant interaction, a higher process of thought was introduced. But we cannot conceive the sudden appearance of the faculty of abstraction together with its ready-made signs or words.

I have often wished that Prof. Müller would state distinctly how his theory accounts for the very first beginnings of language. I have not been able to discover any explanation of this point in his "Lectures on the Science of Language."

Clapham, June 6. ARTHUR EBBELS.

As poets have extraordinary inklings and *aperçus* on the most abstruse scientific questions, Wordsworth's opinion on this matter (quoted by De Quincy) is worth considering: Language is not the "*dress*" of thought, it is the "*incarnation*." This is Shelley's *aperçu* of Darwinism. Man exists "but in the future and the past; being, not what he is, but what he has been and shall be."

How to "distil working ideas from the obscurest poems"—to use Lord Acton's words—is one of the secrets of genius.

A. GRENFELL.

THE interesting discussion between Mr. Francis Galton and Prof. Max Müller on this subject will doubtless raise many questions in the minds of those who have paid some attention to the habits of animals. I have been asking myself whether, if Prof. Max Müller is right in his conclusion—"Of course we all admit that without a name we cannot really know anything" (an *utterable* name, I presume), and "one fact remains, animals have no language"—animals must not, therefore, be held by him incapable of knowing anything. This would bring us to the question whether animals *know* in the same manner as men, or in some other manner which men do not understand. Now, I think—at least it is as strong a conviction as I am capable of entertaining—that animals not only know, but deal with the materials of knowledge—facts—in a manner quite indistinguishable from the manner in which I mentally handle them myself. Thus, I place an animal in circumstances which are quite unfamiliar to it, and from which it is urgently pressed to escape. There are two, or perhaps three, courses open to it; one being, to my mind, patently the most advantageous. It tries all of them, and selects that which I should have chosen myself, though it is much longer in coming to its conclusion. Here the animal has the same facts as the man to deal with, and, after consideration and examination, its judgment precisely corresponds with the man's. I cannot, then, find it possible to deny that the mental operations are identical in *kind*; but that they are not so in *degree* can be demonstrated by my importing into the situation an element foreign to the experience of the animal, when its failure is certain. It makes no difference whether the animal is under stress, or acting voluntarily. It may frequently be found to choose the method which most recommends itself to the man's judgment. Every student of animals is familiar with numbers of such cases. Indeed they are constantly being recorded in the columns of NATURE, and abound in all accepted works on animal intelligence. I am quite prepared to admit that where there are two or more courses open to it the animal will occasionally select that which presents the greatest difficulties, and labour most assiduously to overcome them, sometimes trying the remaining courses and returning to that which it first chose. Darwin gives a good example of the honey-bee ("Origin of Species," p. 225, edition 1872). But no one will be surprised at imperfect judgment or vacillation of will in an animal, when such are common among men.

Prof. Max Müller lays down the very distinct proposition that "animals have no language." I suppose *utterable* language is meant. Is this so? That their sign-language is both extensive and exact (and even understood to some extent as between widely different species) most naturalists, I apprehend, will entertain no doubt. But has any species an utterable language? What is to be the test of this? First there is the whole gamut of vocal expressions—which even we understand—conveying the ideas of pain, pleasure, anger, warning. What sportsman who has stalked extremely shy animals does not know the moment a bird or animal utters a certain note that he is discovered? If Prof. Max Müller will not admit this to be language, I, for one, must ask him what it is. It conveys to others a distinct idea, in general if not in special terms, and seems to me quite equivalent to "Oh, dear!" "This is nice" (expressed, I believe, in some African language by the reduplicated form *ñum-ñum*, the letter *ñ* having the same value as in the Spanish *mañana*), "Leave off," "Look out," "Come here," &c. Those who have heard animals calling to one another, particularly at night, and have carefully noted the modulations of their voices (why should there be modulations unless they have a definite value), will find it very hard to accept Prof. Max Müller's conclusion that "animals have no language." Every female mammal endowed with any kind of voice has the power of saying "Come here, my child," and it is an interesting fact beyond question that the knowledge of this call is feebly or not at all inherited, but must be impressed upon the young individual by experience. Further, the young brought up by an alien foster-mother pay no attention to the "Come here, my child," of the alien species. The clucking of the hen meets with no response from the ducklings she has reared, even when she paces frantically by the side of the pond imploring them not to commit suicide. But let us creep up under the banks of a sedgy pool at about this time of year. There swims a wild duck surrounded by her brood, dashing here and there at the rising *Phryganidæ*. Now let the frightful face of man peer through the sedges. A sharp "quack" from the duck, and her brood dive like stones, or plunge into the reeds. She, at least, knows what to say to them.

The already inordinate length of this letter precludes me from offering any instances of the communication of *specific* intelligence by means of the vocal organs of animals. I think it probable that we far under-rate the vocabulary of animals from deficient attention—and, I speak for myself, stupidity. Possibly Prof. Max Müller has not yet examined "Sally," the black chimpanzee. If not, he would surely be much interested. She is by no means garrulous, but, in spite of her poor vocal capacity, if he should still consider that she "cannot really know anything" on that account, I must have completely misinterpreted his letter to Mr. Galton. ARTHUR NICOLS.

Watford, June 3.

Two Friends.

THE remarks on the reasoning powers of animals (dogs in particular) given in your issue of June 9 (p. 124) induce me to relate an experience of my own. We possess a dog and a cat, both males, the former called Griffon here, much like a Skye terrier, the latter a splendid animal (a cross of the Angora). These two animals are bound to each other by the closest friendship, which began thus:—The dog came to us two years ago, quite a pup—about three months old. Soon after a small, wretched, half-starved kitten arrived at our door asking hospitality. The dog at once adopted it, let it eat out of the same dish, let it sleep on the same mat (and continues to do so still), in fact took entire charge of it. A black cat, a very vicious creature, and seemingly wild, haunted our garden, to the great destruction of birds' nests and to the excessive terror of the kitten. As the dog grew, it became the kitten's protector against the black cat, and has been so now for two years. If it was indoors and heard a cry of distress from our cat, you could not hold it from flying wildly to its rescue, forcing someone to open the door, or darting through a window. It has done this so long, and with such effect, that the black cat scarcely dares show its face in the garden, as the dog invariably attacks it with fury and drives it away, following it along the road to see if it is quite gone. I do not know if you will think this worthy of insertion, but I think it curious, and I can vouch for its truth. M. C.

La Tour de Peily, June 13.

The Use of Flowers by Birds.

As a curious incident enacted by sparrows has just come under my notice, which possesses some added interest in connexion with the two occurrences recorded by your correspondent

J. M. H.—viz. the employment by some finches of flowers in the formation of their nests (NATURE, vol. xvi. p. 83, and vol. xxxvi. pp. 101-2)—it may be worth while to submit a detailed consideration of the case.

The front of the house of a friend living at No. 47 Highbury Hill is covered by an extensive growth of white jasmine which reaches beyond the first-floor windows. For several years house-sparrows have used the bushy branches of this shrub without causing special attention. This year, however, they have taken a new departure in nest-building. Not satisfied, apparently, with the hay, straw, and other ordinary materials of sparrow architecture, they have suddenly aspired to appropriating to their use the bright yellow flowers of laburnum, two trees of which are in full bloom a few yards from the first-floor window-sills below which they are carrying on their operations. Three nests were discovered twelve days ago, built close together in the jasmine, all of which had laburnum flowers strewn upon the top of ordinary nests; one nest contained two young birds just hatched, and the other two had each a couple of eggs. As they rather disturbed the lady occupant of the house, she had all three nests destroyed, the litter from them entirely filling a large foot-bath. But the three pairs of birds, as might be expected, only set to work rebuilding their nests in the same place, furnishing them with more laburnum than before. They were however again disturbed, and an obstacle (which in a previous year had proved effectual in stopping the building in another part of the house front) was set in the place of the nests, but still they did not desist; two pairs continued to add their materials on the top of it, with more laburnum than ever, replenishing the nest as constantly as it was removed, while the third pair rebuilt their nest under the sill of the next window, using laburnum also. Even entire sprays of the flowers were used, and the ground beneath the trees was so much strewn with fragments that my friend at first thought that boys had been pulling the trees. All the birds are now allowed to remain unmolested, and the yellow decoration is withered, without fresh being provided.

This unaccustomed action of the sparrows is apparently somewhat different from the operations described by your correspondent J. M. H., for the bright golden flowers enveloping the nests are so strangely conspicuous as to attract the attention of passers-by, and therefore cannot answer the protective purpose evident both in the case of the goldfinches with forget-me-nots and of the sparrows that used Alyssum. The only explanation I can suggest is that the birds have elevated their æsthetic taste to this "quite too too" extent of art cultus. It is highly interesting to note also that—in opposition to the notions of the obsolete school of naturalists, who believed only in blind instinct—the rage for collecting their favourite "yellow" is infectious with these little yearners for the intense, just as is the desire for "blue" that now and then breaks out (like a disease) amongst larger householders. The three pairs of birds seemed to vie with one another in their revelry of the chosen colour. It will be instructive to learn whether the fashion will last for many seasons: perhaps it will languish of satiety, and some other attraction of a less absorbing kind arise.

The fondness of birds (in this country at least), for the colour yellow is perhaps worth considering in this connexion. A large number of wild or cultivated plants might be enumerated that produce yellow flowers, which are either used as food or have their petals mauled by birds. There need be no doubt, I think, that the mutilation of such flowers is due to a playful fondness rather than to a dislike of the flowers. That birds evidently exercise the selective faculty in the choice of flowers is well illustrated by the fact, twice observed by my brother, that sparrows pull to pieces the yellow flowers only in mixed beds of pansies, and of crocuses, without injuring a single purple, mauve, or white flower of either kind. I have myself also witnessed the same selective operation performed by a sparrow on various crocuses growing in pots upon my window-sill, and I find many correspondents gave similar testimony to this fact in a series of letters which appeared in these pages in the year 1877 (vols. xvi. and xvii.). It may be questioned whether the education of their preference for the colour yellow is in any way connected with the fact that it is proper to the yolk of their eggs, and which they must be aware of; but since all good eggs contain that colour, while probably some birds do not like it and greatly prefer other colours, this suggestion may be no more valid as a theory than would be the argument that some people's taste for claret-colour is due to the analogous physiological accident of arterial coloration. The rich yellow colour, again, of the beaks, entire mouths, and "open sepulchres" of the newly-hatched nestlings affords their parents ample opportunities for the contemplation of colour, and there may be an unconscious mental absorption of the colour in consequence of this course of training. At any rate, canary yellow is very highly developed in many species of the *Fringillidæ*, and there is a strong tendency towards the development of the yellowish colour in the plumage of the males of several British finches, apparently through a greenish-brown tinge. It is also well developed amongst the weavers and the orioles, to which they are so nearly allied. That sparrows should thus use sprays of flowers is perhaps not so remarkable when we recall the close affinity they bear to *Ploceus* and other weaver-birds.

Doubtless the colour-sense in birds, as well as in insects, is a real factor in the evolution of the floral beauty that surrounds them, although the *modus operandi* is not always one that can be so readily traced. WILLIAM WHITE.

55 Highbury Hill, London, June 9.

Names for Electric Units of Self-Induction and Conductivity.

A NAME seems to be wanted for the practical unit of self-induction, viz. an ohm multiplied by a second; in other words, for a length approximately equal to an earth-quadrant. Profs. Ayrton and Perry call it a "secohm." Why not call it a "quad"? It would be a handy great length for many other purposes. For instance, the velocity of light in air would be 30 quads per second, in common glass 20 quads per second.

To avoid misunderstanding, it would have to be understood that the actual earth-quadrant passing through any given place is only approximately a quad, its real value having to be determined geodetically. A quad is to be understood as ten million metres *precisely*.

Another unit requiring a name is the unit of conductivity. Sir William Thomson has suggested the word "mho," but it has not been greedily assimilated. I make the small suggestion of omitting the *h*. True, the expressions 12 mo and 16 mo would at first excite only bookbinding ideas, but they would soon carry a fresh meaning to electricians. OLIVER J. LODGE.

June 13.

Units of Weight, Mass, and Force.

THE necessity for *names* for the units of velocity and acceleration is very clearly illustrated by a criticism of my "Dynamics for Beginners," which appears in the *Practical Engineer* of June 3. After objecting to the introduction of new names, and explaining that *a velo* stands for *a foot per second*, the writer proceeds:—"The second new name is 'celo,' and is meant for an acceleration of *one foot per second*, or unit acceleration; so that if a body is moving with a velocity which is being accelerated *at the rate of one foot per second*, it is said in the new language to possess one celo. In other words, a celo means *an acceleration of one foot per second*, or *of one velo*." The italics are mine. I cannot resist quoting also the following sentence, which occurs a little lower down in the same criticism:—"We think there is something ridiculous about the adoption of these names, which, while possessing the very questionable advantage of shortening the language of the subject by some two or three words, *serve to muddle the mind of the student, and to obscure the sense by wrapping it up in meaningless words*."

Why is not the *Practical Engineer* consistent? He ought to state that just as a celo is unnecessary, for he considers it the same as a velo, in like manner a velo is unnecessary, for by the same line of argument it must be the same as a *foot*. The fact is that the names velo and celo are not *necessary* for scientific men, although I expect they will be found to be convenient. It is, I believe, generally admitted that some such words are greatly needed by teachers; for it is the clear mental differentiation of the ideas expressed by velo and celo, or the want of it, which often marks the distinction between a sound physicist and a muddler. JOHN B. LOCK.

Gonville and Caius College, June 4.

I AGREE with your correspondent, Mr. R. B. Hayward (NATURE, vol. xxxv. p. 604), in holding that names for the dynamical units are of less importance than a convenient nota-

tion for them. To invent names for the pound-foot-second units may be helpful to beginners; but it is a small matter compared with a notation which completely specifies the mode of dependence of each unit upon the pound, foot, and second; and it is still more so when compared with a general notation which will serve for any system of units.

The difference between names and notation is well seen in the case of chemistry. The notation for a substance expresses the manner in which the substance is made up of the elementary substances; while its name, however derived, serves merely as a distinguishing mark: and just as the chemical notation for a substance may be used as a name for the substance, so the notation for a physical unit may serve as a name for that unit.

In my work on "Physical Arithmetic," published by Macmillan and Co. in 1885, and reviewed in NATURE, vol. xxxi. p. 551, I have devised a notation which is the natural and legitimate extension of existing conventions both in language and in the mathematics; and I have made that notation the basis of a method for solving problems in applied arithmetic. If the Committee of the Association for the Improvement of Geometrical Teaching are considering the subject, I ask them to consider whether any notation more in harmony with existing conventions can be devised than the notation of that work.

As a specimen I append the general notation for the chief geometrical, kinematical, and dynamical units. The word *by* corresponds to ×, and the word *per* to ÷, or / as now frequently used by physicists. The same method of notation applies to the thermal and electrical units. The notation for any special system is obtained by substituting the special names of the fundamental units L, M, T. The test of the value of a notation is the amount of facility it offers in reasoning; by referring to "Physical Arithmetic," anyone may see how this notation stands the test.

NOTATION FOR GENERAL UNITS.

Quantity.	Notation.	Dimensions
	I. *Geometrical.*	
Length	L	l
Surface	L by L = S	l^2
Volume	L by L by L = V	l^3
Angle	L arc per L radius	l^0
Sine	L opposite per L along	l^0
Curvature	Radian per L arc	l^{-1}
	II. *Kinematical.*	
Time	T	t
Velocity	L per T	lt^{-1}
Acceleration	L per T per T	lt^{-2}
Angular velocity	L arc per L radius per T	t^{-1}
	III. *Dynamical.*	
Mass	M	m
Density	M per V	ml^{-3}
Mass-vector	M by L	ml
Momentum	M by L per T	mlt^{-1}
Force	M by L per T per T = F	mlt^{-2}
Pressure	F per S	$ml^{-1}t^{-2}$
Work	F by L = W	ml^2t^{-2}
Activity	W per T	ml^2t^{-3}

ALEXANDER MACFARLANE.

Austin, Texas, May 28.

The New Degrees at Cambridge.

A FEW years ago it pleased the dominant body in the University of Cambridge to institute a Doctorate of Science and of Letters. Candidates for these new degrees were required to be of a certain academical standing, and to submit the proofs of their qualifications to the respective Special Boards of Studies, who, after certain formalities, were empowered to forward their claims to the General Board of Studies for approval. By many well-meaning persons this step was thought to be a great encouragement to both letters and science. It was at the same time understood that the qualification for the Doctorate in Science was to be rather less than was required for admission to the Royal Society—a standard which all will admit is not too high. Whether any similar understanding was agreed upon as regards the Doctorate in Literature is uncertain. At first there was no particular desire shown among the best men of science and literature to aspire to the new distinction, and it is rumoured that a considerable amount of persuasion and friendly pressure had to be used to induce such men to submit to the infliction. But in time a few leading lights underwent the ordeal and were duly invested. The way being cleared, a good many others have followed, and as the Boards have not been too severe in judging the claims of candidates, the outbreak of "scarletina" has become rather general. However, no particular harm has ensued, and the coffers of the University have reaped the benefit—for the fee is not small.

But now there is another aspect to this business. The new Doctorate is inferior in rank to that of the old Faculties. The senior Doctor in Science or Letters must always yield precedence to the youngest Doctor in Divinity, Law, or Physics. So far, those who have sought the new degrees have known what their position would be; but of late the Council of Senate has taken upon itself to determine that when an honorary degree should be given to any distinguished man of science or letters he is not to have the higher degree of LL.D., but to be content with the lower rank. As a rule honorary degrees are almost invariably given to strangers—foreigners or colonists. They are not aware of this fine though real distinction; and thus this very day the Senate House at Cambridge has witnessed the time honoured and highly valued distinction of LL.D. being conferred on a number of excellent gentlemen, beginning with the Lord Mayor of London, while the new and inferior rank of Sc.D. is bestowed on one of the most distinguished biologists of the United States, whom the sister University is this week to recognize as a D.C.L.

It may be urged that proceedings like this are necessary to reflect the proper amount of dignity on the new "honour," and that in time it will be regarded as highly as the old one has been. But I submit that this is not fair to the innocent recipients, and, moreover, that the University should recognize the fact that its highest honours are not to be bestowed upon successful merchants, politicians, and persons of eminent social standing, while the greatest men of letters and science have to take up with the lower grade. OUTIS.

June 20.

"After-Glows" at Helensburgh.

I BEG to inclose a letter from Mr. L. P. Muirhead, with reference to the "after-glows" recently seen at Helensburgh, which you may think worthy of a place in NATURE.

ROBERT H. SCOTT.

Meteorological Office, 116 Victoria Street, London, S.W., June 8.

Rosemount, Helensburgh, June 4, 1887, 21h.

DEAR SIR,—I do not notice any remarks in any of the weather reports or in the press concerning the after-glows, and as they may be local only, I drop you a line. All have lasted about 45m.; the first of any note, on the 17th, commencing well down on the eastern, and finally fading away on the western, horizon, all through of a deep rosy red reflected from the under and western side of cirro-stratus. Again, on May 21, 23, 29, 30, 31, and June 1. The last was peculiar, not only as being the most lurid, the cloudscape being marvellously fantastic, but, dying away at 21h., it revived faintly at 21h. 18m. to 21h. 30m., and again from 22h. to 22h. 20m., of a decided rose-colour on western side of roll-cumulus coming up from east-north-east. Thursday, Friday, and to-night there is no glow; overcast and oppressive just now; a little rain fell in forenoon. The glow reminds me, on a more intense scale, of that previous to January 26, 1884, and again on December 8 last year.

From May 21, until to-day, the weather has been genial and fine. Faithfully yours,

LEWIS P. MUIRHEAD.

R. H. Scott, Esq., Meteorological Office, London.

Zirconia.

SOMEHOW I overlooked for a few days the letter of Messrs. Hopkin and Williams, which necessitates a brief reply, since they have confused (I am sure from mere haste) two samples, one of which I never had, and a correspondence most of which took place after what I had recorded.

Briefly, these are the facts. I was informed by Mr. T. Bolas that I could obtain "pure zirconia" of Messrs. Hopkin and

Williams at a certain price. This seemed to me so low that I asked them about it, when they did inform me that the reason was its occurring as a by-product. Nothing whatever was then said, however, about being "impure"; on the contrary, they inclosed two small fragments, one of which they said they sold as "pure," and the other (at half price) as "impure." The last was a light yellow-brown colour, and I never meddled with it; of the other I purchased an ounce for trial. On finding so much silica and soda I wrote them reporting, and asking if the sample was reduced by the hyposulphite process, as Dr. Draper had mentioned the difficulty of getting a pure product in that way. They replied that hyposulphite was used, and that the "pure" sample might possibly contain soda, but they thought not silica; the other sample might contain soda, silica, and probably iron. I wrote again pointing out that oxyhydrogen illumination was the most likely use for the product, and asking if they could not purify it further at an enhanced price, when they declined, as they state.

The difference is, that all this took place *after* I had purchased and tested the sample, and reported to them upon it. I inclose you copy of their price list of 1886, still later, in which you will see that "zirconium oxide" still appears without qualification; and I also forward the original bottle and label which I received from them—the latter you will perceive is "pure zirconia." The correspondence, if sent you in full, will bear out all the details above.

At the same time I would say that I had not the least idea of impugning in any way Messrs. Hopkin and Williams. I simply pointed out, as reference will show, the *generally* unsatisfactory character of samples considered commercially "pure" (one never expects ordinary purchased articles "pure" in any other sense) for one special purpose, and I much regret that their letter necessitates this correction. LEWIS WRIGHT.

P.S.—I am sorry to add that my previous letter has not elicited any very satisfactory information, or real aid towards the desired object. I learn from Mr. Cottrell that Du Motay's cylinders were unquestionably more durable than any prepared since, even with the aid of Prof. Maskelyne. But I am as unable as ever to come across one, or to find exactly how the material was prepared, or what light it gave in comparison with limes.

THE JUBILEE.

II.

WE have already referred to some aspects of the Jubilee which have a special relation to science, and we shall soon have occasion to return to the subject. In the meantime we reprint from the *Times* an admirable passage which presents a striking confirmation of the opinions we have expressed as to the true place of science in the history of the past fifty years. The passage is from the "Jubilee Retrospect" which appeared in the *Times* on Tuesday last:—

"The keynote of the Victorian era is the development of scientific research, the concomitant growth of practical invention, and the expansion of industry which these have brought about. Other ages have been fruitful of profound scientific conceptions, or have been illustrated by great inventions and discoveries, but it would be difficult to point to any half-century in the history of the world in which equal progress in speculative science has been combined with anything approaching to the magnitude, variety, and importance of the applications of science to practical ends which distinguish the present reign. It is as true to-day as at any former period that nothing great can be done in pure science save by men who make the discovery of truth the sole aim of their efforts, and who prize no other reward. But it is no less true that abstract and applied science go hand in hand as they never did before, and that each owns enormous obligations to the other. For if the triumphs of the workshop have been achieved by means of the discoveries made in the laboratory, on the other hand the laboratory depends for every step of its advance upon the technical skill and hitherto unrivalled precision of the workshop. Physical science has reached a stage at which the verification of its hypotheses and the supply of new data for its speculations demand appliances of extraordinary excellence, and in many cases a collation of experience and experiment which nothing but the practical inventions of the age could render possible. It is doubtless to the co-ordination of the two forms of intellectual activity that we owe the rapidity of recent advance. An unprecedentedly large army of inquirers has simultaneously pushed the interrogation of nature in a thousand directions, and has attained unprecedented results. But beside them has been working an army larger, and equally keen, of men eagerly seeking to utilize for practical ends every crumb of available information, and giving to scientific ideas a concrete application which often forms the starting-point for new processes of scientific induction.

"The fundamental conceptions of the material universe entertained by educated men have been revolutionized during the last fifty years. The simple atomic theory of the older chemistry has given place to a molecular theory, which itself has undergone considerable development. The outlines of the elements which the older chemistry accepted as an ultimate analysis are melting under the gaze of the spectroscopist, who across the haze of their wavering figures catches glimpses of a simple primal matter. The evolution of matter is, however, like the evolution of living forms, a philosophical conception which must always rest rather upon the general necessities of thought than upon actual experiment. The immutability of certain forms of matter in all the conditions that we can devise or have any experience of is as absolute as the persistence of specific types in the animal or vegetable kingdom. The most refractory substances have been vaporized in the electric arc, and the most attenuated gases have assumed the solid form under the combined influence of intense cold and enormous pressure. But we have made no nearer approach to actual evidence either of material evolution or of the complexity of the so-called elements than may be inferred from certain spectroscopic observations of the sun and some experiments tending to show that in some cases we have confounded two or more very similar elements under one name. Apart, however, from these abstruse speculations, the whole tendency of physical and chemical investigation has been to bridge the gulf formerly fixed between molar and molecular motion and between chemical and mechanical force. There is an obvious interdependence between this scientific movement and the doctrine of the conservation of energy, which is one of the main philosophical achievements of the epoch under discussion. According to that doctrine, the total energy of any body or system of bodies is a quantity as absolutely fixed and as incapable of suffering either increase or diminution as the matter of which these bodies are composed. Energy, like matter, may assume an endless variety of forms; but the force put forth by the locomotive is as indestructible as the particles which compose its framework or its fuel. But to balance our account we have to take cognizance not only of the forces of impact or pressure of which we have direct experience, and conceive ourselves to have tolerably full understanding, but also of the forces of attraction and repulsion in their various forms, concerning which we as yet know absolutely nothing beyond the fact of their existence as inferred from their effects. To refer the whole complex sum of these energies to a general law, and to deal with them on fundamental physical and mathematical principles, is the aim of the physical science of to-day. Notwithstanding all superficial resemblances, it stands differentiated from the science of all past ages by the clearness with which it apprehends the nature of this quest and the unrivalled range of the analytical methods it has brought to bear. In the domain of biology the theory of evolution, first placed upon a scientific basis by the genius of Darwin, is a product of the same great movement of philosophic thought which brought forth the molecular theory of matter and the doctrine of the conservation of

energy. The idea of evolution itself was not new, but what was new was the proof that in the vast geological changes established by the labours of Lyell and other workers in the same field, in the visible tendency to variation in existing plants and animals, and in the evidence collected by Darwin's industry and observation of the power of the struggle for existence to exercise, in given conditions, a selective and protective influence upon occasional variations, we have all the data required for the construction of a coherent theory. Evolution has now definitely taken its place as a working scientific hypothesis, not, indeed, capable of explaining all the facts of biology, but consistent with these facts and furnishing — the most that a scientific hypothesis can ever do—the means of systematizing our knowledge in preparation for a further advance. The study of embryology is already modifying profoundly the interpretation put upon the evolutionary theory, and is probably paving the way for some new generalization. Mr. Herbert Spencer's application of the theory of evolution to the facts of social order is the expression, in the sphere of human thought and action, of the intellectual movement of which Darwin made himself the exponent in the field of biology.

"But striking as is the enlargement of the intellectual horizon during the last fifty years, the imagination is more powerfully impressed by the enormous extension of the applied knowledge which vivifies and transforms old industries, invents new ones, abridges the whole mass of social labour, annihilates the obstacles of time and space, destroys the enemies of the general well-being, and endows the whole population with conveniences, comforts, and luxuries which a century ago were beyond the reach of kings. It seems as if the tree of national effort, after long putting forth scanty leaves and rare blossoms, had suddenly borne a load of fruit. Knowledge, which had long lain dormant or had led only to slow and trivial change, seems suddenly to have acquired a new significance in the minds of men, and to have taken on a new and unprecedentedly rapid development. Physical science had made great advances between the age of Elizabeth and the close of the last century; but relays of swift horses represented at one period as at the other the most rapid attainable mode of travelling or of transmitting news. The power of steam had been practically utilized by Watt a hundred years ago, and the investigation of electrical phenomena had made great progress before the accession of Victoria, but the whole of the vast improvements in locomotion and the transmission of news which we now enjoy have been effected since that event. With the exception of one or two short lines, the whole railway system of the country is the creation of the last half-century, and its effect upon the fortunes of the nation can hardly be over-estimated. The England of to-day has, in fact, been rendered possible only by the railway system, which in turn has been fed by the industries it fostered, and depends for its very existence in the form we know upon the modern development of telegraphy and engineering. It is easy, but not particularly useful, to give statistics showing the growth of railway enterprise since George Stephenson began his task of developing steam communication. No figures can add to the impressiveness of the consideration that, whereas railways are now everywhere, fifty years ago they were practically nowhere. Our whole modern system of commerce has grown up around this efficient system of intercommunication, and depends absolutely upon rapid transit for its very existence. But the direct results of the application of steam to locomotion are probably trivial in comparison with its profound influence upon the social life and even the moral character of the nation. The population of the country, formerly attached to the soil on which it was born by necessities stronger than feudal custom, has been endowed with the power of easy, rapid, and comparatively cheap locomotion. For good and for evil the habits of mind belonging to an age characterized upon the whole by permanence of local relationships have given place to the habits proper to a time in which labour is nomadic, and all the relations of life in the remotest districts are profoundly affected by the attraction of distant centres of population. The immense increase of these centres, and the corresponding depopulation of rural districts, is one of the most obvious results, not, indeed, of railways alone, but of that industrial revolution in which they have played a central and indispensable part. That revolution may be defined as a great and sustained movement in the direction of economizing and organizing labour. Railways have powerfully promoted economy by reducing to a fraction of its former amount the time spent in the transport of goods and workmen, and they have no less powerfully promoted organization by equalizing conditions and combining a thousand isolated stores of industrial energy into one central reservoir. Nor must we leave out of sight the enormous effect they have produced by facilitating the transmission of correspondence and news. While the railways were yet in their cradle they were utilized for the carriage of the mails, but the whole postal system was so chaotic and inefficient that the public could have reaped but little advantage save for the drastic reforms advocated by Rowland Hill in 1837, and carried into effect, in spite of the opposition of the Post Office officials, in 1840. The establishment of the penny post, together with the novel rapidity and regularity of the service rendered possible by railway extension, is in itself a reform which in earlier ages would have sufficed to render a reign illustrious. It has been supplemented by a telegraph system which as far transcends the penny post as that surpasses the clumsy and costly system of the last century; and the telegraph is in turn yielding the palm to the telephone, in the use of which, however, this country, owing to the obstructiveness of the Post Office, is far behind America and some Continental States.

"The maritime supremacy of this country was fully established long before the accession of Victoria, and the marine steam-engine was familiar long before the locomotive. Patents for screw propellers were even taken out a century ago, although they were not successfully applied until 1837, when Ericsson attained a speed of ten miles an hour. In the following year the *Great Western* performed what was then the extraordinary feat of making the passage from Bristol to New York in eighteen days. Considerable success had thus been attained before the present reign in the application of steam to marine transport, but the advance that has since been made is not less remarkable than the improvement in land transport. The voyage to New York is now performed in six days, and ships are actually sailing between Liverpool and the Isle of Man at a speed equivalent to doing the New York passage in five. But the real measure of the revolution that has taken place must be sought in the supersession of sailing vessels by steamers for all the purposes of commerce, and the consequent multiplication of the resources of industry. At the beginning of the reign the tonnage of British steam-ships was considerably under 100,000 tons. It is now about 4,000,000. But just as the immense growth of railways has not prevented a large increase in the traffic of the canals, so has the increase of steam-shipping left room for an addition of 50 per cent. to the tonnage of British sailing-vessels. The increase of steam-tonnage taken alone gives but an imperfect idea of the progress that has been made. For by continual improvements in marine engines each ton of shipping is moved at a greatly increased rate and a greatly diminished cost; while, as regards a very large and important portion of our trade, the opening of the Suez Canal, to which we supply four-fifths of its traffic, has still further economized time and labour. In this connexion by far the most important

achievement of recent years is the opening of the Canadian Pacific Railway, and the establishment of a line of steamers connecting its western terminus with India, China, and Japan. We thus gain a shortened route to the East, passing entirely over great ocean highways and British territory instead of through a land-locked sea and a narrow gut which accident or design may at any moment render impassable. In view of the expansion of commerce during the last half-century, and of the immense undeveloped resources of Canada, it would be rash to set any limits to the future possibilities of this great Imperial highway.

"The universal acceleration of locomotion and transit is the most extended and general application of science to the great modern purpose of economizing labour and time. Every department of industry can, however, show special applications for effecting the same result."

ATLANTIC WEATHER CHARTS.

THE Meteorological Council has recently issued the second part of the Synchronous Weather Charts for the North Atlantic and the adjacent continents, the folio just published embracing two charts for each day from November 8, 1882, to February 14, 1883. The first part was noticed in NATURE, vol. xxxv. p. 469, when we gave a somewhat detailed explanation of the charts and the observations upon which they were based. The second part embraces a very large portion of an English winter, and the conditions pictured over the Atlantic show that the weather over that ocean in winter is far more disturbed than it is during the summer months. The barometer in the winter ranges both higher and lower, and the changes of pressure are much more rapid and considerable. The movements of the travelling disturbances are also accelerated, and keep in a much lower latitude, the British Islands coming frequently under their full influence after they have passed over the warm and moist air of the North Atlantic. In the summer the barometer is above 30 inches over the greater part of the ocean, but the highest readings seldom exceed 30·3 inches, whilst the areas of low pressure, the readings at the centre of which are seldom especially low, ranging for the most part from 29·2 to 29·5, skirt to the north of the high-pressure area, and pass as a rule well to the northward of the United Kingdom. At times these low-pressure areas scarcely influence our weather. At other times, when from some cause the high-pressure area is situated in rather a lower latitude than usual, the low centres will have a more southerly route in their passage from west to east, and will occasion disturbed weather over our islands, but for want of sufficient difference of barometric pressure will but very seldom materially augment the strength of the wind. If, however, this southerly track of the disturbances is maintained for any length of time in the summer, it will have a very marked effect upon our weather, occasioning frequent and heavy rains; it was this which caused the entire failure of real summer weather in 1879. The winter charts show that the barometer often ranges as high as 30·5, 30·6, and 30·7 in Mid-Atlantic, whilst on the adjacent continents such readings are common, and in North America much higher readings occur—on February 1 the mercury reached 31·1 inches. The charts do not extend to Siberia, but it is notorious that excessively high readings are commonly experienced there during the winter months. The low-pressure areas which are principally limited to the ocean, and almost solely to the northern latitudes, frequently have the barometer at the centre below 29 inches, and occasionally below 28 inches. With these differences of barometric pressure there is ample material for the development and maintenance of storm systems; and the most cursory examination of the charts shows to how great an extent storm after storm rages almost daily in one part or another of the Atlantic, and frequently several storm areas exist at one and the same time. This second series of charts illustrates in the most unmistakable manner the behaviour of storms over the Atlantic: many a disturbance can be traced in its progress for days together. On November 13 a storm area was passing over the north of France, and was occasioning strong easterly gales in the south of England and the English Channel. This disturbance can be traced back day by day until November 3, when it was in the vicinity of the West Indies, where it was apparently bred. The severe storm which was blowing over the British Islands on November 19 was apparently formed over central North America on November 9, and, after travelling slowly over the Lake District, left the Gulf of St. Lawrence on November 14, and followed a north-easterly track, but, after passing over the south of Greenland, it took a more southerly course, the centre subsequently passing between Iceland and Scotland. A fairly good specimen of storm development is shown on the charts of February 7 and 8: on the 7th, a bend is shown in the isobars of 29·0 and 29·1 at about 300 or 400 miles to the west of Ireland, and this on the following day becomes a closed area with its complete wind circulation; the disturbance, however, dies out again on the 9th. A feature of very special interest in the charts is the size of some of the disturbances: this stands out clearly from the graphic manner of representation. There are many instances of a gale blowing simultaneously in America and Europe, due to the same storm area, and in these cases the area of low-barometer readings usually occupies the whole of the northern part of the Atlantic, whilst over the land, both in Europe and America, the barometric pressure ranges very high. On January 23, as the result of a single low-pressure area, a gale was blowing in Hudson's Bay, Labrador, and Newfoundland, and completely across the Atlantic to the North Sea and the north of Norway, the diameter of the area over which the wind was blowing with gale force, being as much as 3800 miles (nautical); the centre of the storm was situated off the south-west coast of Greenland, where the barometer was reading 28·2 inches, whilst in America and Europe the barometer reached 30·8 inches. An almost equally large disturbance is shown on February 10, the gale force extending quite across the Atlantic from Labrador and the Gulf of St. Lawrence to the Gulf of Bothnia, the diameter of the gale area being fully 3000 miles.

The equatorial doldrum is shown to be of less extent than the general charts which have been deduced from averages would lead one to suppose, and very frequently the north-east and south-east trades almost meet. Between longitudes 20° and 30° W., the position at which the trades meet in November is about 5° N., in December about 3° N., whilst in January and the early part of February the south-east trade only just blows north of the equator, and the doldrum is probably at this time at its most southern limit. The north-east trade is far more regular on the eastern side of the Atlantic than in mid-ocean or on the western side, and this is fully accounted for by the fact that the wind blows round the Atlantic high-pressure area in agreement with the ordinary anticyclonic circulation, so that on the eastern side of this high pressure which is also, as a rule, the eastern side of the Atlantic, the wind is northerly, whereas to the westward of this area of high barometer readings the winds are frequently from the southward. The northern margin of the trade varies considerably, and is almost entirely dependent on the position of the area of high barometer situated over the Atlantic; when this area is well to the northward the northerly winds hold from the chops of the Channel down the coast of Africa to about 5° N., so that a vessel may leave England and keep a steady northerly and north-easterly wind until close to the equator.

The winter charts also show that the differences of temperature are much larger over the Atlantic than they

were in the summer or autumn series, and the isotherms of both air and sea run much closer together. On November 25 there is a difference of 30° in the sea temperature in the distance of 340 miles to the south-east of Newfoundland, whilst on the eastern side of the Atlantic the same difference of temperature, 40° to 70°, spreads over 2360 miles. This disparity between the difference of temperature on the western and eastern sides of the Atlantic is quite common throughout the whole period of the charts, but not always to so large an extent. The charts of December 15 and 19 are other instances which show this difference, and on January 6 there is a difference of 30° (from 30° to 60° F.) in 120 miles off the south of Newfoundland, whilst on the eastern side there is only an equal difference of temperature (50° to 80°) in 3300 miles. The largest differences of temperature occur between latitude 40° and 45° N., and longitude 40° to 60° W., which is the area most affected by the meeting of the warm water of the Gulf Stream and the cold Polar current, and the weather which is given on each chart shows that there is almost constant rain in this position, and it is also the breeding-place of many a storm area, and storms when generated have a decided tendency to keep in the track of the Gulf Stream.

These synchronous charts will materially aid investigators in tracing the connexion between the weather in the British Islands and that over the Atlantic, and as it is not possible at present to know what is going on immediately to the westward of us, it is the more necessary to deduce, if possible, laws which regulate the changes from time to time. By the publication of these charts the Meteorological Council afford opportunity for testing many theories. Among these may be mentioned the theory of indraft of wind towards the centre of a cyclone, if this is not already pretty conclusively proved. Light is also thrown upon the question as to the position of rain with regard to the position and development of the general storm area, and upon many other inquiries of a similar nature. We hope that after the two remaining parts of the work have been completed the Council will see their way to undertake a thorough discussion of the material which the charts contain.

A REVIEW OF LIGHTHOUSE WORK AND ECONOMY IN THE UNITED KINGDOM DURING THE PAST FIFTY YEARS.[1]

II.

THE fifty years of the present reign have been distinguished with regard to lighthouse illumination by the development in this country of the beautiful dioptric system of Augustin Fresnel. In 1837, this system had been established in France fifteen years, but had only just been introduced into Britain, where the catoptric system was in full operation. Parabolic reflectors formed of facets of silvered glass were used in the Mersey lighthouses so far back as 1763, and at Kinnaird Head, in Scotland, in 1787. In 1804, perfected reflectors of silver plate rolled upon copper were used at Inchkeith, and similar reflectors have been ever since employed. To Teulère must be attributed the honour of the invention of these parabolic mirrors, in 1783. The Inchkeith Lighthouse is also notable as the first in Britain to receive a Fresnel apparatus (1835), through the exertions of Alan Stevenson, who placed the next one at the Isle of May (1836), and the third at the Start (1836). These lights were all of the first order, Start and Inchkeith being revolving, and Isle of May fixed. They were constructed by Messrs. Cookson, of Newcastle, who subsequently constructed at least a dozen others, mainly as regards the refracting portion.

The lenticular system, as received from Augustin Fresnel by Alan and Robert Stevenson, comprised four principal optical agents of glass, viz. the cylindrical refractor, the totally-reflecting prism, the refracting vertical prism, and the annular lens. These have been continued in use, with few modifications, until the present day, while his auxiliary elements, such as the small inclined lenses, the silvered metallic zones, and the plane silvered glass mirrors, have been abandoned. The first-order fixed light of Fresnel came well-nigh complete from his hands, and has remained unchanged in size and character, save as relates to the number of prisms above and below the lenses, which has been increased from 19 in all to 26, and as to the joints of the lenses, which have been made inclined instead of vertical, the latter improvement being due to Alan Stevenson, who also introduced a refractor of more truly cylindric form. It is in the apparatus of revolving sections that the most striking ameliorations have been effected. The French engineers added little between 1822 and 1852 to Fresnel's original work, a few combinations or modifications of his elements to produce flashes alternately with fixed light being nearly all. But between 1849 and 1852 the great improvement known as the holophotal system was elaborated by Mr. Thomas Stevenson. It is difficult to describe without drawings the various applications to both catadioptric and dioptric instruments of this principle, by which the light of maximum intensity, or the best utilization of all the rays, was attained. The first *catadioptric* holophote was employed at the North Harbour, Peterhead, in 1849. Better forms were realized in 1864. The first use of holophotal metallic mirrors above and below the annular lenses of a large revolving light was at Little Ross. These mirrors, which needed no small auxiliary Fresnel lenses, were, instead of being plane, like Fresnel mirrors, generated by a parabolic profile passing round a horizontal axis. The typical *dioptric* holophote is a central refracting lens of usually three elements, with a series of concentric holophotal totally-reflecting rings, forming an instrument of varying diameter and focal distance, condensing into a parallel beam all the front arc of the diverging sphere of rays. The holophote is perfected by a glass spherical mirror of totally-reflecting prisms so shaped and set as to return all the back hemisphere of incident rays through the flame, to be parallelized and sent out with the front hemisphere of rays. This spherical mirror in its most effective form was the invention, in 1861, of Mr. James Chance, who generated the double-reflecting prisms or zones round a vertical instead of a horizontal axis, separated them, and divided them into segments or panels, thus making it practicable to increase the radius of the mirror and apply it to the largest apparatus as a most useful adjunct. In this instrument the image of the flame is not reversed, and the light sent back is at least three-fourths of that received.

But the most important application of the holophotal system was to the dioptric revolving sea-light. The totally-reflecting zones above and below the refracting lenses were generated round a horizontal instead of a vertical axis, and made to work in complete unison with the lenses, the light being parallelized in every plane from top to bottom. The first holophotal sea-light was the North Ronaldshay, in 1851. Since that date every revolving light with prisms has been holophotal. It has been estimated that the modern plan gives light five or six times more intense than the original plan.

Another material addition to the resources of the lighthouse engineer has been contributed by Mr. Thomas Stevenson in the azimuthal condensing system. This is, briefly, an arrangement of the optical agents before described, and of some others specially devised, by which either one arc of the horizon is illuminated by a beam of the greatest attainable intensity while the rest is dark, or else two or more sectors are lighted with equal or with unequal intensity while the others are dark; these distinctions being governed by the nautical requirements as to range and direction of the sea-coast, channel, or harbour

[1] Continued from p. 105.

where the light is established. The beams thus sent out may be white or coloured, the differences in coloured media themselves, or, as compared with white light, being equalized approximately by the instruments used. The condensing method has been applied more freely to the smaller than to the larger orders of apparatus during the past twenty-five years; and among the most beautiful illustrations of the system, designed not alone by Mr. Stevenson, but by Mr. Chance, Mr. Alan Brebner, and Dr. Hopkinson, may be cited the Buddonness, the Isle Oronsay, the Lochindaal, the Dartmouth, the Hoylake, and many apparatus for certain narrow seas in Australia. But the large lights of Orme's Head, Dungeness, Bidston, Longships, St. Tudwal's, Dublin Bay, and McArthur's Head, may also be selected as good examples of the condensing plan.

A third and very valuable improvement is the group-flashing system of Dr. John Hopkinson, F.R.S., by which a new series of characteristics has been added to revolving lights. This invention dates from 1874, and consists in so shaping and combining on unequal axes the panels of an apparatus that a double, triple, or fourfold flash may be produced, each flash of the group being of such duration and divided from another flash by such an interval of time that compass-bearings may easily be taken from the ship; while each group is separated from another group by a longer interval, the whole period being one of the usual periods of revolving lights, such as half a minute. Thus, while adequate power is maintained for each flash, an unmistakable distinction is established. This plan became rapidly popular. The Trinity House were the first to apply it, in 1875, to the catoptric floating light on the Royal Sovereign Shoals, near Hastings. The next applications were to a dioptric light for Mexico, and to the Little Basses light, Ceylon. It is now used all over the world. At the Casquets, in 1876, it enabled the Trinity Corporation to dispense with two of the three lights hitherto employed, and show from one tower a half-minute light in triple flashes, each lasting two seconds, each interval between them three seconds, and the long interval between the groups eighteen seconds. The great lights of Bull Point, Hartland Point, and Eddystone are other examples of double and triple group-flashing by optical combinations.

The use of colour in lighthouse practice has been gradually diminishing since 1837, and is now almost restricted to harbour-lights and ship-lights, with a few cases of fixed sea-lights where a danger is to be marked over a narrow sector. The loss by absorption in red and green, the only two colours available, being from 60 to 80 per cent.—a loss slightly redeemed in the case of red by a certain relative superiority to white in thick weather—it is obvious that colour must sooner or later disappear from the list of effective lighthouse agents. Meanwhile the power of a coloured beam (without regard to the illuminant) has been optically enhanced by one of two methods, superficial amplitude and azimuthal condensation.

Where a revolving light is to show, in alternate or other series, red and white beams, the power may be approximately equalized by assigning to the red a certain greater angular breadth in the panels of prisms and lenses than to the white. The Wolf Rock light (1869), the Flamborough Head (1872), the Hartland Point (1874), were so treated by Mr. James Chance, though with different arrangements of panels, the average proportion being 73 for the red, and 27 for the white. The coloured glass plates used were of a selected tint of "copper ruby." The second method, condensation, is mainly applicable, as before mentioned, by means of vertical prisms and other agents to lighting sectors of the horizon, or to securing perfect definition between two coloured arcs or between a white and a coloured arc. The Kingswear fourth-order light, Dartmouth (1865), designed by Mr. Chance, is an excellent example. In a seaward arc of 45° there is a central white beam of 9½° between a red beam of 17¾° and a green beam of 17¾°. Ten vertical prisms were used, four condensing the lights on the border of the red and white, and four on the border of the green and white, while two augmented the central beam. The fairway channel to the harbour is indicated by the coloured light, and the bright beam constitutes a sea-light which is frequently observed at a distance of sixteen miles, though the lamp is inferior to the lamps of to-day.

The signal-lights of the port and starboard sides of a vessel are coloured in order that a marked contrast may be visible at a distance of at least two miles, and her course and evolutions plainly understood. But the great inferiority of green to red, and of both to white (the third signal carried by a steamer being a white light), combined with the imperfection of the optical apparatus and of the burner used, renders too many ship-lights lamentably untrustworthy at even this short range, and can only tend to multiply such terrible collisions as those with which we have become familiar during the past fifteen years. It might be impracticable, on account of weight or cost, to introduce condensing agents into side-lights generally, though Mr. Thomas Stevenson, ever foremost in the van of improvement, tried them on the small steamer *Pharos* in 1866; but there can be no sufficient reason for not adopting such lenses of true lighthouse types as are now made for the purpose in Birmingham and Paris, and in not fitting them with the incandescent electric light in two different degrees of power, so as to equalize nearly the red and green lights, and in not making them both equal in visibility to the white; thus securing an effective signal for the adequate protection of life and property at sea. The writer has long, but with small success, advocated this course. Public opinion, however, may yet be stimulated by some crowning disaster to insist on a reform so urgently needed, and so perfectly easy to realize.

In 1873 the first dioptric light established in England, Start Point, received its present apparatus in substitution for the old Fresnel lenses and concave mirrors. The new revolving light, the design of Mr. Chance, and which was repeated in 1874 at Cape Bon, Africa, and the South Stack Rock, Holyhead, was composed symmetrically of six sides of 60°, with the usual upper and lower prisms, the central lens having nine elements in circular settings. The panels are thus the widest in azimuth hitherto constructed, except some of those of Flamborough Head, which subtended 69½°, or the four holophotal quadrants constituting the South Stack Low Light (1879), designed by Dr. Hopkinson, and the only existing light of the kind. By a subsidiary arrangement of totally-reflecting prisms and a holophote, a fixed red beam at Start Point was projected to a lower chamber in the tower, and thence sent out to mark the position of certain rocks. The Watling Island (Bahamas) second-order double-flashing light of 1885, designed by Dr. Hopkinson, is a unique specimen of holophotal circular settings, with the most recent improvements.

A remarkable variation of the usual elements of a dioptric sea-light dates from 1879 or 1880. Lower prisms for sea-lights had, at the suggestion of the writer in 1874, been suppressed on several occasions; and for port-lights, Messrs. Chance had dispensed with all prisms, and raised the lenses to a vertical angle of 80°. But now it was determined to produce a first-order apparatus with refractors only, extending the vertical angle to 92° from 56° or 57°, the old normal height. This was attained by Messrs. Chance by means of dense flint glass in the superior and inferior limits. The power of the lenses, always counting for 75 per cent. of that of the complete light, was thus considerably augmented, while the cost and bulk were reduced, though doubtless at the expense

of symmetry. The first-order lights, Anvil Point (Dorset), the Eddystone, and the Minicoy (Indian Sea), were constructed on this principle at Birmingham (1880-83). In the case of the Eddystone, two apparatus exactly alike were employed by the Trinity House—one superposed on the other, and each lighted by its own lamp, the whole height of optical glass exceeding 12 feet. The plan of superposed lenses was first suggested, in 1859, by Mr. J. W. D. Brown, of Lewisham, and first practically set forth, in 1872, by Mr. John R. Wigham, an engineer of conspicuous ability, in connexion with his large gas flames for Irish lighthouses; and it has been since fully approved and adopted by the Trinity House. The great lights of Galley Head, Howth Bailey, and Rockabill attest the excellence of this arrangement of lenses, and the Eddystone biform (1881) is not less successful.

The enhancement of illuminating power through the amplification, vertical and horizontal, of lenticular panels has been described. But a more emphatic change, associated with the name of Stevenson, has recently been consummated. The radius or focal distance of Fresnel's first-order light is 920 millimetres. The Fresnel of our time proposed a radius of 1330, and such a lens has been already constructed in France. The name "hyper-radiant," given to it by Mr. Stevenson, seems hardly so accurately formed as "hyper-radial," which was independently suggested by the writer in 1885, although the new lens will be excellently adapted to the large flames of the day, at once utilizing their volume and not suffering from their heat. In the lights for the Bishop Rock and Round Island (Scilly) now (1887) being prepared by Messrs. Chance for the Trinity House, the apparatus will be of the hyper-radial type, and it will have a vertical angle of 80°, with glass all of the usual refractive index. There will be for each lighthouse a biform structure 15 feet high, the Bishop having lenses for white double flashes arranged in a pentagon of five groups, each lens subtending 36° horizontally, with an eight-wick burner; and the Round Island having lenses for red single flashes, each lens subtending 60° horizontally, with a ten-wick burner. Petroleum will be used in both cases. The latter apparatus would seem to mark the maximum limit of dimension, with regard to optical agents and to illuminants, compatible with the present conditions of lanterns and towers. Hyper-radial apparatus is also being prepared in Paris for the Tory Island and Bull Rock lights in Ireland.

But the true maximum of power or intensity for lighthouses must ever be sought in the electric light. This application of the branch of physical science that has perhaps more than any other distinguished the Victorian epoch had its experimental beginnings, under the auspices of Faraday, at Dungeness and the South Foreland. The apparatus used at Dungeness was of 150 millimetres radius. In 1881 the apparatus for Macquarie was constructed of 920 millimetres radius. Six large electric lights have been established in Britain since 1862, all the work of Messrs. Chance, and all of their design except the Isle of May, which was planned by Mr. Thomas Stevenson. The Souter Point light, revolving, of second and third order elements, dates from 1871; the South Foreland, High and Low, fixed, of the third order, from 1872; the Lizard fixed lights, of the third order, from 1877; and the Isle of May, which gives a fourfold flash, and is of first and second order radii, from 1886. In addition, there have been designed by Dr. Hopkinson, and made at Birmingham, the Macquarie (Sydney), a first-order revolving, the most powerful light in the world, and the Tino (Spezia), a second-order triple group-flashing light. It is needless to give details of these apparatus, which are throughout distinguished by skilful optical combinations and the utmost precision of workmanship. They have all been, with the exception of the Isle of May, the subject of elaborate papers and exhaustive discussion before the Institution of Civil Engineers. An apparatus of the second order is being prepared at Birmingham for the new electric light of St. Catherine's (Isle of Wight). It is composed of refractors only, extended to 97° of vertical angle, and with certain special arrangements for divergence. The carbons will be of 50 millimetres diameter and of a novel and perfect form.

There has been during the past fifty years, but especially since 1861, with regard to lighthouse characteristics, a selective process in operation by which the fittest have survived. Not only has the optical apparatus been perfected in curvature, finish, and adjustment to nautical conditions, and the intensity of light increased threefold, but the weaker forms of distinction have been suppressed, and the better forms retained and multiplied. Fixed lights for the most part have been discontinued, and, in this country at least, lights composed of fixed and revolving portions. Long periods in revolving lights have been altered to short periods, the uncertain aid of colour largely abandoned, the varieties of the group-flashing system invoked, and the quick contrasts of light and dark resorted to in occulting or intermittent apparatus, although the very ingenious but too complicated plan of Babbage, with its rhythmical longs and shorts, has not prevailed. The enhanced speed of steam-vessels, the multiplication of all kinds of vessels, the improvement of shore-lights, and the spread of commercial enterprise, by which new ports are opened and new coasts explored, have naturally effected these changes. And, *pari passu*, striking improvements in the mechanism of revolving carriages and of clockwork both with weights and springs, in occulting-cylinders and gun-metal framing of apparatus, have resulted from the combined efforts of our best lighthouse engineers.

The early rivalry between the catoptric and the dioptric systems has wholly ceased, the latter having, by the weight of its general and well-tried superiority, displaced the old system in all directions save in one or two revolving sea-lights of exceptional merit, like Beachy Head or St. Agnes, and save in all light-vessels where the excellent 21-inch reflectors, with the two-wick Douglass burners, often send out beams of 20,000 candles over the shoal-beset waters.

There were in the United Kingdom, in 1886, 202 sea-lights, of which 147 were dioptric and 55 catoptric, and, in addition, about 450 small lights of all kinds, making, with the 74 light-vessels, a total of about 730. Surely this is a noble growth of lighthouse illumination, even in the long period under review. It compares not unfavourably with the United States, the first country to adopt the lenticular system on a bold and comprehensive scale, or even with the country of Fresnel himself and of his brother Léonor, where the elucidations and experiments of Allard and of Reynaud, and the practical work of Lepaute, Sautter, Barbier and Fenestre, have done much to promote science and benefit humanity.

J. KENWARD.

(To be continued.)

THE OBSERVATORIES AT OXFORD AND CAMBRIDGE.

THE following is the Annual Report of the Rev. Prof. Pritchard, the Savilian Professor of Astronomy at Oxford, to the Board of Visitors of the University Observatory; read June 8, 1887:—

I. *Lectures.*—The statutable lectures have been given, and the Observatory and its instruments have been freely accessible to the students during every day of Term time. For next Term I offer a course of elementary lectures expressed as far as possible in untechnical language. I desire to add also two public lectures on the development of astronomy during the last century.

II. *Instruments.*—As a matter of practical convenience, portions of both the equatorial instruments have been within the last day or two placed in the hands of the opticians, with a view to modifications or repairs which shall render them applicable to the entirely new departure which is now in progress in respect of the processes and methods of practical astronomy. The De la Rue equatorial, which has long possessed an historical value, has been rehabilitated mainly at the expense of Dr. De la Rue in certain of its more delicate working parts, and this has been so advantageously completed that Dr. De la Rue has been induced to introduce still further renovations, whereby that instrument will be placed in a condition probably equal to that in which it first left its designer's hands.

The mounting of the large equatorial refractor, originally supplied at the expense of the University, is now required for some experimental inquiries suggested by the Photographic Committee of the Royal Society. Dr. De la Rue has supplied two mirrors of 15 inches aperture of different focal length, and these are to be mounted alternately on the tube of the refractor, together with a camera as arranged by Mr. Grubb. The expense of these valuable additions is borne by the Royal Society and by Dr. De la Rue. The delicacy of the projected inquiries necessitates the electrical control of the driving-clock.

The transit-circle recently presented to the University by Mr. Barclay has realized my expectations of its excellence. I find it to be thoroughly stable, and sufficient for all the purposes required, whether for University instruction or for accurate meridional observations. In the latter respect it completes the Observatory equipment. The electrical illumination of the circles and other necessary parts has proved entirely successful, and the general aspect of the instrument as it stands on its massive piers is such as to suggest confidence.

III. *Buildings.*—The fabric of the building and its complicated roofs and domes are in excellent substantial repair, and will require no outlay that I can foresee during the present year.

IV. *Astronomical Work.*—The somewhat hazardous enterprise of attempting for the first time in the history of astronomy to obtain the distance of the fixed stars from our earth by the aid of photography has been attended with success. The final results of the investigation have been placed in my hands only during the writing of this Report. The first observation was obtained on May 26 of last year, and the last was effected on May 31 of the present year. The intermediate computations were systematically continued during the interval. They involved the reduction of no less than 30,000 bisections of star images, on 330 photographic plates, procured on 89 nights. Eight independent determinations of the parallax of the two components of 61 Cygni resulted from all this work, and these happily indicate a substantial agreement between themselves, and afford other necessary proof of reliability.

By a happy coincidence, on the very day when the final results of these investigations were evolved, I had the pleasure of a visit from Her Majesty's Astronomer at the Cape of Good Hope, a practical observer whose experience in parallactic investigations is probably unrivalled. His remarks, after critical examination of the entire work, have encouraged and gratified me. Astronomical photography is hereby placed on a secure basis as an efficient and exact exponent of the highest form of astronomical science.

Simultaneously with these observations, similar work has been in progress for the determination of the parallax of μ Cassiopeiæ and Polaris. These observations will now be treated on a less laborious scale. Photographic plates of the Pleiades have also been taken with the view of obtaining the accurate relative positions of about one hundred stars therein. The necessary triangulations have been commenced.

I should say that the experimental investigations required by the Photographic Committee of the Royal Society originated in the necessity of ascertaining what are the limits of accurate field obtainable from mirrors of different focal lengths: the inquiry had distinct reference to the questions which were open for discussion at the recent Paris International Conference. I deeply regret that I was unable to fulfil my intention of taking part (as invited by Admiral Mouchez) in that important meeting.

V. *Finance.*—The funds granted by the University have been sufficient, notwithstanding the continuous activity, which requires a corresponding continuity of outlay. This grant, hitherto triennial, expires on December 31 next. If the Board of Visitors see fit t request the University to continue this grant for fiv years, it would assist me in undertaking, for the Unive sity, a share in the production of a photographic map the heavens, a valuable and extended class of worl which under other circumstances I should not be justified in contemplating.

The details given above testify without further words of mine to the unwearied perseverance and intelligence of my two able assistants, Mr. Plummer and Mr. Jenkins.

Prof. J. C. Adams has just presented the Report of proceedings in the Cambridge Observatory, from May 27, 1886, to May 26, 1887. From this Report we take the following extracts:—

The total number of observations made with the transit-circle during this interval, for determinations of right ascension and north polar distance, is 2253.

These include 726 observations of clock stars made on 151 nights; 68 observations of Polaris at the upper transit involving 169 circle readings, and 61 observations at the lower transit involving 149 circle readings; 1331 observations of zone stars made on 88 nights; and 67 observations of stars compared with the minor planet Sappho.

For instrumental adjustment, the nadir point was observed 218 times, the bisections of the declination wires with their images being in every case made in two positions of the observer, on the north and south sides of the tube respectively; the level and collimation errors were each observed 217 times.

At the request of Mr. Bryant, F.R.A.S., the planet Sappho was compared with adjacent stars 70 times on 7 nights from January 12 to February 2, by means of the Northumberland equatorial and square bar micrometer for differences of right ascension and declination. Before the end of February all the compared stars were repeatedly observed with the meridian circle; and in addition to this 9 stars which had been compared elsewhere with Sappho.

State of the Reductions.—The true right ascensions are obtained up to February 17, 1887, and the true north polar distances to April 27, 1887.

The mean right ascensions and north polar distances for January 1, of the standard stars are calculated to the end of 1886, as are also nearly all the observations of stars made in the present year for comparison with Sappho. The mean R.A. and N.P.D. of the zone stars are similarly reduced up to the end of 1881. The right ascensions of zone stars are reduced to the epoch 1875 as far as March 16, 1878, and the north polar distances to March 1880.

The collection of the observations of the zone stars for the Catalogue has been commenced.

A fresh determination of the intervals of the right ascension wires from 73 observations of Polaris, from 1885 November 17 to 1886 July 6, was completed on July 12. As no change seems to have taken place in the wires, the results were combined with those previously

obtained: so that the final determination rests on 145 observations of Polaris made from 1885 January 21 to 1886 July 6. These intervals were used till 1887 March 3, since which time another determination, from 78 observations of Polaris, from 1886 July 7 to 1887 April 27, has been used.

Sixty-five observed north polar distances of Polaris above the pole, deduced from observations made in 1886, with observed nadir point and assumed colatitude 37° 47' 8".4, and corrected for flexure and errors of division, give a north polar distance less than that given in the *Berliner Jahrbuch* by 0".557: 68 observations below the pole, treated in the same way, give a polar distance greater than the Berlin one by precisely the same quantity. Thus our polar distance of Polaris for 1886 exactly equal to the Berlin one, and the correction of umed colatitude is +0".557; results very similar to se of previous years.

he observations of Polaris above the pole, direct and cted, made by Miss Walker on 1886, April 8, May 3, nd 6, when corrected for errors of division and for fraction, give for the colatitude 37° 47' 8".853. The mean for eight years, given in the last Report, is 37° 47' 8".854.

579 observations of clock stars made by Mr. Graham in 1886, Mr. Todd in nearly every case reading the circle, give, as a mean value for reduction to the Berlin N.P.D. +0".353; or, if we take the means for each separate night as of equal weight, +0".319. These have not been corrected for errors of division and flexure, which, for the limits of the zone, 60°-65° N.P.D., have probably a mean value of −0".26 or thereabouts; this would have to be applied with an opposite sign to the above means: but the results for intervals of 1° show that the errors of division ought to be determined for each star, as they have been for Polaris and for the nadir point.

Meteorological Observations.—The meteorological observations continue to be communicated daily by telegraph to the Meteorological Office.

The sunshine recorder has been regularly employed, and the records are sent at intervals to the Office.

NOTES.

In the distribution of Jubilee honours the claims of science have not been forgotten. Among those who have been raised to the peerage we are glad to see the name of Sir William Armstrong, C.B., F.R.S. The honour of knighthood has been conferred upon Warington Smyth, Esq., F.R.S.; Dr. Garrod, F.R.S.; G. H. Macleod, Esq., Queen's Surgeon, Edinburgh; and J. Wright, Esq., C.B., late Civil Engineer to the Navy. Among the new Knights Commanders of the Bath are John Simon, Esq., M.D., C.B., F.R.S., late Medical Officer, Privy Council Office; and Capt. Douglas Galton, C.B., F.R.S.; Prof. W. H. Flower, F.R.S., British Museum, and Prof. Brown, Agricultural Department of the Privy Council, have been made Companions of the Bath.

The names of the following gentlemen have been added to the list of the Tyndall Dinner Committee:—The Duke of Northumberland, President of the Royal Institution; Sir W. G. Armstrong, F.R.S., ex-President of the Society of Mechanical Engineers; Dr. Haughton, F.R.S., President of the Royal Irish Academy; E. H. Carbutt, Esq., President of the Society of Mechanical Engineers; and G. B. Bruce, President of the Institution of Civil Engineers.

Mr. Harford J. Mackinder, M.A., has been elected Reader in Geography at the University of Oxford.

In the Report on the Oxford Observatory, which we print to-day, reference is made to important improvements effected, either wholly or in part, at the cost of Dr. De la Rue. We may add to what is there stated that Dr. De la Rue generously offers £500 to convert the Oxford 12½-inch refractor into a Henry—photographic telescope—practically, to buy a new object-glass.

The annual general meeting of the Marine Biological Association will be held to-morrow in the rooms of the Linnean Society. The Laboratory on the Citadel Hill, Plymouth, erected by the Association at a cost of £9000, will be opened for work in the summer, and the Council are anxious to co-operate in the foundation and management of laboratories on other parts of the British coast.

Miss Oldfield has presented to the Herbarium of the Royal Gardens, Kew, the botanical collections made in Australia by her late brother, Mr. Augustus Oldfield. This gentleman was, as stated by Mr. Bentham in the preface to "The Flora of Australia," an acute observer as well as "an intelligent collector." His series of *Eucalypti* are especially good, as he took great pains to obtain the various forms of foliage characteristic of each species, as well as the fruiting and flowering stages. Sir Joseph Hooker used his Tasmanian plants in his "Flora" of that colony. Mr. Oldfield "made large additions to the West Australian plants previously known." These collections were placed at Mr. Bentham's disposal for the purposes of his "Flora Australiensis."

The biennial Exhibition of Agriculture and Entomology in Paris will take place from August 27 next to September 29, at the Orangerie, one of the terraces of the Tuileries Gardens. The French Minister of Public Works is the President of the Society which organizes the display.

The Pilot Chart of the North Atlantic Ocean for June, issued by the Hydrographic Department of Washington, states that Capt. Lassan, of the Norwegian barque *Petty*, while in lat. 17° 38' N., long. 46° 34' W., on April 1, experienced three distinct shocks of earthquake, diminishing in force, and accompanied by strong eruption of air-bubbles, covering the surface during the continuance of the shocks. The ice-reports show large numbers of bergs north of lat. 42°, and between long. 47° and 53°.

On June 1, M. Hervé Mangon, President of the Council of the French Central Meteorological Office, read the ninth Annual Report of the work of the Office (see Nature, vol. xviii. p. 96). It shows satisfactory evidence of continued energy and progress in all departments of the service. No less than 154 telegraphic reports are received daily from Europe and Algeria, and 41 telegraphic summaries and weather forecasts are issued, including one to a London daily paper. The success claimed for the forecasts is 88 per cent., and for the warnings of storms 82 per cent., being a greater success than in any previous year. There are 153 climatological stations (including 12 observatories) taking not less than 3 observations daily, in addition to a large number of minor stations. The Office is also actively engaged in collecting observations made at sea, and received upwards of 500 log-books during the past year. This branch is encouraged by the presentation of medals, awarded by the Association Scientifique to the best observers. M. Hervé Mangon reviewed the work of the various observatories, and referred especially to the investigations of M. Renou, at St. Maur, who has just completed an inquiry into the rainfall for the last 200 years, and is finishing a work on the climate of Paris, on which he has been engaged for 40 years. Reference is also made to the reports now received daily from America and the Atlantic, of which our own Meteorological Office bears half the cost. The telegrams are regularly published in the French *Bulletin International*. The other half of the expense of these telegrams is borne by a lady whose name is not generally known. M. Hervé Mangon spoke at great length of the damage

caused yearly by the inundations and mountain torrents, and of the advantage of planting the mountain declivities with trees or shrubs. One of the chief features of the past year is the completion of the Observatory of the Pic de l'Aigoual, in the department of Gard, which has been established in the interest of forest meteorology. A series of experiments is to be made on the influence of various kinds of soil and vegetation in storing the water caused by rainfall, and on the time necessary for its evaporation and percolation.

THE *Bollettino Mensuale* of the Italian Meteorological Society for May contains the report of the first annual meeting of the Council, held on April 14. The principal matters discussed were: the co-operation of the Italian Navigation Societies; the development of the service of medical meteorology at Naples and other towns; and the preparation of a map of the globe showing all the stations of the Society both at home and abroad. It was proposed to encourage observations of the temperature of the surface of the ground, and to publish the results of these and other observations already collected. The second annual meeting of the Council was fixed for the autumn.

THE Observatory at Batavia has just published vol. vii. of its series, containing the magnetic observations (only), from September 1883 to December 1885, together with the results from July 1882 to December 1885, prepared under the direction of Dr. van der Stok. The observations show a well-defined decrease of the declination in 1884-85, at the rate of nearly two minutes a year, and a decrease of the horizontal force at the rate of 0·00012 a year. The vertical force has continued to increase, and the dip shows a progressive value of about 7'·5 a year. It is intended in future to issue, yearly, a volume containing both the magnetic and the meteorological observations, but the publication of the meteorological observations for the years 1883-85, and the discussion of the results for the twenty years during which the observations have been made, are indefinitely delayed, owing to pressure of other work.

MR. CLEMENT L. WRAGGE, the newly-appointed Government Meteorologist of Queensland (see NATURE, vol. xxxv. p. 229), has published the meteorological synopsis of the Brisbane Observatory and rainfall reports for the colony for January to March 1887, and also his report of the inspection of the stations. The inspection disclosed the thorough disorganization of many of the stations. For instance, at Cooktown, a station of the first class, the spirit thermometer had the enormous error of 15°, owing to the volatilization of the alcohol. At Normanton, another first-class station, the shade thermometers were "exposed" in the sitting-room. It is unnecessary to multiply instances, and we merely quote Mr. Wragge's concluding remark that "the majority of the meteorological records and results already published are unreliable and valueless." We hope with him that the new system will gradually attain a position of excellence equalling that which obtains in this country.

WE have received a copy of the lecture delivered lately by Dr. Orme Masson, the Professor of Chemistry in the University of Melbourne, on the first occasion on which he addressed himself publicly to a Melbourne University audience. The subject is, "The Scope and Aims of Chemical Science, and its Place in the University." Dr. Masson has a clear, fresh, and vigorous style, and in this lecture he brings out with much force the part which chemistry has played in modern material progress, and its fitness to serve as an instrument of intellectual culture. He expresses a hope that there may always be at the University of Melbourne a small band of students devoting the bulk of their time for a few years to chemical research. The University, he says, will soon have "well-equipped laboratories, not only for the practical instruction of large classes of medical students and others, but for the accommodation of those specialists who go further in the work, requiring to be provided with the more elaborate paraphernalia of experimental science."

AT the opening meeting, on April 19, of the Royal Society of Tasmania for the session of 1887, Mr. R. M. Johnston read an interesting paper on the question, "How far can the general death-rate for all ages be relied upon as a comparative index of the health or sanitary condition of any community?" The object of the paper was to demonstrate that the general death-rate of any one place, although in itself due to a combination of many causes, may be taken as a fairly trustworthy local index to health and sanitary condition, but that it is a most faulty index as regards the comparative health and sanitary condition of different localities. The latter fact he attributed mainly to the extreme variability in the proportions of persons living in different places under the principal age groups.

MR. E. STANFORD, of Charing Cross, has just issued three volumes of his series of Tourists' Guides. They are Guides to Suffolk, Wiltshire, and the Wye and its neighbourhood; the first by Dr. J. E. Taylor, the second by Mr. R. N. Worth, and the third by Mr. G. Phillips Bevan. Each of the volumes has been carefully compiled, and is worthy of the useful and well-known series to which it belongs.

AN interesting collection of Indian antiquities is now being exhibited at the Albert Hall. It includes, among other objects, a large number of Palæolithic and Neolithic implements, remains from Indian grave-mounds of the prehistoric aborigines, copies of rude cave pictures and marks on rocks, and Buddhist sculptures and terra-cotta seals found among the ruins of Kusinagara. The objects exhibited form part of a collection made in India by Mr. A. C. Carlyle, late of the Archæological Survey of India.

THE remains of a cemetery belonging to the age of the Gauls have recently been discovered in Paris, in the old Faubourg St. Germain, at the corner of Rocroi and Bellechasse Streets. Fifty-two tombs have been found, with skeletons, most of which are skeletons of women and children. Only twelve are skeletons of men. Many weapons and implements have also been unearthed: swords, lances, shields, and bronze and iron instruments of all descriptions.

THE grasshopper plague is giving serious trouble in Algeria this year. The efforts made to destroy the eggs have proved useless. In one district 50,000 gallons have been collected and burned. This represents the destruction of 7,250,000,000 insects.

IT is observed in the French army that diseases of the heart are very common. In a recent study of this subject, certain military doctors show that they arise from the fatiguing duties imposed on recruits, at an age when, generally, the development of the body is not in harmony with that of the heart, being either in advance of it or behind it. In the latter case, there is hypertrophy of growth; in the former, insufficiency (the more common occurrence). An instance is given in which a regiment in garrison in the West, in 1880, had on an average twelve to fifteen men per thousand invalided annually (the normal figure for the French army), of which number two or three had hypertrophy of the heart. A colonel came to the regiment who had very faulty notions as to the amount of drill and fatigue the men could stand. By September 1883, the number of heart-invalids had risen steadily to twenty-two out of forty-five (*i.e.* about one in two).

A BRILLIANT discovery is announced in the current number of the *Berichte der Deut. Chem. Ges.* by Dr. Theodor Curtius, who has succeeded in preparing the long-sought-for hydride of nitrogen, $(NH_2)_2$, amidogen, diamide, or hydrazine, as it is variously

termed. This remarkable body, which has hitherto baffled all attempts at isolation, is now shown to be a gas, perfectly stable up to a very high temperature, of a peculiar odour, differing from that of ammonia, exceedingly soluble in water, and of basic properties. In the course of his work upon the diazo-compounds of the fatty series, Dr. Curtius treated diazo acetic ether with hot, strong potash, and obtained the potassium salt of a new diazo-fatty acid, which on addition of mineral acids yielded yellow tabular crystals of the free diazo-acid. On digesting the yellow aqueous solution of this acid with very dilute sulphuric acid the colour disappeared without the usual evolution of nitrogen; and on cooling a magnificently crystalline substance separated out, which was shown by analysis to be no other than the sulphate of amidogen, $(NH_2)_2 . H_2SO_4$. These crystals remained unchanged at 250°, but on strongly heating over a flame melted with explosive evolution of gas and deposition of sulphur. On warming this salt with potash solution the free diamide, $(NH_2)_2$, was expelled as a gas which changed red litmus into blue, and rendered itself evident by its irritating odour. The gas fumed on contact with hydrochloric acid forming the hydrochloride, and on leading it into sulphuric acid re-formed the sulphate. It possessed energetic reducing properties, reducing Fehling's and ammoniacal silver solutions in the cold, gave a dense red precipitate with neutral copper sulphate, and formed crystalline compounds with aromatic aldehydes and ketones. It is very seldom that chemistry is enriched by the discovery of a new gas, and the intrinsic value of the isolation of amidogen to both organic and inorganic chemistry renders the communication of Dr. Curtius one of exceptional and of far more than passing interest.

MEASUREMENTS have lately been made by Messrs. A. von Ettingshausen and W. Nernst, upon the Hall effect manifested in different metals. They have found that tellurium far surpasses bismuth in its power, hence they think that the Hall effect is connected with the thermo-electric properties of the metals. The effect is least in tin. Taking this as unity, the effects in other metals are relatively as follows: platinum, 6; copper, 13; gold, 28; silver, 21; palladium, 29; cobalt, 115; iron, 285; nickel, 605; carbon, 4400; antimony, 4800; bismuth, 252,500: tellurium, 13,250,000. The sign of the effect is positive in the case of cobalt, iron, steel, antimony, and tellurium, also lead, zinc, and cadmium. It is negative in all the others.

THE mining engineer, M. Dahll, who has been examining the north of Norway on behalf of the Norwegian Government, states in his Report that all the rivers in the interior of Finnmarken, a district of fifty Norwegian square miles, carry gold. The metal is found in sand contained in little hollows, which by their shape prevent its being washed away by the water. The weight of the gold grains varies from 10 milligrammes to 1 gramme. Platinum is also found occasionally.

DURING the cutting of peat in a moss at Vevang, near the town of Christiansund, in the north-west of Norway, the workmen recently dug out a log of oak over 12 feet in length, and about 4 feet in diameter. It was found at a depth of 9 feet. The trunk and root of a great oak-tree were unearthed in the same moss some years ago, so we may conclude that there was once an oak forest in this spot. The remains of the oak were found below a layer in the bog in which remains of firs are often found.

IN the new number of the Proceedings of the Geologists' Association there is a paper by Dr. H. Hicks on the explorations which he, in conjunction with others, has carried on in the Ffynnon Beuno and Cae Gwyn Caverns in North Wales. He has no doubt whatever as to the accuracy of the conclusions presented by him in his previous papers on the subject. "I am," he says, "perfectly convinced by the evidence found during the exploration of these caverns that they must have been occupied by man and the animals before the climax of the Ice age; also that the thick stalagmite was formed some time during that age; that this was broken up by marine action during the submergence; and that the caverns were afterwards completely covered over by materials deposited from floating ice. There seems, therefore, to be every reason to suppose that man and the so-called Pleistocene animals arrived in this country in advance of the glacial conditions, and that their migrations were mainly from northern and north-western directions."

THE first number of the *Technology Quarterly* has been sent to us. This new American periodical is published by a Board of Editors chosen from the senior and junior classes of the Massachusetts Institute of Technology, representing, as far as possible, all the departments of the Institute. A large amount of original work is done in the Institute every year by advanced students, and it is thought by the editors that the *Quarterly* will be an acceptable journal if it contains nothing more than the results of the original investigations made in the chemical, physical, mining, mechanical, and biological laboratories, and also in the departments of civil engineering and architecture. But it is expected that the *alumni* of the Institute will be glad of this medium for recording their investigations and the results of their practical work. Among the contents of the present number are articles on "The Control of Rivers and the Prevention of Floods," "The Efficiency of Small Electromotors," "The Use of the Aneroid Barometer in Western Massachusetts by the U.S. Geological Survey," and "The Constitution of Benzol."

THE additions to the Zoological Society's Gardens during the past week include two Macaque Monkeys (*Macacus cynomolgus*) from India, presented respectively by Mrs. Slatter and Mrs. Beeston; a Lesser White-nosed Monkey (*Cercopithecus petaurista*) from West Africa, presented by Miss Kate Wood; a Grey Ichneumon (*Herpestes griseus*) from India, presented by Miss Dudding; a Common Squirrel (*Sciurus vulgaris*), British, presented by Mrs. Dick; a Virginian Deer (*Cariacus virginianus*) from North America, presented by Mr. Tom Jay; three Kestrels (*Tinnunculus alaudarius*), British, presented by Dr. J. W. Trentler; two Blue Titmice (*Parus cæruleus*), British, presented by Mrs. Francis L. Barlow; a Blue-eyed Cockatoo (*Cacatua ophthalmica*) from New Britain, presented by Mr. W. H. Fellows; four Horned Vipers (*Vipera cornuta*), three Dwarf Chameleons (*Chamæleon pumilus*), a Many-spotted Snake (*Coronella multimaculata*), a Rufescent Snake (*Leptodira rufescens*) from South Africa, presented by the Rev. G. H. R. Fisk, C.M.Z.S.; a Crowned Horned Lizard (*Phrynosoma coronatum*) from California, presented by Mr. Duff Gordon; a Pig-tailed Monkey (*Macacus nemestrinus*) from India, four Herons (*Ardea cinerea*), six Night Herons (*Nycticorax griseus*), European, deposited; a West African Python (*Python sebæ*) from West Africa, purchased; a Mesopotamian Fallow Deer (*Dama mesopotamica*), two Japanese Deer (*Cervus sika*), two Collared Fruit Bats (*Cynonycteris collaris*) born in the Gardens; two Yellow-legged Herring Gulls (*Larus cachinnans*) bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

THE GREAT SOUTHERN COMET, 1887 *a*.—Mr. Chandler continuing his researches on the orbit of this comet (referred to in last week's NATURE), gives, in No. 157 of the *Astronomical Journal*, the following elements deduced from the Cape and Adelaide observations published in the *Monthly Notices* for March last:—

T = 1887 January 11·230 G.M.T.

$\omega = 63° 36'0$
$\Omega = 337\ 42'8$ True Equinox.
$\iota = 137\ 0'0$
$\log q = 7{\cdot}73892$

The observations on which this orbit depends differ widely from the estimates of position at Cordoba and Windsor, which Mr. Chandler had used in his previous computations; and the elements now found are in fair agreement with those deduced by Mr. Finlay from the Cape observations of January 22, 25, and 28 alone, which are published in the above-mentioned number of the *Monthly Notices*.

THE COMPANION OF SIRIUS.—Prof. A. Hall gives, as the mean results of his observations during the present year (*Astronomical Journal*, No. 157): Epoch 1887·238; position-angle, 24°·18; and distance, 6″·508.

A SHORT METHOD OF COMPUTING REFRACTIONS FOR ALL ZENITH DISTANCES.—In continuation of his paper in *Astronomische Nachrichten*, No. 2768 (NATURE, vol. xxxv. p. 329), the application of which was limited to zenith distances less than 45°, Mr. Schaeberle, of Ann Arbor, U.S.A., in No. 2788 of the same publication, gives his method for the computation of refractions, with Bessel's constants, for 45° to 77° of zenith distance, and for zenith distances greater than 77°, with an accuracy sufficient for practical purposes. Starting from Bessel's expression $r = \alpha\beta^{\lambda}\gamma^{\lambda} \tan z$, Mr. Schaeberle finds that Δr (the quantity to be added to the mean refraction r_0) can be represented only by $\Delta r = r_0 F + \epsilon \frac{\Delta\gamma}{\gamma}$, between the limits $z = 45°$ and $z = 77°$. In this expression $F = \frac{\Delta\beta}{\beta} + \frac{\Delta\gamma}{\gamma}$ and $\epsilon = r_0 (\lambda - 1)$. For zenith distances greater than 77°, the final equation becomes $\Delta r = r_0 F + \epsilon \left(F - \frac{\sigma}{\gamma}\right)$, where $\sigma = 0{\cdot}9 \frac{\Delta\beta}{\beta}$.

The requisite quantities can evidently be easily tabulated, and the computer is thus provided with a very convenient method for calculating refractions which will not materially differ from those deduced directly from Bessel's Tables.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1887 JUNE 26—JULY 2.

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on June 26.

Sun rises, 3h. 46m.; souths, 12h. 2m. 29·7s.; sets, 20h. 18m.; decl. on meridian, 23° 22′ N.: Sidereal Time at Sunset, 14h. 36m.

Moon (at First Quarter on June 28) rises, 9h. 35m.; souths, 16h. 38m.; sets, 23h. 29m.; decl. on meridian, 8° 53′ N.

Planet.	Rises. h. m.	Souths. h. m.	Sets. h. m.	Decl. on meridian. ° ′
Mercury ...	5 51	13 51	21 51	21 6 N.
Venus	7 39	15 11	22 43	16 40 N.
Mars	2 39	10 55	19 11	23 23 N.
Jupiter... ...	14 1	19 20	0 39*	8 51 S.
Saturn... ...	5 20	13 23	21 26	21 33 N.

* Indicates that the setting is that of the following morning.

Occultations of Stars by the Moon (visible at Greenwich).

June.	Star.	Mag.	Disap.	Reap.	Corresponding angles from vertex to right for inverted image.
			h. m.	h. m.	° °
27 ...	10 Virginis ...	6 ...	23 36	near approach	199 —
July.					
1 ...	ξ^1 Libræ	6 ...	0 52	near approach	201 —
1 ...	η Libræ	6 ...	21 23 ...	22 4 ...	19 320

June.	h.	
29 ...	17 ...	Jupiter in conjunction with and 3° 40′ south of the Moon.
July.	h.	
1 ...	10 ...	Mercury at greatest elongation from the Sun, 26° east.
2 ...	9 ...	Sun at greatest distance from the Earth.

Meteor-Showers.

	R.A.	Decl.	
Near σ Herculis	253 ...	47 N.	Swift meteors.
δ Cygni..	294 ...	39 N.	Slow meteors.
ϵ Delphini	305 ...	9 N.	
Between β and γ Cephei.	330 ...	77 N.	

Variable Stars.

Star.	R.A. h. m.	Decl. ° ′		h. m.	
U Cephei	0 52·3 ...	81 16 N. ...	June 27,	23 54	*m*
			July 2,	23 33	*m*
R Piscium	1 24·8 ...	2 18 N. ...	June 26,		*M*
S Ursæ Majoris ...	12 39·0 ...	61 43 N. ...	July 1,		*m*
W Virginis	13 20·2 ...	2 48 S. ...	,, 2,	22 0	*m*
U Ophiuchi	17 10·8 ...	1 20 N. ...	June 30,	23 25	*m*
U Sagittarii	18 25·2 ...	19 12 S. ...	,, 28,	0 0	*M*
β Lyræ...	18 45·9 ...	33 14 N. ...	,, 30,	0 0	*M*
R Lyræ	18 51·9 ...	43 48 N. ...	July 1,		*m*
S Vulpeculæ ...	19 43·8 ...	27 0 N. ...	June 26,		*m*
η Aquilæ	19 46·7 ...	0 43 N. ...	July 2,	0 0	*m*
S Sagittæ	19 50·9 ...	16 20 N. ...	June 27,	23 0	*M*
T Aquarii	20 44·0 ...	5 34 S. ...	,, 26,		*M*
W Cygni	21 31·8 ...	44 52 N. ...	,, 29,		*m*
δ Cephei	22 25·0 ...	57 50 N. ...	,, 28,	23 0	*M*

M signifies maximum; *m* minimum.

THE ZOOLOGICAL SOCIETY OF LONDON.

A GENERAL meeting of the Zoological Society of London took place on the afternoon of Thursday, the 16th inst. In celebration of the fiftieth anniversary of Her Majesty's reign the meeting was held on the lawn of the Society's Gardens, which was reserved for the occasion. A very large number of the members and their friends were present.

After the meeting there was a garden party, the visitors being received by the President, Prof. Flower, F.R.S., and the Secretary, Dr. P. L. Sclater, F.R.S. Among those present during the afternoon were the following:—The Queen of Hawaii and Princess Liliuokalani, His Highness the Thakore Sahib of Limbdi, His Highness the Prince Devawongse, the Maharajah of Bhurtpore, the Earl of Buckinghamshire, the Earl of Cawdor, Lord Wantage, the Earl of Lauderdale, the Earl of Kilmorey, the Earl of Wharncliffe, Lord Coleridge, Lord Walsingham, the Dowager Marchioness of Tweeddale, Lord and Lady Thring, Sir James Paget, Sir Harry Lumsden, Sir Richard Pollock, Sir Joseph Hooker, Prof. Huxley, Capt. Douglas Dalton, and the following members of the Council of the Zoological Society:—Lord Abinger, Mr. W. T. Blanford, F.R.S., Mr. H. E. Dresser, F.R.S., Mr. C. Drummond, F.R.S., Colonel J. A. Grant, F.R.S., Dr. A. C. L. Günther, F.R.S., Dr. E. Hamilton, F.R.S., Mr. E. W. H. Holdsworth, Dr. St. George Mivart, F.R.S., Prof. A. Newton, F.R.S., Mr. Henry Pollock, Mr. H. Saunders, F.L.S., Mr. J. Travers Smith, and Surgeon-General L. C. Stewart.

At the general meeting the President presented the silver medal of the Society to the Maharajah of Kuch-Behar. In doing so he said that His Highness had been good enough to present to the Society a fine specimen of an Indian rhinoceros.

The Maharajah of Kuch-Behar, in reply, said that he would be happy to supply specimens of such animals as the Society might desire to possess, so far as it was in his power to do so.

Prof. Flower then delivered the following address:—

Nowhere has the progress which the world has made during the fifty years of Her Majesty's reign, the completion of which we are now happily celebrating, been more strikingly manifested than in the advance of that so-called "natural knowledge" for the improvement of which our Royal Society was instituted more than two centuries ago. Although there have been, without doubt, immense strides in other directions—in morals, in art, in historical and literary criticism—I venture to say that none of these can be compared with the marvellous progress that has been made in scientific knowledge and scientific methods.

The tangible results that have followed the practical applications of mechanics, physics, and chemistry have so deeply affected the material interests of mankind, that the progress of these branches of knowledge may seem to put into the shade the wonderful changes that have taken place in the kindred sciences. Nevertheless, I think we may safely say that zoology, in a certain sense one of the oldest of human studies, has in the e latter times undergone a new birth, which has not only changed the standpoint from which we view the special objects of our studies, but has also spread its influence far and wide, and profoundly modified our conceptions on many questions at first

sight entirely remote from its sphere. The universal abandonment of the doctrine of fixity of species, which was an article of faith with almost every zoologist in 1837, has introduced new interests, as well, it must be confessed, as new difficulties, the extent of which we are only beginning to appreciate. The definite systems of classification and methods of nomenclature on which our fathers relied utterly fail before the wider field of vision which it is the privilege, as well as the embarrassment, of the present generation of zoologists to realize.

But it is no part of my intention, in the brief space of time for which I shall ask your patience, to attempt to give a history of the recent advances of zoological science in general, but only, as requested by your Council, to say a few words on the progress of the particular institution established for its cultivation in which we are personally interested, and the duration of which is so nearly cotemporaneous with that of Her Majesty's reign.

Before this Society was founded there was no distinct organization in the country devoted solely to collecting, recording and discussing the facts upon which zoological science rests. The dignified parent of all our scientific Societies, the Royal, certainly undertook, as it does still, the discussion of many zoological subjects; but it could not be expected to treat them in any detail. The Linnean was a Society of great respectability, devoted solely to biological research, both zoological and botanical, already nearly forty years of age, and possessed of all the usual appurtenances of a scientific organization—meetings, library, and collections for reference. I cannot help thinking that if its leading Fellows had, at that time, displayed more energy, it might have kept in its hands the principal direction of the biological studies of the country, instead of allowing what has since proved so formidable a rival to spring up, and to absorb so large a portion of its useful functions. However, for reasons which it is perhaps not worth while to inquire into now, it did not supply all the needs of the lovers of zoology; and in the year 1826 an active and zealous band united together, and, as the Charter tells us, "subscribed and expended considerable sums of money for the purpose" of founding the Zoological Society of London.

The leading spirit of this band was Sir Stamford Raffles, then just returned from the administration of those Eastern islands of which the history, both natural and political, will ever be intimately associated with his name. He was chosen for the office of President, but his death, on July 4, 1826, deprived the Society, while yet in its infancy, of his valuable services even some years before it acquired its Charter of Incorporation. In this deed, dated March 27, 1829, Henry, Marquis of Lansdowne, is named as the first President of the chartered Society, Joseph Sabine as the first Treasurer, and Nicholas Aylward Vigors the first Secretary.

The Society appears to have acquired great popularity in a surprisingly short time. The first printed list of Members that I can discover (dated January 1, 1829) contains the names of 1294 ordinary Fellows and 40 honorary and corresponding Members. The list is an interesting one from the number of names it includes of persons eminent either in science, art, literature, politics, or social life: indeed, there were not many people of distinction in the country at that time who are not to be found in it.

A piece of ground in the Regent's Park having been obtained from the Government at little more than a nominal rent, the Gardens were laid out, and opened in 1828, during which year 98,605 visitors are recorded as having entered. In the following (the first complete) year there were as many as 189,913 visitors, and this number was increased in 1831 to 262,193.

While the menagerie of living animals was being formed in the Regent's Park, the Officers and Fellows of the Society were also engaged in establishing a Museum of preserved specimens, which soon assumed very considerable dimensions. A Catalogue printed as early as the year 1828 contains a classified list of 450 specimens of Mammalia alone; and it continued for many years to attract donations from travellers and collectors in all parts of the world, and became of great scientific importance, inasmuch as it contained very many types of species described for the first time in the publications of the Society. It was at first lodged in rooms in the Society's house in Bruton Street; but these becoming so crowded as to present the "confused air of a store rather than the appearance of an arranged museum," premises were taken in 1830 in Leicester Square; the same which were formerly occupied by the museum of John Hunter before its removal to the College of Surgeons. At this time the Museum is reported to have contained as many as 6720 specimens of vertebrated animals, and numerous additions were still being made both by donations and by purchase. The rooms in Leicester Square being found inconvenient for the purpose, it was finally resolved, after considerable discussion of various sites, to transfer the collection to the Gardens in the Regent's Park; and in 1843 the building which is now occupied as a lecture-room on the upper floor and a store-room below was constructed and fitted up for its reception.

Although the Museum was at one time looked upon as a very important part of the Society's operations, being spoken of as "the centre of the Society's scientific usefulness" (Report of Council, 1837), and one upon which considerable sums of money were spent, it was afterwards a cause of embarrassment from the difficulty and expense of keeping it up in a state of efficiency; and when the Zoological Department of the British Museum acquired such a development as to fulfil all the objects proposed by the Society's collection, the uselessness of endeavouring to maintain a second and inferior zoological museum in the same city became apparent, and in 1856 it was, as I think very wisely, determined to part with the collection, the whole of the types being transferred to the National Museum, and the remaining specimens to other institutions where it was thought their value would be most appreciated.

Another enterprise in which the Fellows of the Society were much interested in its early days was the Farm at Kingston, the special object of which was thus defined:—"It will be useful in receiving animals which may require a greater range and more quiet than the Gardens at the Regent's Park can afford. It is absolutely necessary for the purpose of breeding and rearing young animals, and giving facilities for observations on matters of physiological interest and research, and, above all, in making attempts to naturalize such species as are hitherto rare or unknown in this country." The Farm, however, apparently not fulfilling the objects expected of it, and being a source of expense which the Society could not then well afford, was gradually allowed to fall into neglect, and finally abandoned in 1834.

The mention of this establishment, however, causes me to allude to one of the objects on which the Society laid considerable stress at its foundation, and which is defined in the Charter as "the introduction of new and curious subjects of the animal kingdom," but which, as may be gathered from the Annual Reports of the Council and from other documents, meant not only the temporary introduction of individuals for the purpose of satisfying curiosity about their external characters and structure, but also the permanent domestication of foreign animals which might become of value to man, either for their utility in adding to our food-supplies or for the pleasure they afforded by their beauty.

Abundant illustrations of the vanity of human expectations are afforded by the details of the hopes and disappointments recorded in the Reports of the Society relating to this subject. It is mentioned in the Report of the year 1832 that "the armadillo has three times produced young, and hopes are entertained of this animal, so valuable as an article of food, being naturalized in this country." More than fifty years have passed, and British-grown armadillo has not yet appeared upon the menu-cards of our dinner-tables. At one time the South-American curassows and guans were confidently looked upon as future rivals to our barn-door fowls and turkeys. Various species of pheasants and other game-birds from Northern India, collected and imported at great expense, were to add zest and variety to the battue of the English sportsman. The great success which for many years attended the breeding of giraffes in the Gardens not unnaturally led to the expectation that these beautiful creatures might become denizens of our parks, or at all events a source of continued profit to the Society; and it is possible that some who are here now may have been present at the feast for which an eland was sacrificed, amid loudly-uttered prognostications that the ready acclimatization of these animals would result, if not in superseding, at least in providing a change from, our monotonous round of mutton, beef, and pork. Unfortunately for these anticipations, no giraffe has been born in the Gardens during the last twenty years, and elands are still far too scarce to be killed for food of man in England.

It is well that these experiments should have been tried; it

may be well, perhaps, that some of them should be tried again when favourable opportunities occur; but it is also well that we should recognize the almost insuperable difficulties that must attend the attempt to introduce a new animal able to compete in useful qualities with those which, as is the case with all our limited number of domestic animals, have gradually acquired the peculiarities making them valuable to man, by the accumulation of slight improvements through countless generations of ancestors. While all our pressing wants are so well supplied by the animals we already possess, it can no longer pay to begin again at the beginning with a new species. This appears to be the solution of the singular fact, scarcely sufficiently appreciated, that no addition of any practical importance has been made to our stock of truly domestic animals since the commencement of the historic period of man's life upon the earth.

I now turn to the history of one of the most important features of the Society, the scientific meetings. In the early days of the Society there was only one class of general meetings for business of all kinds; and the exhibition of specimens and the communication of notices on subjects of zoological interest formed part of the ordinary proceedings at those meetings. The great extent, however, of the general business was soon found to interfere with such an arrangement. The number of the elections and of the recommendations of candidates, the reports on the progress of the Society in its several establishments during each month, and other business, were found to require so much time as to leave little for scientific communications, and the Council saw with regret that these were frequently and necessarily postponed to matters of more pressing but less permanent interest. To obviate this inconvenience and to afford opportunities for the reception and discussion of communications upon zoological subjects, the Council had recourse to the institution of a "Committee of Science and Correspondence," composed of such Members of the Society as had principally applied themselves to science; at the meetings of which communications upon zoological subjects might be received and discussed, and occasional selections made for the purpose of publication.

The first meeting of the Committee took place on the evening of Tuesday, November 9, 1830, at the Society's house in Bruton Street, when a communication was received upon the anatomy of the urang utan by a young, and then unknown, naturalist, Richard Owen by name, the first of that long series of memoirs, extending over a period of more than fifty years, the publication of which in our Transactions has done so much to advance the knowledge of comparative anatomy and to give an illustrious place to their author in the annals of science.

Among the names of others who are mentioned as having taken part in the business of the Committee during the first year of its existence, either by their actual presence or by forwarding communications, are N. A. Vigors, W. Yarrell, J. E. Gray, J. Gould, E. T. Bennett, Andrew Smith, T. Bell, W. Martin, Joshua Brookes, W. Kirby, W. H. Sykes, Marshall Hall, W. Ogilby, John Richardson, and B. H. Hodgson, who, I am happy to say, is with us at the meeting to day.

The Committee continued in existence for two years, having met for the last time on December 11, 1832. The success of its meetings was so great that it was thought desirable to make an alteration in the by-laws, by which the meetings of the Committee were replaced by the "General Meetings of the Society for Scientific Business." The first of these meetings took place on Tuesday, January 8, 1833, and they have continued to be held on two Tuesdays in each month during the season to the present time. As long as the Society retained its house in Bruton Street, the meetings were held there. In 1843 the Society took another house, which it occupied for forty-one years, No. 11 Hanover Square; but its needs having outgrown the accommodation afforded there, it removed in 1844 to the far more spacious and commodious premises, in No. 3 of the same square, which we at present occupy. These meetings of the Society, which are open to all the Fellows and to friends introduced by them, have exercised a considerable influence upon the progress of zoological knowledge, not only by the reading and discussing of communications formally brought before them, but also by the interchange of ideas at the informal social gatherings over the coffee-table in the library afterwards, which have great value as affording a common meeting-ground and bond of union for all the working zoologists of the country, as well as of many visitors from foreign lands.

The more important scientific communications to these meetings have from the commencement been published in the form of quarto Transactions and octavo Proceedings, which constitute a series of inestimable importance both for the value of the material contained in them and for the excellence of the illustrations of new or rare forms of animal life with which they are embellished. In later times they have also formed a vehicle for communicating to the world the important results obtained from the dissection of animals which have died at the Gardens, and which, since the establishment of the office of Prosector in 1865, have been systematically used for this purpose.

In connexion with the scientific meetings must be mentioned the Library, the first formation of which is described in the Report of the Council for the year 1837, and which has been steadily growing ever since by donations of books, by exchange of publications with other learned Societies, and by judicious annual expenditure of money, to be one of the best-selected, well-arranged, and most accessible collections of works reference that it is possible for the zoological student to enjoy. value has been greatly increased by the publication within past month of an excellent Catalogue, which contains the ti of about 6560 publications.

The most recent addition to the functions that the Society undertaken with a view to carry out the purposes of its founda tion is the publication of an Annual Record of Zoological Literature, containing a summary of the work done by British and foreign naturalists in the various branches of zoology in each year, a publication of the utmost value to the working zoologist. Such a Record has been carried on for some years past by a voluntary association of naturalists, but, owing to the difficulties met with in obtaining sufficient support, it was in danger of being abandoned, until the Council, after the full consideration which the importance of the subject deserved, resolved to take it in hand as part of the operations of the Society.

The Society has, however, not only been mindful of advancing scientific knowledge—it has also endeavoured to spread some of this knowledge in a popular manner by means of lectures. In former years these were only given in an occasional manner; but the liberal bequest of Mr. Alfred Davis to the Society in 1870 has enabled the Council to undertake a more regular and systematic method of instruction; and the Fellows and others have had every summer for several years past the opportunity of hearing many of our most eminent naturalists and able expositors upon subjects which they have made especially their own. I must, however, confess that the interest taken by the Society generally in these lectures has not quite equalled the expectations that were raised when the question of establishing them was first brought before the notice of the Council.

Although, as will be seen by a consideration of the various subjects which I have already referred to, the Society has a wide sphere of operations and many methods by which the objects of its founders are carried out, it is undoubtedly the maintenance of the menagerie of living animals in the Gardens where we are now assembled, by which it is most known both to the public as well as to a large number of our Fellows. It will be well, therefore, before concluding, to add a few words upon some points of interest connected with the past history and present condition of this branch of the Society's operations, the one which is at the same time the largest source of its revenue and cause of its expenditure.

The collection and exhibition of rare and little-known living animals has long been a subject of interest and instruction in civilized communities, and in many countries either the State or the Sovereign has considered it as part of their duty or privilege to maintain a more or less perfect establishment of the kind.

Before the Zoological Society was formed, the "lions" at the Tower had been for centuries a national institution; and it may be interesting to those who derive pleasure in tracing the links between the present and the past, to be reminded that our collection is in some measure a lineal continuation of that time-honoured institution, as it appears from the Reports of the Council that in the year 1831 His Majesty King William the Fourth "was graciously pleased to present to the Society all the animals belonging to the Crown lately maintained at the Tower." It is also recorded that in the previous year His Majesty had made a munificent donation of the whole of the animals belonging to the Royal Menagerie kept in Windsor Park. This may perhaps be the place to mention that, in the Report read April 1837, the Council "had the gratification to call the special attention of the members to a donation from Her

Royal Highness the Princess Victoria," consisting of a pair of those pretty and interesting little animals the Stanley Musk-deer. During the fifty years that have elapsed since this first-recorded mark of interest in the Society on the part of her present Majesty, the Queen and her family have never failed to show their regard for its welfare whenever any opportunity has arisen, of which the acceptance of the Presidency by the late Prince Consort, on the death of the Earl of Derby in 1851, was one of the most signal instances. The advantages which the Society has received from the numerous donations to the Menagerie, and the constant kindly interest shown in its general progress by H.R.H. the Prince of Wales, are so continually before the observation of the Fellows, that I need scarcely do more than allude to them here, beyond stating that in no year of the Society's existence has the number of visitors to the Gardens, or the Society's income, been so great as in 1876, when a large collection of animals brought from India by His Royal Highness formed the special object of attraction.

Except for the collection, necessarily of limited extent, exhibited in the Tower, and a few others having their origin in mercial enterprise (as Mr. Crosse's menagerie at Exeter Change, and the various itinerant wild-beast shows), there were, before the foundation of the Society's Gardens, little means in the country of gaining knowledge of the strange forms of exotic animal life with which the world abounds. An extensive, well-arranged, and well-kept collection, where the circumstances of exhibition were more favourable than in the institutions just referred to, seemed then to fulfil a national need, as the rapidly acquired popularity of the Society already alluded to testifies. Indeed, when we consider the amount of enjoyment and instruction which has been afforded to the 24,572,405 visitors who are registered as having entered our Gardens from their first opening in 1828 to the end of last year, it is easy to realize what a loss the country would have sustained if they had not existed. There was a period, it is true, in which they fell rather low in popular favour, the record of 1847 showing both the smallest number of visitors and the lowest income of any year in the Society's existence. A new era of activity in the management of the Society's affairs was then happily inaugurated, which resulted in a prosperity which has continued ever since, with only slight fluctuations, arising from causes easy to be understood—a prosperity to which the scientific knowledge, zeal, and devotion to the affairs of the Society of our present Secretary, ably seconded in all matters of detail by the Resident Superintendent, have greatly contributed.

One of the greatest improvements which have been gradually effected in the Gardens in recent years is the erection of larger, more commodious, and more substantial buildings for the accommodation of the animals than those that existed before. A few examples will suffice to illustrate the successive steps that have been taken in this direction. The primary habitation of the lions and other large feline animals was the building on the north side of the canal, which many of us may remember as a Reptile-house, and which has been lately restored as a dwelling-place for the smaller Carnivora. The Council Reports of the period frequently speak of the bad accommodation it afforded to the inmates, the consequent injury to their health, and the disagreeable effects on visitors from the closeness of the atmosphere. In September 1843, the terrace, with its double row of cages beneath, was completed; and the Report of the following spring, speaking of this as "one of the most important works ever undertaken at the Gardens," congratulates the Society upon the fact that the anticipations of the increased health of this interesting portion of the collection, resulting from a free exposure to the external air, and total absence of artificial heat, have been fully realized. The effects of more air and greater exercise were indeed said to have become visible almost immediately. Animals which were emaciated and sickly before their removal became plump and sleek in a fortnight after, and the appetites of all were so materially increased that they began to kill and eat each other. This, however, led to an immediate increase in their allowance of food, since which time, it is stated, no further accidents of the kind have occurred. As this structure, looked upon at that period as so great an improvement upon its predecessors, still remains, though adapted for other inmates, we all have an opportunity of contrasting the size of its dens and the provision it affords generally for the health and comfort of the animals and the convenience of visitors, with those of the magnificent building which superseded it in 1876.

In the Report of the year 1840 it is stated that the only work of considerable magnitude undertaken since the last anniversary was the erection of the "New Monkey-house," and the Council speak with great satisfaction of the substantial nature of the structure and the superior accommodation which its internal arrangements are calculated to afford to its inmates.

Many of us may remember this building, which stood on the space now cleared in the centre of the Gardens. Twenty-four years after its erection, in their Report dated April 1864, we find the Council speaking of it as "what is at present perhaps the most defective portion of the Society's Garden establishment," and the erection of a second "New Monkey-house" was determined upon. This is the present light and comparatively airy and spacious building, the superiority of which over the old one in every respect is incontestable.

Up to the year 1848 the only attempt which had been made to familiarize the visitors with the structure and habits of animals of the class Reptilia was by the occasional display of a pair of pythons, which were kept closely covered in a box of limited dimensions in one of the smaller Carnivora-houses. In 1849 the building which had been rendered vacant by the removal of the lions to the new terrace was fitted up with cases with plate-glass fronts on a plan entirely novel in this country, and which for many years afforded an instructive exhibition of the forms, colours, and movements of many species of serpents, lizards, and crocodiles. This house was a vast improvement upon anything of the kind ever seen before; but the contrast between it and the present handsome and spacious building so recently erected in the south-eastern corner of the grounds affords another illustration of the great progress we are making.

If time allowed I might also refer to the Elephant-house, completed in 1870, to the Insect-house, opened in 1881, and to various others of less importance.

The erection of these houses has necessarily been a very costly undertaking; in fact, since what may be called the reconstruction of the permanent buildings of the Gardens, which commenced in the year 1860, more than £50,000 has been expended upon them. It is only in years of great prosperity, when the Society's income has considerably exceeded its necessarily large permanent expenditure, that works such as these can be undertaken.

Much as has been done in this direction, we must all admit that there is still more required. The buildings of to-day will, we may even hope, some day seem to our successors what the former ones appear to us. The old idea of keeping animals in small cramped cages and dens, inherited from the Tower and the travelling wild-beast shows, still lingers in many places. We have a responsibility to our captive animals, brought from their native wilds, to minister to our pleasure and instruction, beyond that of merely supplying them with food and shelter. The more their comfort can be studied, the roomier their place of captivity, the more they are surrounded by conditions reproducing those of their native haunts, the happier they will be, and the more enjoyment and instruction we shall obtain when looking at them. Many of our newest improvements are markedly in this direction. I may especially mention the new inclosure for wild sheep near the Lion-house in the South Garden, with its picturesque rock-work and fall of water, and the large aviary for herons and similar birds just completed on what used to be called the Water-Fowls' Lawn.

All such improvements can, however, only be carried out by the continued aid of the public, either by becoming permanently attached to the Society as Fellows or by visiting the Gardens. I trust that this brief record of the principal events of the Society's history will show that such support is not undeserved by those who have had the management of its affairs.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—In the Natural Sciences Tripos, Part I., the following women students were placed in the first class: E. E. Field, A. J. Flavell, and M. M. Smith, all of Newnham College.

In Part II. the following men were placed in the first class in alphabetical order, the subject for which they were so placed being named:—Adie, Trinity, and Couldridge, Emmanuel (Chemistry); Durham, Christ's, and Edgeworth, Caius (Physiology);

Lake, St. John's (Geology); Melsome, Queens' (Physiology); Rendle, St. John's (Botany); Turpin, St. John's (Chemistry). No women were placed in the first class.

Mr. Lake, of St. John's, whose name appears in the above list, has been elected to the first Harkness Scholarship for Geology and Palæontology.

Dr. William Hunter, M.D., F.R.S.Edin., has been elected the first John Lucas Walker Student in Pathology.

The degree of Doctor in Science has been conferred on Mr. James Ward, of Trinity College, and Prof. F. O. Bower, of Trinity College and Glasgow University.

In consideration of this year being the two hundredth anniversary of the publication of Newton's "Principia," the Chancellor's Medal is to be given for an English poem on Isaac Newton.

The botanical teachers in the University have made a pressing appeal for the erection of a class-room for practical microscopical botany.

The Examiners for the Mathematical Tripos, Part II., have issued the following class list:—

Class I. Division 1: C. W. C. Barlow, and Bryan, Peterhouse; Dixon, Trinity; Fletcher, St. John's; Platts, Trinity. Division 2: Coates, Queens'; F. W. Hill, St. John's. Division 3: Clark, Pembroke; H. G. Dawson, Christ's.

Class II. Division 1: Askwith, Trinity. Division 2: Johnston, Peterhouse; McAulay, Caius; Nicolls, Peterhouse. Division 3: Tate, St. John's.

Class III. Division 1: Dickinson, Trinity.

The appointment of a Demonstrator of Pathology has been approved.

The proposals regarding the teaching of geography and the appointment of a University Lecturer in Geography have been confirmed.

The modified proposals to build new plant-houses in the Botanic Garden have been approved. A small research laboratory is to be built in connexion with them.

At the annual election at St. John's College, on June 18, the following awards in Natural Science and Mathematics were made:—

Foundation Scholarships:—Science: Rendle, £50; d'Albuquerque, £60; Groom, £50—Mathematics: Norris, £40; Varley, £50; H. H. Harris, £50; Rudd, £40. Scholarships prolonged or increased in value:—Science: Rolleston, £80; Shore, £60; Seward, £40; Harris, W., £50; Lake, £80—Mathematics: Fletcher, £80; Hill, £60; Tate, £40; Orr, £80; Sampson, £80; Baker, £100; Flux, £100.

Exhibitions:—Science: Grabham, d'Albuquerque, Baily, Hankin, Shaw—Mathematics: Orr, Sampson, Carlisle, Millard, Cooke, Humphries, Shawcross, Palmer. Proper Sizarships:—Science: Kellett—Mathematics: Box, Brown, Lawrenson; Shawcross, Palmer. Hughes Prizes:—Science: Lake; Mathematics: Baker and Flux, equal. Wright Prizes:—Science: Turpin, d'Albuquerque; Mathematics: Orr, Cooke. Hockin Prize (for Physics, and in particular Electricity): Turpin. Herschel Prize (for Astronomy): Flux. Hutchinson Studentship (for Sanskrit): Strong.

Among the distinguished persons upon whom honorary degrees were conferred on June 20 was Prof. Asa Gray, Professor of Natural History and Keeper of the University Herbarium and Botanical Library, Harvard University, author of the "Elements of Botany" (1836), the "Botanical Text-Book" (1842, ed. 6, 1880), "Darwiniana" (1876), "Flora of North America" (1878), &c., &c. We append the text of the speech delivered by the Public Orator, Dr. Sandys, in presenting him for the degree:—

Iuvat tandem pervenire ad historiae naturalis professorem Harvardianum, botanicorum transmarinorum facile principem. Annorum quinquaginta intra spatium de scientia sua pulcherrima quot libros, eruditione quam ampla, genere scribendi quam admirabili composuit. Quotiens oceanum transiit ut Europae herbaria diligentius perscrutaretur, virosque in sua provincia primarios melius cognosceret. In aliorum laboribus examinandis, recensendis, nonnunquam leviter corrigendis, iudicem quam perspicacem, quam candidum, quam urbanum sese praebuit. Quanta alacritate olim inter populares suos occidentales Darwini nostri solem orientem primus omnium salutavit, arbitratus idem doctrinam illam de formarum variarum origine causam aliquam primam postulare, et fidei de numine quodam, quod omnia creaverit gubernetque, esse consentaneum. Viro tanto utinam contingat ut opus illud ingens quod Americae Borealis Florae accuratius describendae olim dedicavit, ad exitum felicem aliquando perducat. Illum interim, qui scientiam tam pulchram suis laboribus, sua vita, tam diu illustravit, usque canam ad senectutem, ut poeta noster ait, 'vitae innocentis candidum florem gerens,'—illum, inquam, his saltem laudis flosculis, hac saltem honoris corolla, libenter coronamus.

Plurimos in annos Academiae coronam illustriorem reddat Florae sacerdos venerabilis, Asa Gray.

SCIENTIFIC SERIALS.

The *Journal of Botany* for May contains the following articles:—Angolan Scitamineæ, by Mr. H. N. Ridley.—Forms and allies of *Ranunculus Flammula*, by Mr. Chas. Bailey.—Notes on British Characeæ for 1886, by Messrs. H. and Groves.—The progress of botany in Japan, by Mr. F. Dickins.—Conclusion of the Rev. Mr. Purchas's list of pl for South Derbyshire.

In the number for June Mr. E. M. Holmes describes figures two species of seaweed new to Britain, *Ectocarpus si* and *E. insignis*.—There are also papers on Queensland fe by Baron von Müller and Mr. J. G. Baker; on the gen *Potamogeton*, by Mr. A. Fryer; on plants of Northern Scotland, by Mr. F. J. Hanbury and Rev. E. S. Marshall; on Chinese ferns, by Mr. J. G. Baker; and on Australian species of *Potamogeton*, by Mr. A. Bennett.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 16.—"Abstract of Investigations upon Rabies." By G. F. Dowdeswell.

The first experiments made by inoculations with the saliva of rabid street dogs, during the outbreak of the disease in 1885, all failed to produce infection, thus confirming the reputed uncertainty of the result of the bite of a rabid animal.

Subsequently, adopting the methods recently described by M. Pasteur, it was found:—

(1) That the virus of rabies in the lower animals and of hydrophobia in man resides in the cerebro-spinal substance and in the peripheral nerves, and is not confined to the salivary secretion, as previously believed, nor is even as constantly present or as actively virulent in it as it is in the nervous tissues.

(2) That inoculation of a portion of the nervous tissue from a rabid animal upon the brain of another by trephining produces infective rabies or lyssa, much more certainly, and with a far shorter incubation period, than by subcutaneous inoculation of the same substance; but that the disease is identically the same in both cases.

(3) That the virulence of "street rabies" is usually increased and ultimately becomes remarkably constant by passing through a series of rabbits, in which animals the symptoms are somewhat different from those in others, and which are generally regarded as typical, being essentially paralytic, but that paresis to some extent is always present in this disease in dogs and others of the lower animals, and that there is no constant distinction between the so-termed "dumb" and "furious" rabies in the latter animal, the difference consisting in the preponderance of the paralytic or other symptoms.

(4) That the tissues of an infected animal do not themselv usually become infective till towards the close of the incubation period.

(5) That of a large number of drugs that were tried, both germicides and those which act specifically upon the cerebro-spinal system, including those most esteemed for the treatment of rabies and hydrophobia, none have any material effect in modifying the result of infection in the rabbit.

(6) Lastly, that with respect to the methods of protection against infection by a series of inoculations with modified virus, as advocated and practised by M. Pasteur, these are unsuccessful with the rabbit, and that his recent "rapid" or "intensive" method of inoculation is liable itself to produce infection; and that with the dog the natural refractoriness of this animal to infection with rabies by any method of inoculation, is so great, that it is exceedingly difficult to determine the effect of any remedial or prophylactic measures upon it; and that with man the statistics of the treatment must determine its effects.

Physical Society, June 11.—Mr. Shelford Bidwell, F.R.S., Vice-President, in the chair.—A number of Pulaj and other vacuum-tubes were exhibited by Dr. Warren De la Rue. The Pulaj tubes consisted of a phosphorescent lamp, and radiometers with phosphorescent vanes and mica disks painted with phosphorescent substances. The other tubes contained different phosphorescent minerals, such as magnesium carbonate, calcium silicate, and Iceland spar. When illumined by a large induction-coil, beautiful colour-effects were produced.—The following papers were then read:—Note on beams fixed at the ends, by Profs. Ayrton and Perry. This paper contains a simple method of solving problems relating to horizontal beams with vertical loads, and fixed at both ends. The curve of bending-moment for the given distribution of load is first plotted, supposing the beam "*supported*" at the ends, and the constant c, by which the ordinates of this curve exceed those of the true curve, is determined from the condition that the angle between the end tions must be nought. If M is the bending-moment at a ion, I the amount of inertia of the section about its neutral and E Young's modulus of elasticity for the material, then is the curvature of the beam at that section. If O O' is a t length of the beam, the angle between the originally parallel sections at O and O' is $\frac{M}{EI}$. O O'. Hence, if the beam be divided into a great number of parts, and the values of M and I determined at the middle of each, then

$$\Sigma \frac{M}{I} \cdot OO' = 0 \quad . \quad . \quad . \quad . \quad . \quad (1)$$

since E is supposed constant. But $M = m - c$, where m is the bending-moment at the same section, supposing the ends "supported";

$$\therefore \Sigma \frac{m - c}{I} = 0,$$

or,

$$\Sigma \frac{m}{I} = \Sigma \frac{c}{I},$$

$$\therefore c = \frac{\Sigma \frac{m}{I}}{\Sigma \frac{1}{I}} \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

The following rule results: Knowing m and I at every point, divide the beam into any number n of equal parts, find $\frac{m}{I}$ at the middle of each part, and take their sum; this gives the numerator of (2). Find $\frac{1}{I}$ at the middle of each part, their sum gives the denominator of (2). From this c is determined. Diminish all the ordinates of the m diagram by c, and we have the diagram of bending-moment for a beam fixed at both ends, with any assumed distribution of load and variation of cross-section. Particular cases are worked out in full. Numerous drawings made by students of Finsbury Technical College were exhibited, showing applications of the method to different distributions of loading.—Note on Messrs. Vaschy and Touanne's method of comparing mutual induction with capacity, by Prof. G. C. Foster. In November last the author described a method of comparing the mutual induction of two coils with the capacity of a condenser. Since then he has found that a very similar method was used by Messrs. Vaschy and Touanne in July 1886, and published in the *Electrician* the following month. The formulæ are identical, and the difference consists in interchanging the galvanometer and the variable resistance f. Messrs. Vaschy and Touanne's arrangement has the advantage that the resistance of the secondary coil need not be known. Prof. Foster's method had been used by one of his students (Mr. Draper) about two years ago, but priority in publication belongs to Messrs. Vaschy and Touanne.—Prof. Perry asked the meeting for suggestions to explain why a strip of steel twisted about its longitudinal axis at a red heat, and allowed to cool, tends to untwist when under tension, and for a formula to calculate the amount.—A note on magnetic resistance by Profs. Ayrton and Perry was postponed.

Geological Society, June 8.—Prof. J. W. Judd, F.R.S., President, in the chair.—The following communications were read:—A revision of the Echinoidea from the Australian Tertiaries, by Prof. P. Martin Duncan, F.R.S. After calling attention to a previous paper by himself published in the Society's Journal for 1877, and to additions to the fauna made by Prof. R. Tate and Prof. McCoy, the author proceeded to give notes on the characters, relations, and nomenclature of 29 species of Echinoidea. A few notes were added on the relations between this fauna and that now inhabiting the Australian seas, also on the connexions with the Tertiary Echinoidea of New Zealand, Sind, &c.—On the lower part of the Upper Cretaceous series in West Suffolk and Norfolk, by Mr. A. J. Jukes-Brown, and Mr. W. Hill. The district described in this paper is that of West Suffolk and Norfolk, and is one which has never been thoroughly examined; for no one has yet attempted to trace the beds and zonal divisions which are found at Cambridge through the tract of country which lies between Newmarket and Hunstanton. Until this was done the Hunstanton section could not be correlated definitely with that of the neighbourhood of Cambridge. It was the authors' endeavour to accomplish this, and the following is an outline of the results obtained by them. The paper was divided into six parts: (1) stratigraphical, (2) palæontological, (3) microscopical, (4) chemical analyses, (5) faults and alteration of strike, (6) summary and inferences. In the four first parts separate lines of argument were followed, and each led to the same set of conclusions. The chief interest of the paper probably centres in the gault, and its relations to the chalk marl and the red chalk. Quite recently the very existence of gault in Norfolk has been disputed, but the authors think the facts they adduce and the fossils they have found will decide that point. The gault at Stoke Ferry is about 60 feet thick, and in the outlier at Muzzle Farm *Ammonites interruptus* occurs plentifully in the form of clay-casts with the inner whorls phosphatized. At Roydon a boring was made which showed the gault to be about 20 feet thick, the lower part being a dark blue clay, above which were two bands of limestone inclosing a layer of red marl, and the upper 10 feet were soft gray marl; the limestones contained *Amm. rostratus*, *Amm. lautus*, *Inoceramus sulcatus*, and *Inoc. concentricus* (?), while the marls above contained *Belemnites minimus* in abundance. At Dersingham another boring was made which proved the gray marl (2 feet) to overlie hard yellow marl, passing down into red marl which rests on Carstone. The gray marl thins out northward, and as the red marl occupies the position of the red chalk, the authors believe them to be on the same horizon, an inference confirmed by the presence of gault *Ammonites* in the red chalk. Another point of importance is the increasingly calcareous nature of the gault as it is followed northward through Norfolk. This was regarded as evidence of passing away from the land supplying inorganic matter, and approaching what was then a deeper part of the sea; this inference is borne out by the microscopical evidence. As regards the chalk marl, it also becomes more calcareous: at Stoke it is still over 70 feet thick, and its base is a glauconitic marl which can be traced to Shouldham and Marham, but beyond this the base is a hard chalk or limestone, which is conspicuous near Grimston and Roydon, and passes, as the authors believe, into the so-called "sponge bed" at Hunstanton. The Totternhoe stone is traced through Norfolk, but is thin at Hunstanton (2 feet); its existence, however, enables the limits of the chalk marl to be defined, with the result that some 13 feet of the hard chalk at Hunstanton must be referred to that subdivision. The gray chalk also thins northward, and from 90 feet near Cambridge is reduced to about 30 at Hunstanton. The Belemnite-marls are traceable in Norfolk, but either thin out or are replaced by hard white chalk near Heacham. The Melbourn rock is continuous, and maintains similar characters throughout. The total diminution in the thickness of lower chalk is from 170 feet at Newmarket to 55 feet at Hunstanton, viz. 115 feet. An endeavour was made to estimate the amount and extent of gault removed by erosion from Arlesey and Stoke Ferry.—On some occurrences of Piedmontite-schist in Japan, by Mr. B. Kotô. Communicated by Mr. Frank Rutley.

Mathematical Society, June 9.—Sir James Cockle, F.R.S., President, in the chair.—The President announced that the Council had awarded the second De Morgan Medal to Prof. Sylvester, F.R.S.—The following communications were made:—Note on the linear covariants of a binary quintic, by A. Buchheim.—The motion of a sphere in a viscous liquid, by A. B. Basset (the method of solution was by definite integrals analogous to Fourier's solution of equations determining the propagation of heat).—On the reversion of series in connexion with reciprocants, by Capt. Macmahon, R.A.—Explanation of illustrations

THURSDAY, JUNE 30, 1887.

FORESTRY.

School of Forestry in Germany, with Addenda relating to a desiderated British National School of Forestry. By John Croumbie Brown, LL.D. (Edinburgh: Oliver and Boyd; London: Simpkin, Marshall, and Co., 1887.)

"SILVER and gold have I not; but what I have I am prepared to give." This is what the author tells us towards the end of the present volume, and there can be no doubt that he has fully acted up to his promise. He has now presented the public with what appears to be the fifteenth volume on subjects of forestry, and he offers to publish some thirty additional volumes if the necessary inducement is held out. Surely Dr. Brown must be extremely philanthropic, or else the publishing of books is considerably cheaper than we have so far believed it to be. These works, published and unpublished, deal with forest subjects in almost every known country of the earth, and we wonder how Dr. Brown has managed to collect all the information. The above-mentioned offer seems to have been made in succession to a variety of bodies, but none of them have availed themselves of it, and the world at large must, for the present, be satisfied with the information contained in the fifteen volumes which have so far passed through the press. That, however, extends over a considerable range, including information regarding forests and schools of forestry in Germany, France, Spain, Norway, Russia, and the Cape; on modern forest economy; the effects of forests on humidity of climate; hydrology of South Africa, &c., &c. Now, it appears to us either that Dr. Brown's works are deficient in interest, or that his countrymen are very ungrateful in not availing themselves of his handsome offer. If we follow the dictates of common-sense, we must, it seems, decide in favour of the former alternative.

We hear occasionally of a Parliamentary Committee which considers "whether, by the establishment of a forest school, or otherwise, our woodlands could be rendered more remunerative"; or a feeble effort is made to start a National British Forest School in Edinburgh; or a languishing controversy turns up, whether the junior officers of the Indian Forest Department should be educated in France, Germany, or at home. But on the whole these matters do not excite much curiosity or interest. Parliamentary Committees on the subject die away without making any proposals beyond suggesting the re-appointment of a similar Committee in the next Parliament, which event may come to pass if members have no bigger game to hunt; Edinburgh is still without its forest school, and a forestry branch has actually been added to the Royal Indian Engineering College at Cooper's Hill, for the education of Indian forest officers, without many people being aware of the fact. The explanation of all this indifference is that even the perseverance of Dr. Brown has not yet succeeded in convincing Englishmen of the importance of afforestation. The mere fact that it is of importance in various Continental countries and in several British dependencies is not sufficient to show that the same holds good in these islands, and it will be as well to say something more on this subject.

Forests are, in the economy of Nature and of man, of direct and indirect value: the former through their products, and the latter through their influence upon climate, the regulation of the water-supply, the healthiness of a country, and allied phenomena. These islands are rich in iron ore, coal, and peat, wherewith to produce more iron than is required by the country, and to render the question of firewood of very subordinate importance. What is more, they are so situated that the importation of wood and other forest-produce is comparatively easy and cheap, owing to their sea-bound position, and a multitude of railways and other means of communication scattered over the country. At any rate, we have received, so far, as much timber as we require, and at a lower rate than it has been possible to produce it at home. Whether this state of things will last for ever is a different question; but it rests with us to initiate measures in our dependencies (such as Canada) which will secure us against a timber famine as long as the British Navy rules the sea. After all, the whole question turns on this point, and the decline of the British Navy would raise other issues of such immense importance, that the question of the future timber-supply of this country may well be added without producing a nightmare in even the most imaginative mind.

Again, in respect of the indirect effects of forests, Englishmen may rest assured that the absence of woodlands will not ruin their country. The climate and rainfall of these islands are principally governed by their geographical position. Strong moist air-currents come to us direct from the sea, and, compared with their effects, those of forests, even if 20 per cent. of the total area of the United Kingdom were covered with them, would be found comparatively small. Nor need we cry for forests on account of the general regulation of moisture; because, thanks to an ample rainfall and a comparatively moist state of the atmosphere, our waste lands are generally covered with heath, mosses, and other growth, which act as powerful retainers of moisture. To add a crop of trees to these would make comparatively little difference, especially as afforestation would, in many cases, have to be accompanied by the draining of the soil.

In some respects, however, an increase of our woodlands might be highly beneficial. They would afford protection not only to cattle and birds (the latter being the great destroyers of noxious insects), but also to agricultural lands which are at present exposed to strong sea breezes. A judicious distribution of woodlands along the coasts (especially the western) of these islands would no doubt be followed by beneficial results in this respect. Again, our waste lands (occupying upwards of 40,000 square miles, equal to 34 per cent of the total area), might be made more remunerative than they are at present, and their afforestation would provide a very considerable amount of work, not only by the creation and subsequent management and working of the forests, but also by the springing up of a variety of industries dependent on the existence and sustained yield of woodlands. We take this opportunity to recommend the subject to the careful attention of those who are about to legislate once more on

the Irish land question. Experience has shown that the climate of a considerable portion of Ireland (especially in the coast districts) is not sufficiently favourable to produce crops which will permanently support the cultivator and yield large rents to the owners of the soil. In such cases the afforestation of surplus lands (that is to say, lands not required for agricultural operations) might prove a useful auxiliary in the solution of the Irish land question, by providing additional work which would enable the small cultivator to earn a day's wages whenever his presence was not required on his holding. Instead of sitting idle during a good portion of the winter, he could appreciably augment his income (and capacity to pay rent), without being obliged to leave his home in search of distant work

However, we must return to Dr. Brown. Our author has in the book under notice placed before the few who may be interested in the question, a fair account of how forest schools are arranged in Germany, the country where forest science has attained its highest development. The arrangement of studies at the several schools is given in considerable detail, and the book shows the high standard of education of German forest officers. Some of the schools are independent institutions situated in or near extensive forests, while others form part of Universities or technical Colleges. In the former case the education takes generally a more practical turn, while under the latter arrangement a higher standard of general education is likely to be secured. Dr. Brown is in favour of attaching the desired British forest school to a University or other similar educational establishment. In our opinion the decision on this point should depend on the class of men whom it is desired to educate. The ordinary foresters required by British landowners for the management of their woodlands are men who could not be enrolled as members of a University College; and their education must be of a more simple description, with a strong practical tendency. But men who are to join the general administration of India should attain a high standard of education, and a forest school for their benefit might well be attached to a University or to a high-class College. Unless such men are fit to take their proper place amongst the rest of the governing staff of the country, they will not be able to do justice to the work which will be intrusted to them on their arrival in India.

Both wants cannot be met by one set of men. The employment of men who have merely had a practical training might be disastrous to the Indian forests. On the other hand, British landowners would decline to receive men who, in consequence of a College education, would be above the ordinary work of a British forester, not to mention the fact that such men would expect higher rates of pay than the owners of woodlands would be willing to give them. In short, the course of studies to be followed by each of these two classes of men must be arranged on different lines. In either case, however, a tract of well-managed woodlands should be situated close to the seat of the school. To do without such a training-ground would be equivalent to training medical men without a hospital ready at hand. On this point we are decidedly at issue with Dr. Brown, who, in declaring such a school-forest unnecessary, has, in our opinion, only proved that he has failed to grasp the essential requirements of a forester's training. At the same time, the reader of Dr. Brown's books cannot help wondering at the marvellous industry employed by the venerable author in the compilation of his various works on Continental forest schools. Such energy and devotion are deserving of a better reward than they are likely to meet with, owing to the apathy on forest questions existing in this country. Sw.

OBSERVATIONS AT GODTHAAB.

Observations Internationales Polaires, 1882-83. "Expédition Danoise: Observations faites a Godthaab sous la direction de Adam Paulsen." (Copenhague, 1886)

THIS part of the publications of the Meteorologi Institute of Denmark deals with the meteorologi tidal, and other observations made in 1882-83 by Danish Arctic Expedition at Godthaab (64° 11′ N. l 51° 44′ W. long.). The pages devoted to meteorolog present us with detailed tabular views of the hourly observations of atmospheric pressure, temperature, and humidity, and the direction and velocity of the wind These are prefaced by an interesting and full discussion of the atmospheric pressure (illustrated with 186 pressure and wind charts of Greenland), which includes a valuable comparison of the observations of that year with those at all the stations since 1866.

In summer the mean lowest temperature, 38°·2, occurs at 2 a.m. and the highest, 43°·1, at 2 p.m., the daily range being thus 4°·9. On the other hand, the mean daily range of temperature is extremely small in winter, owing to the proximity of Godthaab to the Arctic circle. Thus the highest and lowest hourly temperatures were respectively in December, 19°·5 at 10 a.m. and 18°·0 at 10 p.m.; in January, 15°·1 at 5 p.m. and 14°·1 at 1 a.m.: and in February 4°·4 at 6 p.m. and 3°·7 at 3 p.m. Thus in February the mean warmest and coldest hour of the day show a difference of only 0°·7, and are only three hours apart from each other. Quite different is the amount of the daily range of temperature deduced from the maxima and minima of the month; in February the mean of all the highest was 9°·0 and of the lowest 0°·3, the difference being 8°·7. In these months the changes of temperature are but little influenced by the sun, being almost altogether occasioned by the passage of the cyclones and anticyclones. It is this practical elimination of the influence of the sun which gives a peculiar value to the temperature and hygrometric observations of such stations when any serious attempt is made to assign to these important elements the parts they play in the history of storms. The mean annual temperature calculated from the twenty-four hourly observations is only about one-tenth of a degree lower than that from the daily maxima and minima. In all the months the agreement is close, the greatest difference being 0°·5 in February and August; and in seven of the months the difference did not exceed 0°·1.

The results giving the variations in the hourly velocity of the wind are interesting as showing that such diurnal variation as may exist will require a number of years' observations to show it clearly, this periodicity being masked in an unusual degree by the high winds which accompany the low-pressure systems of Greenland.

With eighteen years' observations (1866-83) at Ivigtut, Godthaab, and Jacobshavn, and nine years' (1875-83) at Upernivik, we can now present, with an approximate correctness not hitherto attainable, the distribution of pressure over Greenland during the months of the year. The following mean pressures, at 32° and sea-level, give the highest and lowest, with the months of their occurrence:—

	Highest. Inches.		Lowest. Inches.		Year. Inches.
Ivigtut	29·827	in May.	29·398	in January.	29·666
Godthaab ...	·847	,,	·445	,,	·684
Jacobshavn..	·898	,,	·565	,,	·749
Upernivik ...	·981	in April.	·603	,,	·753

Thus in Greenland pressure increases with latitude. The difference between the extreme south and north is in January 0·205 inch, and in spring 0·154 inch; but the difference in summer is small, being in July only 0·008 inch. The above mean of January at Ivigtut 29·398 inches, and for the same month at Stykkisholm in the north-west of Iceland 29·396 inches, are, so far as known, the lowest mean monthly pressures anywhere yet observed in the northern hemisphere; and it is interesting to note that it is in the region immediately to the south and south-west of these places that a very large number of our European storms have their origin.

Attention is forcibly drawn by the 186 charts of pressure and wind to the remarkable fact that the depression areas of Greenland appear to travel from north to south. An extension of the area charted would doubtless show that while in many cases these areas travel northwards yet in a considerable number of cases this direction is more apparent than real. It is, however, abundantly evident that Greenland exerts an important influence on our Atlantic storms that remains still to be investigated.

The most elaborate part of the paper is the discussion of the diurnal curves of pressure from the hourly observations. The curve for the year exhibits the two usual maxima at 8 a.m. and 8 p.m., and the two minima at 2 a.m. and 1 p.m., the morning minimum and the evening maximum being respectively the greater, and these features of the curves are, with one exception, reproduced in the curves for the months. The results will be made to tell their story more clearly if we eliminate the more prominent irregularities attaching to means of one year only, by bloxaming the hourly means, by taking for the hourly means of each month means calculated from that month, the month immediately preceding, and that immediately following it. In these new mean hourly values the morning greatly exceeds the evening maximum in February, March, and April, whereas in every other month the reverse holds good, and that in a very pronounced degree. On the other hand, the morning greatly exceeds the afternoon minimum in each month of the year. From the relations the results show to those for places in similar situations in lower latitudes, we may conclude that unusual care has been taken in securing for the barometer a position where it was subject to only a very small daily change of temperature. It is absolutely necessary that this condition should be attended to, if observations are to be of any use at all in the discussion of the important question of the horary variations of pressure in high latitudes. Since the variations dealt with seldom exceed 0·010 inch, and are generally much less, it is evident that the inquiry is for these regions a refined one; hence it is essential that the attached thermometer should represent the temperature of the whole instrument to within 1° F. It is the neglect of this point that vitiates several series of horary barometric observations in the Arctic regions.

Over the open sea in high latitudes during the summer months, where the sun either does not set, or only for a brief interval, the diurnal curve of pressure differs essentially from the above. The observations made by the *Challenger* Expedition in the Antarctic Ocean, and those made by the Norwegian Expedition in the north of the Atlantic, show only one maximum and one minimum in the day, the maximum occurring during the day and the minimum during the night. This peculiar curve is restricted to the open sea of high latitudes. Director Paulsen is inclined to the opinion that the diurnal variation of pressure at Godthaab is caused not so much by local variations of temperature and humidity as by transmissions from lower latitudes of their diurnal variations of pressure. In this opinion we to some extent concur, it being probable that some of the more prominent features of these daily curves of pressure are the results of vast quasi-tidal movements communicated through the higher regions of the atmosphere, in which the space traversed by the individual aërial molecules is not necessarily great.

OUR BOOK SHELF.

Essays and Addresses. By the Rev. James M. Wilson, M.A. (London: Macmillan and Co., 1887.)

In these "Essays and Addresses" Mr. Wilson deals chiefly with problems connected with religion and morality, and his main object seems to be to show that theological and ethical principles, properly interpreted, are supported, instead of being contradicted, by scientific ideas. The book is evidently the result of much independent reflection. Mr. Wilson tries to grapple with no intellectual difficulty which he has not thoroughly examined, and in all his statements of scientific doctrine he is scrupulously exact. He refers to science in so many aspects that much of what he has to say may be studied with interest even by readers who do not feel that his arguments with regard to such subjects as "Miracles" and "Christian Evidences" are perfectly conclusive.

Introductory Text-book of Physical Geography. By the late David Page, LL.D., F.G.S. Twelfth Edition. (Edinburgh and London: W. Blackwood and Sons, 1887.)

This book was originally published about twenty-five years ago, and has done good service in many schools and colleges. After the author's death it was brought up to date by Dr. Charles Lapworth, who, besides making a number of minor corrections and additions, contributed a summary of those results of the *Challenger* Expedition which had reference to the depths, deposits, and temperature of the ocean; an account of British storms; a description of the biological regions of the earth; and a short sketch of Prof. Huxley's arrangement of the human family. In the present edition Dr. Lapworth has again sought to bring the work abreast of scientific knowledge, introducing new matter relating to geology and petrography, meteorology and climatology, and the distribution of animals and plants. On the latter subject he has obtained from Prof. D'Arcy Thompson an excellent summary of recent biological research and theory. The

value of the book has also been increased by the insertion of several new maps illustrative of the astronomical and meteorological sections.

Longman's New Geographical Reader. Standard VII. (London: Longmans, Green, and Co., 1887.)

THIS "Reader" contains lessons on the ocean, currents, tides, the planetary system, and phases of the moon. The subjects are of more scientific interest than those treated in most books on geography, and are arranged in a progressive and readable form.

The book is divided into sixty lessons, each being followed by a list of some of the words contained in it, with their meanings.

In the chapters on the ocean the subjects are well selected, and the various depths and currents are illustrated by maps. In the lesson on the tides the differential action of the sun and moon on the water of the earth should have been mentioned. The diagram illustrating neap tides has one bad point, the sun being shown as shining on a part of the moon which is turned away from it.

In the diagram on page 231, which represents the sun as seen in full daylight from the surface of the moon, the sun is shown with its corona. The fact of the sun being seen from the moon, which has no atmosphere, would not make the corona visible, but would only tend to intensify the light of the sun and the corona proportionally. It is a pity that this illustration should have been put in without any explanation whatever.

The chapters on the inhabitants of the sea and methods of catching them are very interesting; also the voyages to the Arctic and Antarctic regions. An appendix is added which contains a summary of the whole book.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

The New Degrees at Cambridge.

THE letter of "Outis" in yesterday's number of NATURE (p. 175) is likely, I fear, to convey a false impression as to the new degrees of Doctor of Science and Doctor of Letters, which, by the way, were instituted, for good or for evil, by the Commissioners, and not by any "dominant body in the University." It is true that Doctors in the new faculty take precedence after Doctors in Medicine just as Doctors in Medicine take precedence after Doctors in Law, and Doctors in Law after Doctors in Divinity, but this distinction is only of importance when a procession has to be marshalled; to all intents and purposes the academic rank of all Doctors is the same.

If it be true, as I believe it is, that the standard for admission to the regular degree of Doctor in Science is only "rather less than that required for admission to the Royal Society," and that the standard for Doctor in Letters is much the same, it follows that the standard for such degrees is much higher than that for any other Doctorate in the University, while that for Doctor in Law is notoriously the lowest of all.

Since the new degrees were instituted the Council has usually offered the new degrees to those persons selected as recipients of honorary degrees whose claims were essentially scientific or literary, while it has continued to give the honorary LL.D. to persons whose distinction was of a less academic kind. This may have been wise or unwise, but the Council had certainly no idea that in what they were doing they were offering to men of science an honour of a lower grade than that to which they had been accustomed. It is true that, fearing perhaps that the less familiar title might at first be not so well understood outside the University, they began by offering to the recipients the choice of the degree of LL.D. or of Litt.D. or Sc.D., as the case might be; but I believe that in all cases those who had the choice preferred the literary or scientific degree.

No doubt these degrees, like that of LL.D., have been and will continue to be given to men of very different degrees of eminence. It is not every year that the University has the opportunity of enrolling among its honorary graduates a man like Asa Gray; but I think that, even if he is excluded, the roll of our honorary Doctors in Science and Letters need not fear comparison with that of the honorary Doctors in Law who have received their degrees within the same period.

Cambridge, June 24. C. T.

Weight, Mass, and Force.

THE position taken up by "P.G.T." and some others in the discussion on the proper use of the words "weight" and "mass" is similar to that assumed by an astronomer coming forward to tell us that we have been calling the stars by their wrong names.

The following extract from an American technical journal is submitted to the consideration of "P. G. T.," Mr. Hayward, and Mr. Alfred Lodge, in order that they should point out for our benefit where they consider the dynamical language is erroneous, and that they should translate it into the terminology necessary in their opinion to make it correct by using the mathematical terminology of poundals, dynes, moms, poundems, &c.

"DESCRIPTION OF THE STRONG LOCOMOTIVE."

American Journal of Railway Appliances, March 15, 1887.

"The weight of the engine in working order is 137,000 lbs., of which 90,000 are on the drivers, 27,000 on the front truck, 20,000 on the back truck. The weight of the tender loaded is 75,000 lbs. The boiler carries 160 lbs. of steam, which pressure is easily maintained when the engine is pulling the heaviest and fastest trains over the 96-feet grades across the mountains.

"The engine having 20-inch by 24-inch cylinders, and 62-inch drivers, the traction force is, according to the well-known formula, $20^2 \times 24 \div 62 = 154{\cdot}8$ lbs. for each lb. of mean effective pressure in the pistons. The resistance of modern rolling-stock as deduced from the most recent experiments both in this country and in Europe is from 12 lbs. per ton of train including engine and tender at speeds of 30 miles an hour to 15 lbs. at 50 miles an hour, above which point the resistance increases in a much greater ratio.

"Let us suppose then that the engine is hauling a train at 30 miles an hour on the level, cutting off at 10 inches of the stroke. From indicator cards taken from the engine under these conditions we find that a mean effective pressure of 100 lbs. is maintained in the cylinders. The traction force exerted will thus be $154{\cdot}8 \times 100 = 15480$ lbs.; and taking the resistance at 12 lbs. per ton, we find the maximum load the engine can pull is $15480 \div 12 = 1290$ tons, and subtracting from this the weight of the engine and tender there remains a weight for the train $1290 - 106 = 1184$ tons, or the equivalent of no less than 59 20-ton cars.

"Now suppose the engine is running up a grade of 96 feet to the mile (1 in 55) at the same speed and cutting off at the same point as before. The resistance to gravity on a 96-feet grade is $2240 \div 55 = 41$ lbs. per ton, and this added to the 12 lbs. resistance on the level gives $41 + 12 = 53$ lbs. per ton for the train going up the grade. Under these conditions the load hauled would be $15480 \div 53 = 292$ tons; or, subtracting the engine and tender, $292 - 106 = 186$ tons, the equivalent of $9\frac{1}{2}$ 20-ton cars.

"Turning now to the question of adhesion, we find that taking the coefficient of adhesion at one-fifth, we have a weight of 18000 lbs., one-fifth the weight on the drivers, as against the 15480 lbs. of traction. We need hardly say that the average coefficient of adhesion is usually higher, one-fourth being generally taken in calculations relating to the performance of locomotives. Under this condition the weight available for adhesion would be 22222 lbs., or one-fourth the weight on the drivers, and the mean effective pressure in the cylinders would have to amount to $22222 \div 154{\cdot}8 = 143{\cdot}6$ lbs. per square inch before the wheels would begin to slip or the use of sand become necessary. At the speed of 30 miles an hour and 100·M.E.P. (mean effective pressure) this engine would exert about 1240 H.P.," &c.

This account is written by someone to whom the dynamical problem is a reality and no theoretical abstraction: he employs throughout the gravitation measure of force, and to an engineer there is no ambiguity in his use of the words pound and ton sometimes in the sense of mass or weight and sometimes in the sense of force.

Prof. A. B. W. Kennedy, in his "Mechanics of Machinery," pp. vii. and 222, has called attention to the same ambiguity of language, and points out that the word pound is used in two senses (three senses when pound-sterling is to be distinguished), which he proposes to distinguish as weight-pound and force-pound; not, observe, mass-pound and weight-pound as the mathematician would have us call them.

An article in the current number of *Wiedemann's Annalen*, No. 6, 1887, by A. Oberbeck, "Ueber die Bezeichnung der absoluten Maass-systeme," shows that a similar controversy on dynamical terminology is now going on in Germany.

The mathematical definition that "the weight of a body is the force with which the earth attracts the body" must disappear and be replaced by "the attraction of the earth on a pound, a ton, or a kilogramme, is called the force of a pound, a ton, or a kilogramme;" these are gravitational units of force, derived originally from astronomical considerations, but used in practice for dynamical problems also; but inasmuch as the magnitude of these units depends on the local value of g, they are unsuitable for astronomical or electrical purposes, and are now replaced in such cases by the absolute units of force, the poundals, dynes, &c.

The defect of modern dynamical teaching is the unreality of its applications; it is too much the "dynamics of a particle." Were the student accustomed to examples taken from the magnificent problems presented by the latest industrial developments, he would become accustomed to the use of gravitational and absolute units of force, and recognize their respective advantages.

A. G. GREENHILL.

Woolwich, May 30.

Upper Cloud Movements in the Equatorial Regions of the Atlantic.

RECENT communications to your paper have given the motion of the upper clouds from the eastward in the equatorial regions of the Atlantic. My observations (the result of having passed through these regions sixteen times in sailing-ships) give the motion of the upper clouds from the westward; and the motion of the intermediate cloud layers, consisting of the high low-level stratiform clouds (cirro-cumulus and such like), from a point somewhat to the north of east on the north side of the equator. Intermediate clouds are rare in the equatorial regions south of the Line. The high low-level clouds are constantly being confounded with the true high clouds.

There is another source of error in noting upper cloud movements; little attention has been paid to a movement of propagation. So marked is this at times, that they are propagated over the sky quicker than they are moving, this movement being frequently at right angles to the direction of motion.

DAVID WILSON-BARKER.

The Shadow of Adam's Peak.

THE shadow of Adam's Peak, to which Mr. Abbay refers in his letter to NATURE, vol. xxxvi. p. 152, is certainly not the kind of shadow that I witnessed, but that which is only seen in the clearest weather and without the intervention of mist. This is mentioned in one of the last paragraphs of my paper.

Nevertheless, I cannot think that mirage has anything to do with that shadow. When the Observatory was first established on Pike's Peak, the observers used to see the shadow of the mountain rising against the sky on the far distant horizon. At first they thought this very curious, but soon found that the appearance was always there in very fine weather.

Further observation showed conclusively that the appearance was simply the ordinary earth shadow of sunrise projected so clearly against the sky, that an irregularity such as a sharp peak could be distinguished on the edge of the generally circular shadow.

I do not think that mirage has anything to do with this anti-crepuscular shadow, but no doubt there are abundant thermometric observations in America for anyone who wishes to investigate the subject further.

RALPH ABERCROMBY.

21 Chapel Street, London, June 17

Temperature and Pressure.

I HAVE to thank Mr. S. A. Hill for replying to my letter, and it is most interesting to know that the same connexion between temperature and pressure exists in India as in Jamaica (NATURE, vol. xxxv. pp. 437, 606).

No doubt, as Mr. Hill observes, different localities will have different values of the coefficients λ and μ in the equation—

$$\delta T = \lambda \delta P + \mu (\delta P)^2;$$

indeed, we must expect very different values; but still, by putting $\delta P = 0$ in the equation for *minimum* temperatures, each locality should give the same limiting temperature, which we may regard as the temperature of space.

It is of course to such concordance that we must look for the determination of the temperature of space, so defined, rather than to extreme care in the taking of observations in any one particular part of the world.

With reference to Mr. Hill's remarks about extrapolation, it is hardly necessary for me to point out that astronomical refraction is caused by the whole terrestrial atmosphere, and that some law between temperature and pressure must be adopted before refraction-tables can be constructed; Mr. W. H. M. Christie, the Astronomer-Royal, has, in the Memoirs R.A.S., vol. xlv. p. 177, recently pointed out how errors may arise from this source.

Indeed, errors must arise from this source. In Jamaica the values of λ and μ are not the same for mean and minimum temperatures, or, roughly speaking, for day and night; neither is it to be expected that they will be the same anywhere else. But enough has been said to indicate the importance of the problem, and the steps which should be taken for its solution.

Jamaica, June 6. MAXWELL HALL.

British Association Sectional Procedure.

IN reference to Prof. Thompson's letter (June 16, p. 151), will you allow me to say that in 1884 I went from the meeting of the Association of American Microscopists at Rochester, N.Y., to that of the British Association at Montreal. At the former the proceedings commenced daily at 9 a.m., closing about noon, and another short session was held in the afternoon. The middle of the day was thus left at liberty for Committee work, sight-seeing, or rest, and the greater amount of work got through in the day as compared with the usual plan at our Association was very striking.

ALFRED W. BENNETT.

6 Park Village East, Regent's Park, June 18.

Mirage.

THIS afternoon, shortly after 4.30 p.m., my attention was drawn to an extraordinary and wonderfully perfect "mirage." My house, situated almost on the extreme point of Hartlepool, near the Heugh Lighthouse, overlooks with a south aspect the Hartlepool or Tees Bay, Redcar, Saltburn, and in clear weather a beautiful high coast-line stretching from Saltburn to Staithes. When first seen, all the houses of Redcar, some seven miles distant, and lying almost at sea-level, were enormously elongated to at least six or seven times their ordinary height, and looked like high square towers with intensified colouring. I could not however determine (with the aid of an opera glass) whether the phenomenon was a simple elongation or whether the upper part of the "mirage" was an inverted image of the houses. I am inclined to think that the lower two-thirds was an elongation of the buildings, while the upper third was an inverted image.

During the height of the mirage a dark misty stratum of air, bounded by a distinct upper margin parallel with the horizon, and decreasing in density towards it, stretched from the western end of Redcar through an arc of almost 90° seawards. I estimated the height of this stratum at 35′ to 36′ of arc. After some 10 minutes the "mirage" gradually dwindled over Redcar, but remained distinctly visible for a short time longer over Saltburn, the coast-line, and out to sea. At Saltburn, about 11¼ miles distant, some of the buildings were duplicated, a white house being visible as two spots widely separated. The normal coast-line south of Saltburn was obscured by the haze, but a beautifully clear "mirage" of it was visible, taking as its horizon the upper margin of the misty air stratum, the horizon being thus bodily raised through some 36′ of arc. Out at sea in an almost easterly direction a smoking steamer was faintly visible with an inverted

image, masthead touching masthead, and a small schooner under sail, some 8 or 10 miles away, exhibited an inverted image of its topsails. In the direction of Saltburn a tug-boat (paddle steamer) steaming within perhaps 2 miles of the coast was quite normal in appearance. The smoke rising from it drifting eastward appeared normal for a short time, but suddenly expanded on rising to about ten times its thickness, and then tailed off again at its topmost eastward corner to the normal thickness. A large steamship lying about half-way across the bay showed no signs of being affected by the "mirage."

These phenomena disappeared in about 20 minutes, and were followed by a haze which obscured the distance.

The weather had been very hot and sultry all day, with about 70° in the shade, and a gentle south-east by east breeze, and a perfectly clear sky.

Estimating the height of the Redcar houses at 50 feet and the distance at 7 miles, they would occupy 5′ of arc; and taking the thickness of the air stratum producing the "mirage" at 35′ of arc, the elongation of the buildings would be seven times their ordinary height.

Though I have been informed that "mirages" were visible on the previous hot days, the phenomenon is on the whole of rare occurrence here, and has never been witnessed by myself before.

CHAS. O. TRECHMANN.

Hartlepool, June 18.

P.S.—My point of view would be about 20 feet above sea-level.

A Suggestion for Anthropologists.

So far as the undersigned has seen, all reviewers of the "Précis d'Anthropologie," lately issued by Profs. Hovelacque and Hervé, of Paris, have noted with no little interest the attitude of the work towards the problem of the origin of man. Rejecting on the one hand the doctrine of the monogenesis of the human family in the way of a purely natural evolution out of lower forms of life, and on the other hand discrediting the polygenesis of men by special creation in different centres of distribution, these eminent anthropologists present, as the probable truth, a compromise hypothesis, which they call *transformisme polygénique*. According to this view, men were evolved from the lower animals, but in more than one original centre, and from more than one original pair. A French reviewer has well intimated the significance of this new teaching by observing that it marks a distinct schism in the ranks of the Darwinistic anthropologists, and inaugurates debates and investigations from which most important new light may be expected.

In this connexion it has occurred to me that if I were an anthropologist, and especially one of Darwinian principles, I should be exceedingly eager to institute investigations looking to the establishment or overthrow of a still different conception of the matter—one not yet studied with anything like the thoroughness which it deserves. I might call the hypothesis to which I allude the hypothesis of *transformisme bighnique*. Being neither its inventor nor a believer in it, I can the more freely call the attention of believers in transformism to its decided richness of promise. Indeed, if there is any middle ground of truth between the anthropology of Darwin and the anthropology of Agassiz, it can nowhere so hopefully be sought as precisely here. The hypothesis to which I refer is that according to which the human family consists of the descendants of two primitive human races—the one white and originating at the North Pole, the other dark and originating at the South Pole.

The only work in which I have ever found this view suggested is one published in Sweden about the year 1842, and two years later in an English translation, in London, under the following title: "The Theogony of the Hindus; with their Systems of Philosophy and Cosmogony. An Essay, by Count M. Björnstjerna." I may be allowed to add that all I have published respecting the north polar origin of the race was already in its third edition before I had seen, or had any knowledge of, this work.

For the further satisfaction of those readers to whom the work may not be easily accessible, it may be stated that the idea is by no means elaborated and formally presented as a scientific solution of the problem of the origin of man. On the contrary, it is so transient and incidental a suggestion on the part of the Count that the substance of all he says is found in two sentences on page 177 of the English translation, as follows:—"As, according to the nature of the thing [*i.e.* owing to the secular cooling of the earth], both the polar regions must have been prepared equally early for the reception of mankind, it is possible that the appearance of man took place at the same time in both regions; perhaps the white race in the countries about the North Pole, and the black race in those about the South Pole. A number of difficult problems might hence be solved." How singular it would be if this passing remark of a Swedish Count, writing upon the mythology of the Hindus, and more than a generation ago, should prove to be the watchword of the most advanced school of scientific anthropologists at the opening of the twentieth century.

WILLIAM F. WARREN.

Bad Gastein, Austria, June 20.

Snow in Central Germany.

IN a note in NATURE of May 12, p. 42, it was stated th[at] the quantity of snow which fell in Central Germany fr[om] December 19 to 23, between 50° and 52°·5 N. latitude, a[nd] between 7° and 18° E. longitude, weighed no less than 10,000,[000] tons. I think there is a mistake in the calculation. Suppos[ing] that the snow was equivalent only to a stratum of wate[r] 5 centimetres in height, its weight would be not 10,000,000, b[ut] 10,000,000,000 tons.

OTTO KNOPF.

Berlin, June 21.

Meteor.

AT about 7.45 p.m. on June 19 a brilliant meteor was seen in broad daylight from this place. At a rough estimate it followed the meridian of Antares for about 30°, and disappeared near the meridian of that star.

H. KING.

Chithurst, Petersfield.

Medicine in McGill University.

IN a criticism of my "Outlines of Lectures on Physiology" which appeared in NATURE for May 12, you say:—"Pathology, or the application of physiology to disease, is hardly touched upon in this book. It is a most unfortunate omission unless both pathology and therapeutics are taught more systematically than with us." About three years ago "Institutes of Medicine" (then including physiology proper, histology, and pathology) was divided, and now these departments are each taught separately, and each is provided with its own laboratory. A systematic course of lectures and demonstrations in pathology is given, with instruction and practice in making autopsies (after Virchow). Therapeutics is taught from the physiological point of view, and also has its own laboratory. So that it only becomes necessary to make such reference to pathology, &c., in the lectures on physiology as suffices to indicate that the subject does bear on the study of disease, and thus interest the student in it from its bearing on his life-work.

It may be interesting to English readers to learn that very recently two of Montreal's citizens have given one million dollars to erect and endow a "Royal Victoria Hospital" in commemoration of the Queen's Jubilee. This hospital is to be located close to McGill University.

I make these statements simply in justice to the Medical Faculty.

T. WESLEY MILLS.

Physiological Laboratory, McGill University,
Montreal, May 28.

The University of Tokio.

IN vol. xxxv. of NATURE, p. 401, it was stated that the recent amalgamation of the Engineering College and the University of Tokio occasioned the "total elimination of Europeans from the teaching staff, their place being taken by Japanese." Justice to the new University requires the correction of this statement, which is not only misleading, but erroneous. It is true that two well-known foreign Professors vacated their posts—one immediately after the amalgamation, and the other within six months thereafter. Their place, however (for they taught the same subject), is soon to be filled by an engineer who is expected shortly from England. But giving full allowance to this temporary vacancy, any person who will take the trouble to compare the number of foreign Professors in the two establishments before the incorporation with the number

after will find that "the total elimination" amounts to "one." Since the publication of the Calendar, again, no fewer than six have been added to the list of European Professors in the University.

S. SEKIYA.

Imperial University, Tokio, April 22.

SCIENCE FOR ARTISTS.

ON many former occasions, furnished by the opening of the Royal Academy, the Grosvenor, and other exhibitions of pictures, we have made some remarks upon them from a specially scientific point of view, endeavouring in this way to note if any progress has been made in the treatment of natural phenomena by artists. This has also sometimes been accompanied by minute criticisms of certain pictures in which such phenomena have been admirably portrayed, or, on the other hand, travestied. Our remarks naturally have referred more to landscapes than to the other classes of pictures exhibited, first, because we have to deal chiefly with physical phenomena, and secondly, because, in representing the human form, artists have now for many years received such complete instruction that there is little chance of any gross error being committed. Why we think it worth while to write these articles at all is that, so far as we can find out, in no scheme of art instruction does the study of natural phenomena find any place, and one of our objects is to show that such instruction ought to be given to artists side by side with their anatomical work, in order to prevent them from making grotesque blunders which destroy all the artistic beauty of a picture, however well painted, in the eyes of the initiated. It happens very curiously that the various scientific points which are raised by the pictures exhibited vary from year to year. This alone would indicate the many points of contact between science and art, beyond those which we usually recognize. This year we think the questions raised by the pictures exhibited in the Royal Academy to which we now confine ourselves, for it really comes to that, are smaller in number than they have been for some time past, and are more restricted in scope. This arises, we believe, in a great measure from the very distinct improvement in the landscape pictures generally. The air has more atmosphere about it, the skies and clouds are truer in colour and form, the play of light upon water, the forms of waves, and many such points as these, to which reference might be made, have received better and more careful treatment. The most wonderful play of colour in Nature is brought before us at sunrise and sunset, and the only wonder is that artists do not pay more attention to the magnificent pictorial effects which are provided by these natural displays. This wonder, however, no doubt is greatly reduced when we come to consider the enormous difficulty of the problem. In the first place, there is no book, as far as we know, containing any statement in regard to sunset colours which will help an artist who wishes to paint them. Again, the play of colour in cloud and sky, in the objects illuminated by the fading and coloured light, varies incessantly; while, perhaps worst of all, the artist himself has to choose his colours from a palette which is illuminated by a light the colours of which are constantly changing as the sun gets lower and lower. In spite, however, of these enormous difficulties, artists have succeeded in producing sunset pictures of great beauty, nor are they absent in the present Academy Exhibition. No. 52, "Sunset after a Shower," is a case in point. Sunsets are not always so exactly alike as the painter of that picture paints them, as if pictures represented the different states of an etching, but the picture in question has many beauties about it, and, as all good pictures should do, it raises a question. In it we are supposed to be looking very nearly towards the place of sunset, and the sunset is a distinctly coloured one, as is evident by the colours on the clouds, and the very carefully painted zone of the sky getting warmer and warmer as the horizon is approached. The light in fact is so warm that the blue has disappeared from it, and almost the green. Under these circumstances there is no green light, or very little of it, to be reflected from the leaves and trees, which are not green in themselves of course, but only have the capacity of reflecting green light. We venture to think, then, that the trees in this picture are too green, and certainly greener than they would be ever likely to appear when they were backed by a sunset sky. In No. 682, by the same artist, the greenery of the trees would have been more in place, because in that picture the sunset colours are much less warm, albeit they are beautifully true to Nature, being caused by a different meteorological condition. We do not see in this year's Academy any distinct attempt to give us that glorious contrast one sometimes sees at sunset between brilliantly illuminated clouds, running through all the composite colours which are possible between red and yellow, backed by a "daffodil sky," as Tennyson calls it, or even one approaching an olive green. The nearest approach to such a green sky as this last we find in No. 990, which the artist funnily styles "Beneath Blue Skies." Surely the sky in this picture is green, and not blue.

On a former occasion, some years ago now, we ventured to put together a few notes regarding the hints that artists might glean, if they chose, in two or three hours' reading from any elementary books on astronomy about the moon. We are sorry to say that the moons in this year's Academy show that such advice still holds good, for in most cases the moons are wofully wrong. Funnily enough, there is a difference between the moons now and the moons of ten years ago. They were then far too large, now as a rule they err in an opposite direction. It may perhaps be imagined that the artist has no available means of drawing the moon to anything like the correct scale. This really is not so. If the artist has made up his mind that his picture shall contain, say, some 60° in the horizontal scale, so that six such pictures would enable him to give a complete panorama of the landscape around him from the place he has chosen to paint from, we have—provided the 60° are properly estimated—a perfect method of drawing the moon to scale, for the reason that as the diameter of the moon is about half a degree, so the diameter shown should be 1/120 of the length of the picture. We are inclined to believe that a moon of this size would really look rather too small, although, of course, it would be scientifically correct, for the reason that we have been fed upon large moons in pictures all our lives, and it is a part of our artistic education at the present moment to expect to see a large moon on canvas, and there is something uncanny about a small one, even if it is perfectly correctly painted. This artistic treatment of the moon will of course lose all its objectionable characters as the years roll by, and we shall not expect to see one thing in a picture and another thing, which the picture is supposed to represent, in the heavens.

In pictures 118 and 231 the moons would have been truer to nature if they had been slightly larger; but the worst of it is that this is not the only defect about them. Thus, dealing with 118, it is obvious that the sun is setting to the right of the picture; the moon, therefore, cannot have been full. If the artist thought he was drawing a gibbous moon, then he should have shown the imperfect edge of it away from the sun, and not below it as he has done. The fault in No. 231 is that the warm tone of the picture generally, indicates that we are somewhere about the hour of sunset; the sun has evidently not yet set, the luminosity of the picture shows that. Now we cannot get a full moon as high as the artist has represented his until after the sun has set, for a very simple reason which is known to everybody. We should like also to suggest to another

artist that when he gets his picture, No. 137, back from the Academy, he should carefully take out the moon, because its presence shows that the sun is not setting, and if the sun is not setting, then the colours on the clouds are false; without the moon the picture would be entirely satisfactory to a keen observer of natural phenomena, assuming the sunset hour to be approaching, for the colours of the clouds are most beautiful. There can be no doubt, we think, that the study of cloud-forms is now not so neglected as it used to be. Some of the forms of clouds in many of the pictures this year indicate a very close attention given to them and to their floating changes by the artists; witness Nos. 459, 945, and 28.

The forms of water, too, and the illuminations of a water surface, are admirably represented in many pictures this year. The tracery of the water surface could scarcely be more exquisitely shown than in No. 118, the picture we have already referred to as possessing a most unfortunate moon. The little roller stretching nearly across 630 seems absolutely approaching us, while the view of the opening sea with the solitary sail in No. 659 positively makes one feel as if one were on a Cunarder, revelling in the fresh free air.

Although we have pointed out much that we hold to be very excellent in the way of sky and sea colour, we cannot help thinking that the chalkiness is on the increase: we never remember to have seen before so many seas and skies resembling chalk and water. This is an effect really very rarely observed in the sky, and not often in the sea, excepting close in shore, and in the absorptive properties of water we have a very good reason why it should not be so. Let the reader look at 223, 254, 274, 353, and 419.

There is no help for it, we must say a few words about rainbows. Why should an artist who has never seen a rainbow, or, if he has seen one, been so careless as not to take the trouble to look at it or to observe the order of its colours, why, we say, should he take the trouble to paint it? why does he not leave it alone? As most people know, the colours in the rainbow are regulated by a definite law—that is to say, the order of colours is the same. If we have red on one side of the bow, then we have to pass through orange, yellow, green, and blue, till we reach the violet on the other side. But in the two rainbows portrayed this year in the Academy, this order is not at all followed. One of the artists preferred to put the green between the yellow and the red, and the other thinks he has found a more excellent way. The result is that these gentlemen present us, under the guise of a rainbow, with a phenomenon which no mortal has ever seen or ever will see.

It is a matter, we should have thought, of general knowledge that a rainbow is caused by the action of raindrops upon the light which impinges upon them. In the annexed woodcut, we may imagine the beam S I a sunbeam entering a drop of water, a section of which is shown, A I I'. The beam is refracted on its entrance into the drop at I, is reflected at A, and is again refracted on emerging from the drop at I'. The light which originally entered the drop in the direction S I leaves it in the direction I' M, and the eye, to see the raindrop, must be along the line I' M. The observer, therefore, must obviously have his back to the sun, and the bow will appear to be at some distance above the horizon. If the sunlight could not be broken up into various colours by refraction, the bow would not appear coloured; but as refraction, which has two chances of working, does break up white light into its constituent colours, the emerging beam I' M is coloured, and the order of colours must necessarily be the same as that which is observed by means of an ordinary prism or lustre. We begin with the warmest colours, the reds and oranges, outside the bow, the inside of the bow being formed of the cooler colours, blue and violet. This rainbow, which is the one observed under ordinary conditions, is formed by means of the rays of light falling on the outer portions of the drops, and is called the primary bow; as we see, the light suffers two refractions and one reflection in the drop.

There is another rainbow seen, when the conditions are entirely favourable, outside the former or primary one. This is called the secondary bow; it depends for its existence upon the light which falls nearer the front surface of the drop, a condition of things shown in the next woodcut, in which S I represents the light which is refracted at I, reflected internally at A, reflected internally

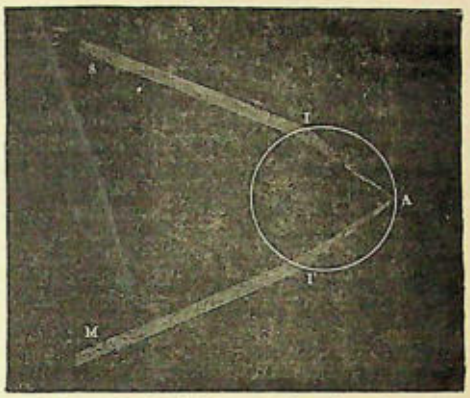


FIG. 1.—Path of light in producing primary bow.

again at B, and refracted at I', and sent along the path I M to the eye. The eye, which receives it therefore in the line I' M, receives it after two refractions and two internal reflections.

In this secondary bow the order of colours is reversed. We get the warm colours, the reds and the yellows, inside, and the blue and violet outside, so that when the primary and secondary bows are both seen, the two reds are together, and the two blues as far apart as they can be.

When we talk of the spectrum colours in the rainbow, it must be always understood that the appearance is not that assumed by an absolutely pure spectrum, for the reason

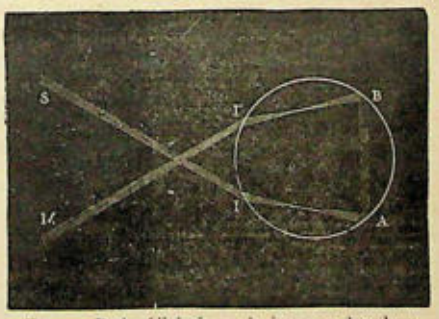


FIG. 2.—Path of light in producing secondary bow.

that the sun, the light of which is in question, has a disk of visible magnitude, and that the ray of light coming from each point of the sun is competent to produce a rainbow. Hence the rainbow is a very composite thing, and really consists of millions of spectra overlapping. The more the overlapping is intensified, the more the pure colours disappear, and hence it is that the rainbows seen when the sun is behind a cloud are very often seen without any trace of colour. The more the light proceeds from a large surface, the dimmer and less clear will the rainbow become, until at last it fades into invisibility.

An artist in painting a rainbow, then, has to consider

that the colours can never be absolutely pure, and that their order is absolutely invariable; and the first thing that one must expect in a picture painted by an artist of intelligence is that this order shall not be interrupted or travestied.

In 624 a very interesting question of perspective is raised. If we imagine a room with an atmosphere very thickly laden with dust, and imagine further this room to be illuminated by a window with an ordinary window-sash: if the sun shines into the room, the sashes will cast their shadows on to the dust-laden air. As the sun is 93,000,000 of miles away, or thereabouts, the shadows of all the horizontal sashes and of all the vertical sashes will be parallel. If on the other hand, instead of letting the sun throw shadows of the sashes in this way, we imagine a strong light not far away from the window to do it, the shadows of the two series of sashes will be no longer parallel, they will diverge, and the nearer the light is to the window the more they will diverge. It is of course quite understood that in the room itself the parallel shadows cast by the sun could not appear to be truly parallel, for the reason that one part of the shadow must be nearer the eye than the other, but we cannot help thinking that the difference between this condition and the one which holds when the source of light is close to us, has not been sufficiently taken into account by the artist, so that a sun 93 yards off instead of 93,000,000 of miles would have been very much more likely to produce the effect shown in the picture.

A REVIEW OF LIGHTHOUSE WORK AND ECONOMY IN THE UNITED KINGDOM DURING THE PAST FIFTY YEARS.[1]

III.

THE growth of improvement in lighthouse towers, lanterns, and apparatus has been glanced at. The source of light, or lamps and their aliment, must now be considered. It is probable that the *phari* of antiquity were open wood fires of great size on the summit of high towers or headlands. "*Ignes*" and "*flammis*" are terms used by Pliny and others, and Statius compares the *pharos* to the moon, not to a star as a modern poet would rather do. Yet Lucan speaks of "*lampada*," and Pliny fears that the flames might be mistaken for a constellation. But in these times oil could hardly have been used, as no form of lamp known could be applied with success. For 2000 years the illuminant was mainly wood or coal. The Cordouan, in 1610, was kindled with oak logs. Coal fires were burnt at Harwich in the end of the eighteenth century. The Lizard was a coal fire in 1812. St. Bees ceased to be one only in 1822. The Isle of May remained a coal light for 181 years. It is now the single specimen of the electric light in Scotland. Sperm oil was not used before 1730, and then but on a small scale until the burners of Argand in 1783 and the reflectors of Teulère in the same year changed the character of lighthouse illumination. The Eddystone in 1759 threw its first beams over the waters from ten pounds of tallow candles, for which, in 1811, wax was substituted.

But in 1837 sperm oil was the general aliment for our catoptric lights. In that year the oxy-oil lamp was proposed by Mr. Gurney. The principle of this light, known as the Bude, was a stream of oxygen injected into an oil flame, and it has since been tried with gas flames. It was followed by the Drummond lime-light, and by ignited platinum wire and various pyrotechnic mixtures. The Bude and Drummond lights were tried by the Trinity House without successful result. In 1845 a Parliamentary inquiry on oils led to the choice of rape-seed as a substitute for spermaceti, and in 1860 vegetable oil was being used everywhere, with perhaps a little gas for small lights. The single lamp of the dioptric system was then in England and Ireland the "fountain," and in Scotland the mechanical or clockwork lamp, as used in France, both having four concentric wicks. It was with this lamp that Fresnel established his first light at the Tour de Cordouan in 1822. So far as can be ascertained, the electric spark was first practically suggested for a light-house in 1852 or 1853 (Holmes), or in 1854 (Watson), as will be later referred to. In 1860, Prof. G. B. Airy wrote to the Royal Commissioners on Lights:—"At present the great excellence of a lighthouse is, or may be, the optician's part. The great defect and waste is in the source of light." Coal gas had been introduced in 1837 at the inner pier light of Troon (Ayrshire), and in 1847 it was used in the Hartlepool Heugh dioptric sea-light. From 1865 to 1867, gas was proposed for lighthouses in Ireland, but not officially adopted. In the same period, mineral oil, which had become familiar to English people in domestic lighting, and had been used in French light-houses in lamps of a single wick and apparatus not larger than the fourth order, was much discussed as a suitable illuminant for sea-lights. After a long course of official experiment and inquiry, the unreserved use of mineral oil was authorized for lighthouses on land, and the Flamborough Head was the first Trinity light to receive the new illuminant (1872). One name is here worthy of distinction. Capt. H. H. Doty may justly be regarded as the chief demonstrator of the "promise and potency" of mineral oil. He also constructed a burner with multiple wicks which produced steady and brilliant flames. This burner is not, however, novel in its elements or combinations, and other petroleum burners of equal and superior merit have since been introduced. It is not on the Doty burner itself that his reputation is best founded, but on his strenuous and intelligent advocacy of mineral oil, and on his practical application of it to a multiple burner. It is gratifying to know that his services have been for this reason recognized by grants of money from the Governments of England and France.

Since 1872 the use of petroleum has been more and more extended, and it is now a trusted and perfectly safe illuminant. Until recently the variety known as "Young's lighthouse oil" was exclusively adopted by the Trinity House, its flashing-point being not lower than 142°, its specific gravity 0·81. Later varieties of it have a flashing-point of 154°. This fluid does not rise to the level of the top of the burner, but is confined to a certain distance below, whence the cotton wicks are charged with it by capillarity, and it is the vapour or gas that is ignited. The absence of overflow leaves the tips of the burner dry and unrefreshed, and therefore subject more or less to rapid deterioration. But in the heavy mineral oil lately recommended by the Trinity House, the specific gravity is between 0·828 and 0·832 (at 60° F.), and the flashing-point is not lower than 250°. This oil, therefore, may probably be allowed to overflow the burner like colza. There is also a very useful variety, under the name of "mineral sperm," which was first introduced by the writer into harbour and ships' signal lights. The flashing-point has reached 270°.

The saving of expense in using mineral oil in a light-house may be understood thus. A six-wick burner of the best Trinity type consumes, when at full power, 79·4 fluid ounces, or half a gallon hourly. In a year of about 4000 hours this would cost perhaps £70. Vegetable oil in the same quantity would cost perhaps £250. There would be no appreciable difference in intensity of light, but much in favour of mineral oil in the facility of service and in the smaller consumption of wicks. *Pari passu* with the adoption of this illuminant has been the improvement in the pressure and pump lamps and their burners effected by the Trinity House and by Messrs.

[1] Continued from p. 181.

Chance. It is, above all, to Sir James Douglass that credit is due in this field. For at least eighteen years he has worked unweariedly, and in the interest of the public service alone, at the perfecting of the burners which bear his name, whether for colza, paraffin, or gas; and some striking developments have been attained by him. For instance, the typical four-wick vegetable-oil burner of Fresnel had an intensity of 230 candle-units, or 23·6 units per square inch of sectional area. The Trinity four-wick has an intensity of 415 candle-units, or 44·3 per square inch. The Trinity six-wick, perhaps the most serviceable and complete burner ever constructed, equals 730 candles, or 40·1 per square inch. The Trinity seven-wick equals 1100 candles, or 46·9 per square inch, and the Trinity nine-wick equals 1785 candles, or 49·8 per square inch. These burners are all for vegetable or mineral oil. The Trinity six-ring gas-burner equals 853 candles, or 44·4 per square inch; and, which appears to be the most powerful combination ever attained, the Trinity ten-ring gas-burner reaches 2619 candles, or 50·9 per square inch of sectional area. The admirable expanding gas-burners of Mr. Wigham are hardly less powerful. They are formed of concentric circles of jets from 28 to 108 in number, disposed so as to suit optical apparatus of several degrees of size, and weather of every degree of clearness. To this gentleman must be accorded the same pre-eminence in the skilful use of gas for lighthouses as to Capt. Doty for the skilful use of mineral oil. His ingenious combinations and contrivances, not only in regard to power, but to distinctiveness of character, are seen to great advantage in Galley Head and other notable Irish lights. It has been urged against gas flames of the largest dimensions on this system, that a portion of light escapes lenticular action, yet this very ex-focality has been found to have a useful side, for it tends to produce a glare or glow in the heavens, visible to mariners when the tower is beneath the horizon, and, in some circumstances, positively useful to them. (The electric light produces a similar effect, though in a different manner.) A more serious objection to large gas flames, especially when used in triform or quadriform series, appears to be the excessive heat, which is capable of injuring the delicate optical glass, and is hardly favourable to the keepers. It is probable that the hyper-radial apparatus just introduced may, both as relates to condensation of light and to mitigation of heat, be well suited to gas-burners of these striking magnitudes. Of the thirty-two dioptric sea-lights in Ireland, about one-fourth are successfully endowed with the gas-illuminant. Of the sixty-five in England, the Haisboro' is the only case. There is no gas in the fifty-one Scottish sea-lights, except Ailsa Craig, which has oil-gas. It should be added that the compressed mineral-oil gas of Messrs. Pintsch, and the petroleum spirit of Herr Lindberg, for the automatic lighting of buoys, have been, since 1878, tried in this country with great success.

The third illuminant, electricity, has been known in England for about thirty-five years. As generated in the magneto-machines of Prof. Holmes between 1853 and 1862, and as tried experimentally in the lighthouses of Dungeness and South Foreland, it was very small in dimension and very uncertain in character. Several forms of the light were suggested during this period, such as the voltaic arc of Watson and the mercurial electric lamp of Way. With the more effective alternating current machines, and with the larger carbons, of later years, the arc grew in power and dimension. At the present time carbons of from 25 to 40 millimetres are available, with an intensity in the focus of a light of ten times that of the most powerful gas or oil burner. The arc is thus become a most valuable resource, not merely for its unsurpassable power, but also for its focal adaptability to the usual dioptric apparatus, and to special optical combinations dictated by nautical circumstances. It is most flexible in its application. It radiates no harmful heat It has the high merit of not exacting any abnormal dimensions of apparatus, lantern, or tower. Lastly, being the most powerful in all its gradations relatively to other illuminants, it is the cheapest of all lights if the cost of establishment and maintenance be computed in terms of the units of the beam transmitted, which is the only strictly logical and practical way of treating it. For these reasons it has been chosen in France as the best illuminant for a large number of coast-lights, and it is making rapid way in Europe and America. It may therefore be safely asserted that the electric light, when it shall have been freed from its last disabilities, and shall have attained its utmost development, will, in the not distant future, be the prevailing illuminant of our own lighthouses and of the other chief lighthouses of the world.

In illustration of the power of the electric arc with suitable optical treatment, I may mention that the direct beams of the Tino light, near Spezia, were observed on April 20, 1885, by Prof. Noceti, from the hill S. Giorgio behind Savona, at an elevation of 2733 feet, and a distance of 73 statute miles, the atmosphere being clear and under moonlight. The beams of the arc were notably brighter than those of the *lanterna* at Genoa, at one-third of the distance. Frequent observations are reported of the Macquarie light in New South Wales, at ranges of 66, 65, and 70 nautical miles, by means of reflections on the sky while the light itself is below the horizon.

The relative merits of gas, oil, and electricity, were established in the prolonged official experiments at the South Foreland in 1884-85. It has been proved that there is no appreciable *qualitative* difference between mineral oil and coal-gas as light-giving agents; and that such differences as appeared were rather *quantitative*, arising from the number and dimensions of the burners, and the modes of their collocation or superposition. It has been proved also that the electric arc (in addition to its superiority in clear weather, which was never in question) has an absolute superiority in thick weather to both gas and oil—"the greatest penetrative power in fog." Much public controversy has been excited by the Report in which conclusions like these are embodied. The fairness and impartiality of persons concerned in the investigation have even been impugned, and objection has been taken to the manner in which the electric light was presented to the observers, and to the refusal of the Trinity House to accept certain maximum arrangements called "double-triform" and "double quadriform." But to anyone reading the Report of the Trinity House (1885) with no bias toward a particular interest or a pre-conceived theory, it must appear that the inquiry was as exhaustive as it was prolonged, and that it is impossible that such names as those connected with it—names eminent in science, in engineering, and in the nautical and official world—should be associated with any other desire than the desire to shed light on a vexed technical question, and to achieve honourably and thoroughly a great public work. With regard to the exclusion of maximum combinations from the Foreland programme, it was obviously sufficient to compare gas and oil in their respective primary burners, multiplied or combined in such a way as, while insuring equal terms or nearly so, to reproduce the actual or allowable conditions of a lighthouse; and nothing would seem to be gained by augmenting the rival elements *pari gradu* to ampler and ampler bulk regardless of all else. The inter-relation of the numbers one, two, three, is not affected, or very slightly so, by raising them to two, four, six, or to four, eight, twelve. And although the highest power of the initial flame or the emerging beam were reached according to the opinion of the moment, the next day might suggest a still higher power, until it became clear that we might as well revert to the old beacon-fire on the headland, for indeed with unlimited tar-barrels or profuse pine-logs a light *could* be kindled exceeding everything

yet achieved by gas, oil, or electricity, and visible not only on the horizon, but across half the midnight sky.

Phonic signals as auxiliary to luminous signals have engaged the attention of our lighthouse authorities from dates previous to 1837, and almost continuously from 1848 to 1875. The early instruments were the bell, the gun, and the gong, with sometimes an explosive such as a rocket. Between 1848 and 1850, Mr. G. Wells produced his patent "fog screamer" (by atmospheric pressure), which, however, did not meet the approval of the Trinity House, who, in 1853, considered that a good-sized bell struck sharply by machinery surpassed any mode yet tried. During the next ten years experiments on fog-signals were carried on in France, and in 1864 there was an important investigation by the Government of the United States. In 1872 a Committee of the Trinity House visited that country and Canada, and tested the merits of the new sound instruments in use, chiefly the Daboll horn actuated by air, and the siren actuated by steam. The Canadian and American steam-whistles and the New York siren, together with air-whistles, air-trumpets, and some guns, were next employed in the most complete scientific and practical inquiry ever held into the laws that regulate the passage of sound through the atmosphere, and into the mechanical agents most suitable to be adopted. The experiments were conducted by the Trinity House at the South Foreland in 1873-74, under the superintendence of Dr. Tyndall, who was able to demonstrate that fog or heavy rain is permeable by sound to a degree never before understood, and that optical transparency might be combined, even as cause and effect, with acoustical opacity or turbidity, and *vice versâ*. These results attracted much attention, and although Prof. Tyndall's inductions as to homogeneity or non-homogeneity of the atmosphere have been to some extent questioned, the large body of facts on which they rest has been still further enlarged and confirmed. It follows that a fog dense enough to quench all light may permit sound to be transmitted with unimpaired distinctness; and where the sound, either by alternations of pitch or of interval, is made a substitute for the characteristics of a light-signal, a very valuable secondary set of signals is realized. Of the instruments tried at the South Foreland the siren was found to be the most effective in almost all circumstances. This instrument was the work of Mr. Brown, of New York, to whom a simple and powerful form of caloric engine is also due. It consists of a trumpet about 17 feet long, increasing from 5 to 27 inches in diameter, having two disks in it, one fixed and one rotating, with radial slits in them. The rotation is from 2000 to 2500 times in a minute, steam at from 70 to 80 lbs. pressure being supplied. A note of varying pitch and intensity, audible at distances from 3 to 10 miles is thus generated. The siren in another form was improved by Dove and by Helmholtz, and previously by Cagniard de la Tour, who gave it this name, presumably on the *lucus a non lucendo* principle. It is now employed at many first-class land lighthouses where space exists for the needful steam or caloric motor. Truly for the help not the harm of the mariner, in the words of the poet, "*Siren assuetos effudit in æquore cantus.*" It is possible that the recent disaster off Dieppe might have been averted if the *Victoria*, moving doubtfully through the fog, could have heard the steam-trumpet on Cap d'Ailly, which seems to have been disabled at the critical time. Both the range of the siren and the facilities for working it have of late been enhanced by the methods of Mr. Charles Ingrey, who, by employing air compressed by engines of 40 horse-power, the air-pressure being 80 lbs. per square inch, has, in the case of the Ailsa Craig establishment, produced from two sirens a sound audible, it is said, at a distance of 20 miles in calm weather. One of these instruments gives single blasts of 5 seconds duration, the other a high, low, and high note in series, each of 2 seconds, with intervals of 2 seconds between them, followed by 170 seconds of silence. This is the phonic analogue of a single-flashing and of a group-flashing light respectively. The compressed air is conveyed from a considerable distance to the siren-house, and Mr. Ingrey is confident that he could work the instrument from an engine placed 10 miles away. After the South Foreland experiments of 1874, the Trinity House proceeded to improve the gun as a sound-signalling agent. It now ranks as second to the siren alone. Gun-cotton is proved to be a more effective charge than powder, and it has been supplied with the gun to a few lightships; but the siren is for principal stations, and the gong, or bell, or an explosive mixture, for others.

The details so far given, though necessarily incomplete, illustrate the notable progress in lighthouse design and construction attained in this country since the accession of our Queen, and not less do they show the increasing number of the lights established on our shores. Along with France and the United States—and due honour must be accorded to the eminent men representing them—Great Britain has proceeded steadily in the path of investigation and experiment. And here the labours of the celebrated Royal Commission of 1859-60 on lights, buoys, and beacons should not be overlooked. This Commission collected from all maritime countries and from the leading authorities in official life, in engineering and nautical science, in mathematics and physics, a vast body of evidence which to the careful student will not prove the *rudis indigestaque moles* it at first sight appears. Some of the recommendations of the Commission have been fully carried into effect during the last quarter of a century, *e.g.* the proper adjustment of optical agents to the flame and to the sea horizon, the development of lamps and burners, the provision of reflectors, testing of foci, &c. The conclusions also of the Commissioners on the complicated and anomalous system of lighthouse government formulated by the Merchant Shipping Act of 1854 have never been impugned; and the expediency of a central Lighthouse Board as suggested by them, and as indeed had been suggested by the Parliamentary Committee of 1834, has become more and more evident down to the present day.

But while Great Britain has, in common with France and the United States, pursued this path of inquiry and reform, she has distanced these countries altogether in the results of research and the realisation of improvement. The splendid gift of the dioptric system was made to the world by the genius of Fresnel, yet little has been added to it by his countrymen. The most solid and important additions and applications are the work of Scottish and English engineers, whether in the optics or the mechanics of lighthouses, whether in oil, gas, or electricity. And the gift of Fresnel has thus been returned enhanced threefold to France and to the world. How it has been received is apparent by this one indication: the yearly statistics of our Admiralty comprise forty lighthouse notices issued to mariners in 1862, and 311 issued in 1886, the subjects of these notices being mainly new lights, and the new lights being mainly on the most modern lenticular system.

NOTE.—Since the above was written the small circle of men associated with lighthouse illumination has been broken by the death of its most distinguished member, Thomas Stevenson, who, during the whole of the half century under review, did more than any other to multiply for engineers the resources of his science, and to diminish for all the world the manifold perils of the sea.

The extraordinary power of the electric light has been referred to in connexion with the apparatus of Isola del Tino. In a recent communication to the *Standard* from "C. P. S." from Via Reggio, further testimony is given to this power in clear weather, but a far more important and

controversial point is conclusively dealt with. The writer says:—"Again, though dimmed by heavy rain and thick fog, as it has been during the last few nights, the triple flash is always clear and unmistakable, and then produces, through the quasi-opaque atmosphere, and at a distance of thirty miles, the effect of the blurred disk of the moon on a small scale. This remarkable penetration power of the Tino light is conclusive proof, not only of how admirably it is designed and suited to its essential purpose as a guiding light under the peculiar atmospheric conditions of the Mediterranean, but also how hazardous it would be to dip—viz. to divert such a light, as has been suggested by some—from the horizon to the nearer sea in foggy weather, forsooth according to the *bene placito* of the man in charge, on the presumption that in such weather the luminous rays could not reach the horizon, and would therefore be wasted. This presumption is wholly fallacious in the Mediterranean, for in the Bay of Spezia, owing to its proximity to the Apennines, the rainfall is much greater than in other parts of the Tyrrhenean Sea, and banks of land fog can often be seen hanging over the bay and Tino, when the horizon as far as Leghorn, Gorgona, and even Corsica, is perfectly clear."

June 1887. J. KENWARD.

REPORT OF THE BOARD OF TRADE ON WEIGHTS AND MEASURES.

ONE of the many official Reports which are laid annually before Parliament, but which unfortunately are not so carefully read by the general public as they might be, is a Report by the Board of Trade on their proceedings and business under the Weights and Measures Act of 1878. In Report No. 9, Sess. II., 1886, there is something of scientific interest to which we would invite the attention of our readers.

The only two units from which all Imperial measures and weights are derived are, as is well known, the yard and the pound, and material standards of these two units are deposited with the Board of Trade. The Act provides that an accurate copy of each of these standards is to be made, and an account of the verification of a new copy of the yard measure is given in the present Report. The results of the comparisons of the new yard, P.C. VI., with the Imperial standard yard No. 1, show that it differs little from the original standard:—

$$\text{P.C. VI.} = \text{No. 1} - 0.00000034 \text{ inch. } t = 62^\circ \text{ F.}$$

There are no two primary standards between which our present scientific methods cannot measure some difference, but the above two standards would appear to be as nearly alike as it is possible to make them.

In determining the rate of expansion by heat of the new standard yard (which is a bronze bar 36 inches long), it was found that with a rising temperature, the new bar expanded 0·000356 inch for 1° F., but with a falling temperature it contracted at a lesser rate, 0·000343 inch for 1° F. It is not stated whether this curious difference in the rate of expansion, as determined when the temperature is alternately rising and falling, is owing to the march of the mercurial thermometers or to other causes. Some doubt has arisen as to the rate of expansion of the metal (bronze) of which the Imperial standard was made. The thermometric expansions stated in the Report of the Astronomer-Royal on the construction of the Imperial standard (*Phil. Trans. Roy. Soc.*, part iii., 1857, p. 61) do not agree with those stated by Colonel Clarke and Sir Henry James in their Report on the comparisons of standards of length (1886). The actual rate of expansion of the Imperial yard was, in fact, not determined by the Standards Committee in 1857, but was assumed to be the same as that of other similar bars of the same metal. The more recent experience, however, is that no two bronze bars expand by heat at precisely the same rate, although they may be of the same dimensions, form, and material. The co-efficient of expansion of an alloy is slightly affected by differences in the age of the alloy, by its being subjected to extreme variations of heat and cold, and by peculiarities in molecular condition.

With reference to the metric system, we are glad to see that during 1886 standards of metric weight and measure were verified for certain authorities for use in scientific research or otherwise. It would, however, appear that in Japan, in the competition for commercial acceptance, the British system is at present outstripping the metric system.

The legal equivalent of the metre is 39·37079 inches, but, as some doubt has been expressed as to the scientific accuracy of this equivalent, Prof. W. A. Rogers, of Colby University, has undertaken to construct for the Standards Department a subdivided standard yard and metre, on which the precise length of the two standards shall be marked off, so that an exact inter-comparison of the two standards may, as far as practicable, hereafter be made at London and at the Bureau International des Poids et Mesures, at Paris.

In this Report we have for the first time complete and trustworthy information as to the standard weights and measures in use in China and Japan, Her Majesty's ministers at Pekin and Tokio having obtained the information from the native Governments and through the different local consuls.

During the year 1886 the Standards Department was specially engaged in the re-verification of the accuracy of its own standards, and in the issue to local authorities of some suggestions with reference to the duties of inspectors of weights and measures. Amongst the re-verifications particularly referred to we notice a memorandum on the re-verification of the gas-measuring standards, a memorandum which shows the several conditions necessary for the accurate measurement of gas used for lighting purposes. The accuracy of the unit of volume, the cubic foot, is made to depend on the Imperial standard pound, and not on linear measurement. Experience has hitherto shown that the determination of the weight of a cubic foot of distilled water may best be made by means of a round vessel which holds a quantity of water equal to 62·321 lb. avoirdupois at 62° F., rather than by a vessel of rectangular shape, which might be made to measure one foot in each of its dimensions. In this memorandum reference also is made to a slight difference in the methods of determining the zero, or freezing-points, of thermometers. It is, for instance, uncertain how long a thermometer should remain in melting ice or snow before its precise freezing-point is noted. At the Bureau of Weights and Measures at Paris, for instance, the thermometer is only left in the pounded ice just long enough for it to reach the maximum of depression. With thermometers made of hard glass it is stated to be desirable not to hurry the observations—the thermometers remaining long enough to allow the use of a micrometer, and several observations to be taken; but with other kinds of glass it is found to be desirable to be as quick as possible. This practice is also stated to be adopted at the Standards Offices at Berlin and Washington. On the other hand, at Kew the freezing-point of a thermometer is not observed until the instrument has been completely buried, both bulb and stem, up to 32° F., or 0° C., in well-pounded block ice for a period of not less than a quarter of an hour, care being always taken in cold weather to insure the whole of the ice being in a melting condition during the experiment by pouring a small quantity of tepid water over it from time to time.

Unlike the determinations of the rate of expansion of gas, there has not been made any determination of the rate of expansion of water which in exact experiments

might be accepted as conclusive, and hence, in determining the weight of a volume of water at any given temperature, the Standards Department have been advised to adopt a mean result from several selected determinations, as those of Despretz, Kopp, and Pierre.

In many technical works, measurements of gas are erroneously referred to the temperature of 60° F., and not to the legal temperature of 62° F., at which temperature alone the standard foot contains 12 inches; the standard gallon 10 lbs. weight of water; and the standard pound 7000 grains. It would appear that an error originally committed in certain hydrometer tables in taking 60° F. instead of 62° F., has been followed by many chemical authorities.

The weight of a cubic foot of ordinary air has been still taken by the Standards Department after the determinations of Regnault, as corrected by Moritz, Broch, and Agamemnone. The amount of carbonic acid present in ordinary air has been taken, after the inquiries of Parkes and Angus-Smith, at 6 volumes in every 10,000 volumes of air. If double the quantity, 12 volumes, is present, as is sometimes the case in common rooms, it will make a difference of about 0·18 grain in the weight of the cubic foot of air. Ordinary air is still taken, after Regnault, as being two-thirds saturated with moisture.

In calculating the true weight of any given volume of air or of gas we may, of course, on very rare occasions have to allow for the accelerative effect of the force of gravity at the latitude of the place where the air or gas is weighed, as well as for the height of the place above sea-level. The normal latitude adopted in all such experiments is that of 45° at sea-level.

For instance, the weight in grains of a cubic foot of ordinary air ($t = 62°$ F., B = 30 in.) at London (lat. = 51° 29′ 53″), at Edinburgh (lat. = 55° 57′ 20″), and at Dublin (lat. = 53° 20′ 38″), has been taken as follows:—

	Dry air.	Air two-thirds saturated.	Moist air saturation = 1.
	Gr.	Gr.	Gr.
Edinburgh	534·42 ...	531·92 ...	530·68
Dublin	534·30 ...	531·81 ...	530·56
London	534·21 ...	531·72 ...	530·48

From time to time, on the application of local authorities, suggestions are issued by the Board of Trade as to the best modes of testing the weights, measures, and measuring instruments used for commercial purposes. In this country the local inspectors are not bound to follow official instructions as they are in other countries, but are free to carry out their technical work in such a way as the Justices and Town Councils may approve. It is therefore only by the issue of such official suggestions that uniformity of local practice can be at all reached, and some amount of co-ordination and local effectiveness thereby secured. It is perhaps to be regretted that there is in this country no central authority like the Normal Aichungs Kommission of Germany or Austria to give force and life to the whole local system; not that we would have the local officers in this country drilled to the dull sameness of official uniformity in the way they are drilled by some Continental Governments, but the absence of a proper scientific training by our local inspectors often leads to complaints from traders and manufacturers. By these official suggestions the Board of Trade endeavour, therefore, to educate local officers in their technical work and to keep them so far in touch with modern progress.

The present Report contains a paper on the testing of weighing-machines, which should be of really practical use to the local officers, for it is the first time that any instructions have been published as to the mode of testing such machines.

Amongst other appendixes to this Report we find papers relating to the well-known model apparatus, designed by Sir F. Abel, for testing the flashing-point of petroleum; abstracts of returns from local officers; notes on the sale of coal by weight and the sale of intoxicants by measure—with reference to which it would appear that there is more petty fraud than ever amongst traders; and a note on the average current weight of the sovereign. In the latter note reference is made to a number of weighings of gold coin, which have been recently made at the leading Banks in London. The results of these weighings show that most of the gold coinage in circulation has really ceased to be legal tender as to weight. Nearly all the coins which were weighed were found to be slightly below the least current weight allowed by the Coinage Act. If the present law, which requires receivers of light gold coins to cut or deface them, were really obeyed, then it would appear from this note that six sovereigns out of every seven ought strictly to be cut or defaced. This seems to be a worse state of things than when Prof. Jevons made his well-known report on the metallic currency of the United Kingdom in 1868.

THE GERMAN METEOROLOGICAL OFFICE.

A HISTORY of the Royal Prussian Meteorological Institute from the time of its establishment in 1847 until its re-organisation in 1885, by Dr. G. Hellmann, has just been published in the year-book of the Institution, "Ergebnisse der Meteorologischen Beobachtungen im Jahre 1885" (Berlin, 1887, 246 pages, large 4to, with plates). Dr. Hellmann is well-known to students of meteorology by many very valuable articles, and especially by his laborious compilation of a "Repertorium der Deutschen Meteorologie," containing a list of the articles, inventions, and observations in the domain of Meteorology and Terrestrial Magnetism in Germany from the earliest times down to the year 1881 (Leipzig, 1883, 995 pages, large 8vo). The kingdom of Prussia was relatively late in organising a regular system of observations, Baden and Bavaria in Southern Germany having established well-appointed services before the end of the last century; and Würtemberg followed with its system in 1821–2. The want of trustworthy data for Northern Germany was much felt by Baron A. von Humboldt at the time of the construction of his first isothermal charts in 1817, and the establishment of the service in Prussia was due to the urgent representations which he made to the present Emperor. In 1847 a system of 25–30 stations was established under Dr. Mahlmann, and observations were taken at the hours of 6, 2, and 10; these hours have been generally adhered to both in Germany and Austria down to the present time. Before commencing operations, all the stations were duly inspected, and suitable observers selected, mostly from teachers in the upper schools. While neither instruments nor remuneration are provided for such observers in this country, in the Prussian system an annual allowance, varying from about £7 10s. upwards, according to circumstances, is made to many of the observers, together with an outfit of instruments. The result of these arrangements has been that probably in no other system upon the globe have so many useful works been published by the various observers, upon whom generally devolved the task of working up their own observations. Dr. Mahlmann having died suddenly on one of his tours of inspection, his work was taken up in April 1849 by the late eminent Prof. H. W. Dove, of the University of Berlin, and his first care was to revise the observations hitherto taken and to publish them in a first Report of the Observations taken in 1848–9. The publication of this Report induced several other states to join the Prussian system, many of the observers now taking up the work without remuneration, and this active co-operation enabled Dove to publish for 1855, and for subsequent years, a summary of observations for each month of the year for Northern Germany, and in 1858 a first sketch of the climatological conditions based upon ten years' observations. Prior to this publication these

conditions were almost unknown for Prussia. Some of the stations were inspected yearly by Dove, but strange to say, it is stated that not a single Report of these inspections is to be found in the archives of the Institute. Among the numerous treatises by Prof. Dove, that best known is his work on the "Law of Storms," which was translated and adopted in this country. After Dove's death, in 1879, the Institute introduced the French measures in its publications, and adopted generally the recommendations of the various International Congresses, to which innovations Dove himself had always been averse, and instruments with new scales were necessarily supplied to the stations. In 1882 Dr. Hellmann was intrusted with the *ad interim* direction of the Institute, and many additional stations, especially for rainfall, were added to those which already existed, and finally (in 1885) the Institute was placed under the able superintendence of Dr. W. von Bezold, formerly director of the Bavarian system, with Drs. Hellmann, Assmann (also Director of the Magdeburg Observatory), Kremser, and Wagner, as principal assistants. The first volume of the new office has just appeared, and contains the observations at 271 stations during the year 1885 (246 pages, 4to, and 6 litho. tables), and also lists of all observations made since 1847. The stations are still very unequally distributed over the Empire, and no doubt improvements will be made in this respect, from time to time. It is plainly shown from the tables that while an open country position is most suitable *meteorologically*, yet for *duration* of the observations the large towns are preferable. These observations formerly appeared in the "Preussische Statistik," and in the publication of the Deutsche Seewarte, but will henceforward form an independent work. It is proposed in future to issue the tabular portion in quarterly volumes, and to publish pamphlets at irregular intervals under the title of "Abtheilungen," containing papers and discussions of a general nature. The Deutsche Seewarte at Hamburg is an independent Institution, dealing chiefly with maritime meteorology and weather telegraphy. J. S. HARDING.

THE HEIGHT OF SUMMER CLOUDS.

A KNOWLEDGE of the heights and movements of the clouds is of much interest to science, and of especial importance in the prediction of weather; the subject has therefore received much attention during recent years from meteorologists, chiefly in this country and in Sweden. In the last published Report of the Meteorological Council for 1885-86 will be found an account of the steps taken by that body to obtain cloud-photographs; and in the *Meteorologische Zeitschrift* for March last, MM. Ekholm and Hagström have published an interesting summary of the results of observations made at Upsala during the summers of 1884-85. They determined the parallax of the clouds by angular measurements made from two stations at the extremities of a base of convenient length, and having telephonic connexion. The instruments used were altazimuths, constructed under the direction of Prof. Mohn, specially for measuring the parallax of the aurora borealis. A full description of these instruments and of the calculations will be found in the *Acta Reg. Soc. Sc. Ups.* 1884. The results now in question are based upon nearly 1500 measurements of *heights*; the *motions* will form the subject of a future paper. It was found that clouds are formed at all levels, but that they occur most frequently at certain elevations or stages. The following are, approximately, the mean heights, in feet, of the principal forms:—Stratus, 2000; nimbus, 5000; cumulus (base), 4500, (summit) 6000; cumulo-stratus (base), 4600; "false-cirrus" (a form which often accompanies the cumulo-stratus), 12,800; cirro-cumulus, 21,000; cirrus, 29,000 (the highest being 41,000). The maximum of cloud-frequency was found to be at levels of 2300 and 5500 feet. Generally speaking, all the forms of cloud have a tendency to rise during the course of the day; the change, excepting for the cumulus-form, amounting to nearly 6500 feet. In the morning, when the cirrus clouds are at their lowest level, the frequency of their lowest forms—the cirro-cumulus—is greatest; and in the evening, when the height of the cirrus is greatest, the frequency of its highest forms—the cirro-stratus—is also greatest. With regard to the connexion between the character of the weather and the height of the clouds, the heights of the bases of the cumulus are nearly constant in all conditions. The summits, however, are lowest in the vicinity of a barometric maximum; they increase in the region of a depression, and attain their greatest height in thunderstorms, the thickness of the cumulo-stratus stretching sometimes for several miles. The highest forms of clouds appear to float at their lowest levels in the region of a depression. The forms of clouds are identical in all parts of the world, as has been shown in papers lately read by the Hon. R. Abercromby before the English and Scottish Meteorological Societies.

IVAN POLYAKOFF.

RUSSIA has lost one of her most promising men of science in Ivan Polyakoff, who died lately at St. Petersburg, from hepatic disease, at the age of about forty. He was born in the small village of Transbaikalia, on the Argun, of Cossack parents, descendants from the earlier settlers of Siberia, and received his first education in a military school for sons of soldiers and Cossacks at Irkutsk—a very limited education indeed. As his parents were poor, and life in his native village offered no attractions, he accepted the position of teacher at the same school where he had been educated. Zoology and botany became the sciences of his choice. A large park belonging to the Governor, close by the military school, peopled with a variety of birds and insects, became the first field of his researches. As the spring came, he would spend the day in the garden, sometimes extending his excursions to the neighbourhood of Irkutsk, where so much is to be learned. He wrote down his observations, and published them in the *Irkutsk Gazette*. From the very first lines of his description one is struck by a remarkable feature of Polyakoff's mind—a feature which is to be found in all his later writings, and which cannot but be highly appreciated by a true naturalist: it is the simplicity of his conception of the animal world; I should say his intimacy, his familiarity, with every bird or animal he describes. He *understood* them. One must be born in a lonely Siberian village on the confines of the civilized world, at the border of the uninhabited Gobi steppe—the Argun is such a border—to be always in so close a contact with Nature.

Early in 1866 I was going to make a great journey to find out the long-searched-for route from the Lena gold-washings to the steppes of Transbaikalia. A topographer accompanied the Expedition; I undertook the geological exploration; for the botanical and zoological I invited Polyakoff to join us. We crossed the region from the Lena to Tchita, and thus Polyakoff and I were able to make a section of the backbone of the Asiatic continent, with its high and lower plateaus, their border-ridges, and the Alpine regions which fringe them. A zoologist like Polyakoff was thus enabled to obtain an insight into the whole of the Siberian fauna, as dependent upon orographical features. His descriptions of the fauna and flora of the region, especially with regard to the dependence of animals and plants upon their surroundings and their mutual interdependence—he excelled in that kind of research—are a most valuable contribution to the geographical zoology and botany of a wide region. His

collection of plants was described by our friend the late Dr. Glehn.

Next year, Polyakoff made another little journey to the upper Irkut valley, from which he returned with something quite new—namely, a rich collection of stone implements. There he studied the actual position of the encampments of our Stone-Age ancestors, and the general surroundings of their life. Afterwards, wherever Polyakoff went—to Olonetz, on the Volga, on the Ural, or to Saghalien—he had only to take a short walk in the region he proposed to explore to have a general idea of it. Then he took a shovel, or invited somebody with a shovel, and indicated the place where some digging ought to be done, and stone implements (Neolithic) never failed to be found. His collections are as numerous as invaluable.

In 1868, he entered the St. Petersburg University—not without some difficulties on account of the Latin examinations—and the late Dean of the University, the much-regretted Prof. Kessler, at once perceived that he would have in Polyakoff a first-rate naturalist, and showed him much attention. Polyakoff's thesis for the degree of Doctor of Sciences—a monograph on the cartilaginous fishes—received high praise, and as soon as he was out of the University, he was appointed Conservator of the Zoological Museum of the Academy of Sciences at St. Petersburg.

After that time Polyakoff was almost always out on some expedition sent either by the Academy or by the Geographical Society. He explored the Olonetz region, the middle Volga, the lower Obi region, and recently he was sent by the Academy of Sciences on a long exploring journey to Saghalien and the Pacific littoral. It was on his return from this last journey that he fell ill at St. Petersburg, where he died in a hospital. A friend who learned of his illness, and went to visit him at the hospital, came too late.

His death is the more a loss for science, as he was going to work out in detail the exceedingly rich zoological and anthropological materials which he had collected during his last journeys. Only preliminary reports of these journeys have been published. Part of his researches on the Stone Age have been embodied in Count Uvaroff's work; others have appeared in the publications of the Academy of Sciences, the Russian Geographical Society, and the St. Petersburg University Society. His preliminary report on the Obi journey (containing an admirable description of the Ostiaks, whom he thoroughly understood) has been translated into German; and there is also a German rendering of his preliminary report, or rather letters, on Saghalien. But most of his observations remain unpublished. It is even doubtful whether his field note-books contain all his observations and generalizations, and whether they were kept in such a state as to render publication possible.

In zoology, Polyakoff's name will remain associated with the description of the *Equus prjevalski*, a separate species established by him, which is the real ancestor of our common horse, discovered by Prjevalski in the Alashan Mountains of Central Asia.

NOTES.

THE dinner given to Prof. Tyndall is going on at Willis's Rooms as we go to press. The hosts number more than two hundred, and many of the most eminent men in the country are present.

ON April 12, 1886, the Local Government Board appointed a Committee to inquire into the efficacy of M. Pasteur's treatment of hydrophobia, and into any dangers which might be connected with its employment. The Committee consisted of Sir James Paget, Dr. Lauder Brunton, Dr. Fleming, Sir Joseph Lister, Dr. Quain, Sir Henry Roscoe, and Prof. Burdon Sanderson, with Prof. Victor Horsley as Secretary. Dr. Lauder Brunton, Sir Henry Roscoe, and Dr. Burdon Sanderson, with the Secretary, visited Paris in order to study M. Pasteur's methods; and after their return Prof. Horsley conducted a series of experiments with a view to the settlement of certain points about which he and his coadjutors had felt some doubt. A copy of the Report of the Committee has been sent to the *Times*, and it appears that the Committee unanimously express confidence in M. Pasteur's system.

THE sixteenth meeting of the French Association for the Advancement of Science will be held at Toulouse from Thursday, September 22, to Thursday, September 29 next. Notice of intention to be present at the meeting should be given to the Secretary of the Association, 4 Rue Antoine-Dubois, Paris, before July 15.

THE *Evening Standard* of Tuesday is our authority for the statement that addresses from the Church of Ireland, the Metropolitan Board of Works, *the Royal Society*, and the Ancient Order of Foresters, were presented to the Queen on Monday last. Let us hope that this is not true.

THE third annual general meeting of the Marine Biological Association took place on Friday last in the rooms of the Linnean Society, Burlington House. Prof. Flower presided, and among those present were Mr. Thiselton Dyer, Mr. Crisp, Prof. Bell, Prof. Charles Stewart, Prof. Ray Lankester, and Sir John Staples. The report for the past year stated that the Council had devoted attention chiefly to the superintendence and fitting of the laboratory at Plymouth, and to preparations for the work of the Association in connexion with that laboratory. It is expected that the laboratory will be ready for partial occupation in the present summer, but the tanks and circulation of sea-water cannot be completed for some months to come. The Council had decided to issue a journal, which might serve not only for the circulation of the official publications of the Association, but also as a means of inquiry and exchange of information among those who are interested in marine biology in its relation to the sea fisheries of the United Kingdom. A first-rate biological library was one of the most important appliances which the Marine Biological Association must possess in its Plymouth laboratory. The Council trusted that the members and friends of the Association would assist in the formation of such a library by gifts of books. The Association was willing and anxious to co-operate with individuals or associations in any part of the British Islands who were engaged in the study of the natural history of marine fishes or in researches in marine biology. The Council had to record with deep regret the death of one of the vice-presidents of the Society, Mr. George Busk. Some formal business having been despatched after the adoption of the report, the meeting concluded with a vote of thanks to the chairman for presiding.

A SPECIAL general meeting of the Fellows of the Royal Horticultural Society was held on Tuesday "to consider the results of the negotiations and inquiries which have been made by the Council as to the future maintenance and housing of the Society." Sir T. Lawrence, who presided, said the Council thought it would be wise as soon as possible to carry on their operations at Chiswick; and this view met with general approval. The meeting adopted a resolution requesting the Council to take such steps for the housing and maintenance of the Society as might appear best calculated to preserve its character and utility and promote the horticultural interests committed to its charge, and insisting upon the importance of

immediately taking steps to secure accommodation for the Society at the close of the year, either of a permanent or temporary character, in some central situation in or near the City.

On Jubilee Day the Royal Gardens, Kew, were visited by 31,000 people.

The *Meteorologische Zeitschrift* for June contains the first part of a comprehensive discussion by Dr. W. Köppen, of the Deutsche Seewarte, on the nomenclature of clouds. The author asks whether the same cloud seen from different sides should receive different names; for instance, when seen from the front, sideways, from behind, above, or below; or, whether the classification should refer generally to the properties observed in a particular cloud, especially as regards its density and dimensions. The *apparent* form plays an important part in Poey's classification, but Dr. Köppen shows that it sometimes leads to erroneous conclusions. The classifications of Hildebrandsson, Ley, Weilbach, and others, receive especial notice, but no reference is made in this first article to Mr. Abercromby's recent researches.

The Editorial Committee of the Norwegian North-Atlantic Expedition (1876-78) have published the eighteenth volume of their General Report (Christiania, 1887, pp. 209 and 48 plates). The memoir in question has been edited by Prof. H. Mohn, Director of the Meteorological Institute at Christiania, and deals especially with the depths, temperature, and circulation of the North Ocean, and to some extent with the winds and atmospheric pressure. The region embraced lies between Iceland and Norway, and extends northwards as far as Spitzbergen. The currents naturally receive much attention, and Prof. Mohn states that he has sought to explain the motion of the water as produced alike by the normal winds and by the difference in the density of the water; and he points out that, while the former cause predominates, the latter too has full significance. The maps are very clear, and the explanatory text is written both in Norwegian and English, as in the previous volumes.

The first of the vessels of the Norwegian seal-hunting fleet have returned to Hammerfest from the Arctic regions, and the captains report that the ice-belt this spring extended far south of Spitzbergen. It appears from their reports that when they left the ice-fields no vessels had succeeded in reaching that island. Seals were very plentiful, and nearly all vessels have full cargoes.

The three courses of Burnett Lectures on "Light," delivered by Prof. G. G. Stokes at Aberdeen in 1883, 1884, and 1885, have now been issued in a single volume belonging to the well-known "Nature Series." As we had something to say about each of these courses at the time of its publication in a separate volume, we need only remind our readers that the first course deals with the nature of light, the second with light as a means of investigation, the third with the beneficial effects of light. On this last subject, Prof. Stokes says in the preface to the new volume:—"The benefits derived from light, which form the subject of the third course, are, it might have been supposed, too obvious to require mention. Yet few, perhaps, have been in the habit of contemplating these benefits as a whole, or have perceived how far-reaching and of what vital importance are the advantages that we derive from light, if we include in that term not merely what the eye can perceive, but all that in its physical nature differs from visible light only in the way in which light of one colour differs from that of another colour."

The "Queen's Jubilee Atlas," which we have received from Messrs. George Philip and Son, contains an excellent series of maps, those relating to the British Empire being especially good. Each map is accompanied by a short explanation, with descriptive and historical notes and statistical tables. A physical map of England is given showing the coal-fields and the heights of all the mountains; this is followed by three separate maps of the British Isles showing the railways alone.

Messrs. George Philip and Son have also issued a "Handy-Volume Atlas of the World," containing 110 maps and plans, with complete index, and statistical notes, by Mr. J. F. Williams. The little volume has been carefully prepared, and is the first of a series designed to present all essential geographical information in a handy and accessible form.

Among recent publications in Paris we notice the "Éléments de Médecine suggestive" of MM. Fontan and Ségard, in which the authors give numerous illustrations of the effects of hypnotism in disease, whether mental or physical; a pamphlet, by Dr. Servier, on the Val de Grace, the military hospital in Paris, comprising the history of the buildings and of the institution; and a book by M. Ed. Dreyfus-Brisac, on "L'Éducation nouvelle," a series of studies well worth the attention of those who take some interest in the present evolution of public spirit concerning educational matters in France.

M. G. Pruvot, *maître de conférences* in the Sorbonne, has recently issued a course of lectures on "Worms and Arthropoda." The lectures were delivered by him in 1885-86. The work is profusely illustrated.

The *Archives Slaves de Biologie*, a periodical containing only Slavonic work in biology, are publishing a long series of papers by Danilewsky on the Hæmatozoa of Reptiles and Birds.

A full account of the New Zealand Industrial Exhibition, 1885, is presented in an Official Record, a copy of which has been sent to us. The facts are brought together in a way that will facilitate comparative study of the progress of the colony in the various arts and manufactures, and the volume will be of service to those who may undertake to organize any future exposition of the industrial resources of New Zealand.

An elaborate synopsis of the North American Syrphidæ, by Dr. Samuel W. Williston, has been issued as the thirty-first Bulletin of the United States National Museum. Dr. Williston explains that he has given especial attention to this family since he began his dipterological studies eight years ago, and that he has collected a large part of the species either in New England or in the West. The types of all but two or three of the new species described by him, together with his entire collection in this family, will be preserved in the National Museum for future reference and revision.

The Manchester Microscopical Society has just issued its Transactions and Annual Report for 1886. The volume contains a valuable address on "Fresh-water Animals," by the President, Prof. A. Milnes Marshall, F.R.S., and papers and communications read by the members. A short paper by Mr. Robert Parkes may, perhaps, suggest to some readers a pleasant way of spending a few of the approaching holidays. In this paper Mr. Parkes describes a dredging excursion he made some time ago to Lamlash Bay, Isle of Arran, in company with two friends. The excursion was very successful, and Mr. Parkes was able to exhibit to the Society some of the specimens he had secured. He assured the members that dredging was not a very expensive pursuit, to be followed only by the use of steam launches and a large staff. They could see by the collection before them that good results might be obtained by two or three joining together and dredging from an ordinary rowing-boat.

The fifth volume of the Journal of the Liverpool Astronomical Society has just been issued. It contains many papers, notes, and reviews, and has some good illustrations.

By permission of the President and Council of the Royal Astronomical Society, the annual general meeting of the Liver-

pool Astronomical Society will be held at Burlington House, London, on Friday, July 8.

THE problem of protection against yellow fever by inoculation seems in a fair way to solution by the Brazilian doctor Freire, who has been seven years at work on the subject. According to a recent account, the number of persons already inoculated is 6524. There died from yellow fever in Rio de Janeiro, between January 1885 and September 1886, 1675 persons, of whom eight had been inoculated (in 1884, the method being then imperfect). This gives a mortality of about 1 per 1000 for the inoculated, and 1 per cent. for the uninoculated. It is remarkable that there has been no epidemic of yellow fever in Rio de Janeiro this year (a thing not known for the last thirty-five years). The microbe of yellow fever is called *Cryptococcus xanthogenicus*. Dr. Freire gets a culture liquid for inoculation, on the principles of M. Pasteur's methods, and he injects about one gramme of it subcutaneously.

EXPERIMENTS have been recently made by S. Leone (*Gazetta Chimica Italiana*) as to how organic substances in water are affected by development of bacteria. He used distilled water, to which a little gelatine was added. The organic nitrogen and carbon are changed by the organisms into inorganic compounds, chiefly carbonic acid, ammonia, nitrites, and nitrates. It appears that up to the fifteenth or sixteenth day the ammonia steadily increased, then it decreased till it was quite gone. Meanwhile, nitrous acid appeared; it increased as the ammonia disappeared, and when this was gone, a formation of nitric acid began, at the cost of the nitrous acid, so that in thirty-five days the latter too was quite gone, and only nitric acid present. If a little gelatine was put in the water which had turned ammonia into nitrates, the reverse process began; ammonia was formed again, and even directly added nitrate was changed into this. If no fresh gelatine was added, however, nitrites and nitrates were again produced. The author ascertained that the same organisms that in *presence* of organic substances formed ammonia, in *absence* of such effected nitrification.

PROFS. KRUSS AND NILSON, of Stockholm, have succeeded in preparing a double fluoride of potassium and the new element germanium, K_2GeF_6, isomorphous with the corresponding double fluoride of ammonium and silicon, thus proving most conclusively that this recently discovered element belongs to the silicon, titanium, zirconium, tin, and lead group of the periodic classification. The fluoride of germanium, GeF_4, which is not gaseous, but resembles zirconium fluoride, ZrF_4, was first prepared by dissolving the oxide, GeO_2, in hydrofluoric acid; and the double fluoride separated in the gelatinous form on adding the calculated quantity of potassium fluoride. On filtering, however, the salt dried to a crystalline powder resembling potassium silicofluoride, but being more soluble than the latter, separated from solution in hot water in beautiful tabular crystals, and from a solution in cold water on evaporation over sulphuric acid in pyramid-capped prisms several millimetres long. Once more the value of Newlands' and Mendelejeff's generalization as an incentive to research is demonstrated, and confidence in its truth inspired, for Mendelejeff himself predicted that "ekasilicon will yield a double fluoride isomorphous with the double fluorides of silicon, titanium, zirconium, and tin, of greater solubility than that of silicon; and the fluoride, like the fluorides of titanium, zirconium, and tin, will not be gaseous."

A NEW synthesis of uric acid, directly proving its constitution, has been effected by Prof. Horbaczewski (*Monatshefte für Chemie*, May 28, 1887). The reaction is very simple and consists in fusing together 1 part of trichlorlactamide, $CCl_3—CHOH—CO—NH_2$, with 10 parts of urea, $CO(NH_2)_2$, when 15 per cent. of uric acid together with ammonium chloride, hydrochloric acid, water, and a few decomposition products are obtained. By a long process of separation and purification the uric acid was obtained quite pure, in crystals exactly resembling those obtained from natural sources. This method of synthesis points to the extreme probability that the constitution assigned by Medicus to uric acid is correct, and shows that it is the di-ureide of acrylic acid. Probably no work has been watched with keener interest than the attempts which have been from time to time made to solve the problem of the constitution of this complex molecule, and it is a matter of great satisfaction to have our knowledge of a substance so widely occurring in animal secretions, and parent of so many derivatives, founded upon a method of synthesis so direct.

SUPERFICIAL tension in liquids being, like the magnetic state, an essentially molecular phenomenon, we might expect that it and phenomena depending on it would be modified by action of an intense magnetic field. Prof. Dufour lately proved such an effect by making mercury flow through a horizontal capillary tube placed between the poles of a strong electro-magnet. The liquid describes a parabola, the vein being continuous to a certain distance from the orifice, when it separates into drops. While the magnet acts the parabola is stretched, and the continuous part of the vein lengthens, indicating more rapid flow.

ATTENTION has been lately called by Herren Kerner and Wettstein, in the Vienna Academy, to two carnivorous plants found in Germany. One of these is the leadwort root (*Lathræa squamaria*) which has no chlorophyll, and passes for a parasite, as it fixes, with small nipples, on the roots of fruit-trees. The pale stems, appearing in shady moist places in spring, are covered thickly with scale-like leaves, each of which has its upper half rolled back on the back of the lower, leaving a hollow space between. Into this open by small holes from five to thirteen separate chambers, having on their surface numerous tufted hairs and hemispherical horns connected with the vascular bundles. Various small animals get into these chambers, and ere long disappear. From both hairs and horns threads of plasma stream out, when the animals come into contact with them, and lay hold of them. Though it is not exactly proved that the plant benefits by the animals it thus catches, this seems very likely from its general character. It is more remarkable that a plant containing chlorophyll, and existing independently, like *Bartsia alpina*, should have similar organs for capture of animals, and should feed on such, as the authors assert. The plant forms in autumn underground buds covered with scales, whose lateral borders are rolled outwards, making a hollow in which are organs quite similar to those in the leadwort root.

THE habits of the rainbow trout (*Salmo irideus*) in their fry stage are in some respects very different from those of other species of Salmonidæ. At the present time many thousands of them may be seen in the ponds belonging to the National Fish-Culture Association at Delaford Park, where they were hatched out in the spring from ova sent from California. Instead of moving about in groups or shoals, they isolate themselves from one another, and are to be found in every part of the pond instead of at certain spots or on shallows. Again, the rainbow trout fry are visible within half a foot of the surface of the water, while other varieties hide from view. They appear to be exceedingly voracious, and this may account for their capacity for rapid growth, which exceeds that of their congeners.

IN one of the Selborne Society Letters, issued the other day, the Rev. S. A. Preston, the founder and for many years the President of the Marlborough College Natural History Society, sets forth his ideas as to the best method of promoting the study of natural history in schools. He thinks (1) that each boy should have the elements of two or three branches of natural

history put before him,—as a general rule, nothing more than the elements would be required; (2) that this should be done so as to make it as interesting to him as possible, so that he may look forward to his natural history lesson; (3) that if he "takes" to any particular subject, means should be at hand to enable him to go on with it; (4) that he should be encouraged to work out of school. Mr. Preston is of opinion that the appointment of "science masters" is not necessary for the attainment of these ends. "Among any body of masters now," he says, "there are sure to be some who are fond of some branch of natural history, and who can teach the elements of their subject (as far as is necessary for boys in general), and do it in a pleasing and interesting manner. At the end of a long afternoon's work at regular school subjects, the master should occupy the last half-hour or so (if the other lessons have been well said) with a discussion upon his special branch, showing specimens, encouraging questions, and making this part of his work as different as possible from the ordinary work. Boys will look forward to this time, and will work all the harder at their other work to get this 'talk,' if a good lesson is required before the natural history one. By the end of a term, with a little system, the elements of the subject may easily be learnt. The next term, masters should change forms for this half-hour, and the boys thus have some new subject put before them. In a few terms, therefore, a very fair general knowledge of natural history may be secured. If a boy showed any aptitude in any one branch, there would be a master at hand ready to help him and get him on."

Mr. C. S. Wilkinson, the New South Wales Government Geologist, reporting upon the seams of coal pierced in the diamond-drill bore at Holt-Sutherland, near Sydney, says that in this bore a depth of 2307 feet from the surface, or 2175 feet below sea-level, has been attained. This is the deepest diamond-drill bore in Australia. The diameter of the bore to a depth of 500 feet is 3½ inches, and below that depth it is 3 inches. The strata passed through consist of Hawkesbury sandstones, 653 feet 6 inches; shales, sandstone, and conglomerates (the upper 314 feet consisting chiefly of chocolate-coloured shales), 1573 feet 3 inches; upper seam of coal, 4 feet 2 inches; shales, sandstone, and conglomerate, 65 feet; lower seam of coal, 5 feet 3 inches; black shaly sandstone, 5 feet 11 inches.

A heavy snowstorm is reported to have occurred on the Scheekoppe on June 11. On the Kapellenberg, between Hirschberg and Schönau, it snowed severely, and in the night the thermometer sank to 3°.

A telegram from Omsk to St. Petersburg of the 21st inst. states that there were several slight oscillations of the ground at Vernoé on that day. To the west of Karakoul the earthquake had been more violent than at the latter place; a lake in the neighbourhood had sunk 3 feet. Almost all the Government buildings at Vernoé are said to be destroyed.

Two beaver colonies have just been discovered at Amlid, near Christiansand, Norway. On the bank of a river the beavers have made lodges of branches of trees, which are held together with clayey mud, the whole resting on logs of wood. The entrance, a hole, faces the river, but is below the surface of the water. Round the entrance there are numbers of aspen and birch trees, the bark of which has served as food for the animals. The beaver gnaws the tree about 2 feet from the root, and if it finds the bark to its taste, cuts the tree up in pieces from 2 to 3 feet in length, which the animal then drags or carries down to its house—proceedings which are fully demonstrated by the many "log-runs" in the woods along the river bank. Observers have also noticed another remarkable habit of this interesting animal, viz. that on arriving by the water-side with such a log of wood it will poise the piece on the back of its neck and swim with it right into the lodge, where the bark is gnawed off and stored away for winter use. This accomplished, it will shoot the log into the river. The largest trees the animals have dealt with in this manner are 11 inches in diameter. The colonies are situated far from human dwellings, where people only come in winter, during the timber-felling season.

At the Ladies' *Soirée* at the Royal Society on June 8, much attention was attracted by the fine exhibit sent from the Royal Gardens, Kew. Great credit is due to the officials at Kew for the care with which the objects were selected and displayed. The following is a list of the flowering plants:—*Myrmecodia Beccari*, *Myrmecodia* sp. New Guinea, *Leea amabilis*, *Impatiens Hawkeri*, *Primula Reidii* and *cortusoides*, *Piper porphyrophyllum*, *Streptocarpus Dunnii* and *polyanthus*, *Coffea liberica*, *Tillandsia splendens* and *usneoides*, *Caraguata Zahnii*, *Cypripedium Stonei*, *Dendrobium Dalhousieanum* and *transparens*, *Epidendrum vitellinum*, *Odontoglossum Hallii*, *Miltonia vexillaria*, *Sarracenia Patersoni*, *Palumbina candida*, *Areca monostachya*, *Licuala grandis*, *Verschaffeltia splendida*, *Caryota Blanci*, *Cycas undulata*, *Hemitelia Smithii*, *Adiantum amabile*, *Acrostichum crinitum*, *Brainea insignis*, *Saccolabium curvifolium*. There were cut flowers of *Hæmanthus magnificus*, *Randia Stanleyana*, *Hexacentris mysorensis*, *Senecio macroglossa*, *Iris Susiana*, *Chamædorea elegantissima*, *Bougainvillea spectabilis*, *Napoleona imperialis*, *Cochliostema Jacobianum*, *Pandanus odoratissimus* (cone), *Musa coccinea*.

The additions to the Zoological Society's Gardens during the past week include a Moustache Monkey (*Cercopithecus cephus* ♀) from West Africa, presented by Mr. Bernard Lawson; a Green Monkey (*Cercopithecus callitrichus*) from West Africa, presented by Mr. G. Choutte; two Lions (*Felis leo* ♂ ♀) from Kittywar, Guzerat, India, presented by Major J. Humphrey; two Striped Hyænas (*Hyæna striata*) from India, presented by the Bombay Natural History Society; a Suricate (*Suricata tetradactyla*) from South Africa, presented by Mrs. H. A. Warwood; an Australian Crane (*Grus australasiana*) from Australia, presented by Mrs. M. S. Richman; a Ring-necked Parrakeet (*Palæornis torquatus*) from India, presented by Mrs. Crabtree; two Edible Frogs (*Rana esculenta*), European, presented by Mr. H. A. Crossfield; three Green Turtle (*Chelone viridis*) from Ascension, presented by Capt. C. Theobald, R.N.; a European Pond Tortoise (*Emys europæa*) from Venice, presented by Mr. Alban Doran; an Alligator (*Alligator mississippiensis*) from Florida, presented by Mr. Hugh Bellas; a Green Monkey (*Cercopithecus callitrichus* ♂) from West Africa, five Common Dormice (*Muscardinus avellanarius*) British, deposited; a Little Egret (*Ardea garzetta*), a Buff-backed Egret (*Ardea russata*), European, a Horrid Rattlesnake (*Crotalus horridus*) from Brazil, purchased; a Yak (*Poephagus grunniens*), born in the Gardens.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1887 JULY 3-9.

(For the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on July 3

Sun rises, 3h. 50m.; souths, 12h. 3m. 53·0s.; sets, 20h. 17m.; decl. on meridian, 22° 59′ N.: Sidereal Time at Sunset, 15h. 3m.

Moon (Full on July 5) rises, 18h. 22m.; souths, 22h. 48m.; sets, 3h. 11m.*; decl. on meridian, 19° 4′ S.

Planet.	Rises. h. m.	Souths. h. m.	Sets. h. m.	Decl. on meridian
Mercury ...	6 11	13 52	21 33	18 12 N.
Venus ...	7 55	15 11	22 27	13 54 N.
Mars ...	2 30	10 49	19 8	23 46 N.
Jupiter...	13 35	18 53	0 11*	8 56 S.
Saturn...	4 57	12 59	21 1	21 25 S.

* Indicates that the setting is that of the following morning.

unnatural conditions. The temperature registered on the death of the fish named exceeded the highest and lowest degrees given below, which are, as already stated, intended to indicate the temperature of water in which they can be maintained in aquaria.

Marine Fish.

Species.	Temp. ° Fahr. Highest	Lowest	Remarks.
Gurnard	62	49	Highly sensitive
Wrasse	55	50	,, ,,
Dogfish	71	45	Occasionally exist when in 38°
Mullet	70	35	Very hardy
Eels (Conger) ...	70	40	Occasionally at 30°
Bullhead	62	49	Thrives best at 55°
Skate...	70	45	
Sole	62	51	Thrives best at 56°
Flounder	70	35	
Plaice	70	35	
Bream	65	45	Thrives best at 58°
Bass	70	35	
Cod	70	35	Thrives best at 55°
Crayfish	60	45	Cannot exist in extremes
Blennie	58	43	

Fresh-water Fish.

Trout...	71	34	
Perch...	65	43	
Dace	60	44	Occasionally at 32°
Tench (Common)	65	45	
,, (Golden)..	68	45	
Roach	60	50	
Catfish	70	43	Occasionally at 38°
Eels	70	35	
Carp	70	35	
Gudgeon	55	43	
Pike	70	36	
Minnow	55	46	
Chub...	50	40	

It will thus be seen that the dogfish, mullet, conger, skate, flounder, bass, cod, trout, catfish, pike, and carp are extremely hardy, and can exist in both a high and low temperature, ranging from 34° to 71°. On the other hand, the gurnard, wrasse, bullhead, sole, bream, crayfish, blennie, perch, dace, tench, minnow, chub, roach, and gudgeon show themselves sensitive to extremes of temperature.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 16.—"On the Tubercular Swellings on the Roots of *Vicia Faba*." By H. Marshall Ward, Fellow of Christ's College, Cambridge, Professor of Botany in the Forestry School, Royal Indian College, Cooper's Hill.

In this paper the author gives a detailed account of his investigations, of which the following is a short abstract.

The curious tubercle-like swellings on the roots of *Vicia* and other Leguminosæ have long been a puzzle to botanists and agriculturists. They have even been described as normal structures by some observers. The general opinion, however, has been that they are not so. Eriksson and Woronin at one time thought they contained Bacteria; Kny and others ascribed them to a Myxomycete; Frank and others had also observed certain extremely minute hyphæ in their tissues; but no one had been able to discover the connexion between the tubercles and a fungus.

By special methods of culture and observations extending over some time, Prof. Marshall Ward has discovered that the tubercles of *Vicia Faba* contain a fungus of a very definite kind, and he exhibited preparations showing the structure of the tubercles and fungus, and the entrance of the infecting hypha into the root-hairs of the plant: this infecting hypha passes down the root-hair and across the cortex, and then breaks up into finer hyphæ, from the ends of which are budded extremely minute germ-like bodies, which Woronin mistook for Bacteria. They are not Bacteria, however, but present more resemblance to the buds discovered by Brefeld in the *Ustilagineæ*.

The author has succeeded in artificially infecting the roots of beans with the fungus, and finds that the minute infecting spores are to be met with in all kinds of soil, so that it is a matter of some difficulty to obtain roots which are not attacked by the fungus. This can be done by burning the soil, and by means of pure water-cultures.

The affinities of the fungus are with the *Ustilagineæ*, and the case is a very remarkable instance of symbiosis.

"On the Structure of the Mucilage Cells of *Blechnum occidentale*, L., and *Osmunda regalis*, L." By Tokutaro Ito, F.L.S., and Walter Gardiner, M.A. Communicated by Prof. M. Foster, Sec. R.S.

The growing point of many ferns is found to be covered with a slimy mucilage, which arises from hairs situated on the palæ and the leaves; this mucilaginous secretion serves a most important physiological function, in that it readily takes up and retains water, and thus keeps the young bud moist, and at the same time it prevents excessive transpiration. The authors investigated two cases of mucilaginous secretion, viz. *Blechnum occidentale*, L., and *Osmunda regalis*, L. They find that the mucilage arises from the protoplasm only, and not from the cell-wall, and that the whole process is distinctly intraprotoplasmic. They point out that the structure of mature mucilaginous gland is wonderfully like that of certain secretory animal cells recently investigated by physiologists; and they find that in the glandular cells of the ferns mucilage is secreted in the form of drops, and that each drop is further differentiated with a ground substance (gum mucilage), in which are embedded numerous spherical droplets (gum).

The secretion commences by the breaking down of a portion of the innermost layers of the endoplasm of a number of contiguous but isolated areas, and the result of these catabolic changes in the protoplasm is the formation of small but rapidly-growing mucilage-drops. The first formation takes place just beneath the free surface, equally around the whole cell-cavity, and the phenomenon steadily continues from within outwards, producing new drops basipetally, until the whole of the endoplasm has taken part in the process. The cell is now full of isolated drops, each inclosed by a portion of the delicate protoplasmic framework which still remains. A remarkable sequence of changes occurs in the drops themselves. At their first formation they are watery and by no means well defined; they shortly become denser, and then in the drops themselves a delicate reticulation may be observed, which gives way to the appearance of numerous minute and brightly shining droplets, all separate and distinct. The result of their observations makes the authors disposed to believe that during secretion the protoplasm gives rise to a gummy mucilage, and the latter undergoes further differentiation into a ground substance, which still retains its mucilaginous character, and into a gummy substance which is present as a number of isolated spherical droplets. Excretion takes place by the rupture of the cell-wall, all that remains in the cell being a layer of endoplasm with the disintegrated nucleus.

In the case of animal glands, *e.g.* serous and mucous salivary glands, the state of active secretion is followed by a resting-period, during which the protoplasm grows, forms new hyaline substance, and this again produces new granules. The authors believe that a series of changes essentially similar in character occur in plant-cells also. Usually speaking, plant-cells are incapable of such active and repeated secretion, and in many cases, *e.g. Blechnum* and *Osmunda*, the secretion-changes occur in the cell once and for all, and then the cell dies; in other instances, however, *e.g.* the glands of *Dionæa*, it appears exceedingly probable that the phenomena which accompany the repeated secretion are quite similar to those which happen in so many animal cells. They believe that in their main features the phenomena attending the formation of the secretion are very wide-spread, and limited neither to the ferns nor to the particular case of the secretion of mucilage.

Royal Meteorological Society, June 15.—Mr. W. Ellis, President, in the chair.—The following papers were read:—Amount and distribution of monsoon rainfall in Ceylon generally, with remarks upon the rainfall in Dimbula, by Mr. F. J. Waring. The principal feature in Ceylon as determining both the amount and distribution of rainfall is a group of mountains situate in the

theses, says Dr. Barrois, the conditions remind us somewhat of the *Dimetian* proposed by Dr. Hicks for Wales. It is evident, however, that he is more disposed to favour either of the other hypotheses.

Certain mica schists are largely developed in the southern plateau; they alternate with subordinate beds of fine-grained gneiss, amphibolites, chlorite schists, micaceous schists, and interstratified masses of diorites and "gneissites" of eruptive origin. These accessory rocks form, together with the mica schists into which they are injected, long parallel bands from one end to the other of the southern plateau. The "gneissites" include a complete assemblage of acid rocks, remarkable for their gneissic, ribboned, and glandular structure, rich in white mica, and in secondary feldspar, with "granulitic" quartz in elongated grains, in rounded drops, and in thin flakes. These include the rothe-gneiss, augen-gneiss, flaser-gneiss, stengel-gneiss, halleflintas, and leptynites of the German geologists; as also the rhyolitic felsites, volcanic breccias, halleflintas, and felsitic tuffs of the English geologists.

Is the injection of the "gneissites" contemporary with the mica schists, or should it be referred to a subsequent epoch? If we accept the first of these hypotheses, the stage so termed may be said to ally itself by its lithological characters to the *Arvonian* of Dr. Hicks. It would seem, however, that in making the (geological) sheets of Lorient and Chateaulin, Dr. Barrois and his coadjutors have adopted another view, by referring the characters of the "gneissites" or "granulites feuilletées" to their consolidation in special "encaissements" under suitable mechanical conditions of depth and pressure, and at an epoch different, but as yet undetermined, from that of the massive granulite of Pontivy.

The schists of Groix constitute a stage of micaceous schists, of chloritic and chloritoid schists, of carbonaceous schists, and of mica schists, especially remarkable for the abundance of the heavy minerals which they contain (staurolite, garnet, magnetite, &c.). The carbonaceous or graphitic schists sometimes referred to the Cambrian would appear to form the base of this stage. The boundary between it and the Cambrian is admitted to be obscure. If this stage, says Dr. Barrois, corresponds to the *Pebidian* of Wales, it is distinguished by its poverty in interstratified basic rocks, which are always of limited extent in Brittany.

Cambrian.—How far these greenish-gray satiny schists, with their beds of quartzite and veins of quartz, correspond to any British Cambrian beds, the author admits is uncertain. Moreover, we would observe that there is no mention here of any bed of conglomerate at the base of the Cambrian. Hence the evidence as to the antiquity of the presumably pre-Cambrian rocks fails in this important particular. The author estimates this stage (Phyllades of Douarnenez) at over 3000 metres. Above these are beds of schist and conglomerate in regular interstratification. The conglomerates are formed of little pebbles of quartz with about 1 per cent. of other stones. They are distinguished from the Silurian conglomerates by the smallness of their component parts, and by their inferior hardness. The equivalents of these beds in the north of the department are fossiliferous, and correspond to the *Paradoxides* beds of la Vega in the Asturias,[1] and to stage C of Barrande. Here then we have our first palæontological horizon in Brittany which would seem to be Menevian.

Silurian.—The lowest stage thus classified consists of red schists, variegated quartzites, and beds of quartzose conglomerate. This is succeeded by the famous "Grès Armoricain," which forms the most salient feature of Menez-Hom and the Black Mountains. It is characterised by *Scolithes*, *Bilobites*, *Lingulæ*, &c., and is the most constant of the fossiliferous beds of Finistère. Barrande's stage D is represented by the slates of Angers with *Calymene tristani*, &c. The three horizons of the third Silurian fauna are with difficulty traced on the north of the Black Mountains.

Devonian.—From a geognostic point of view the schists and quartzites of Plougastel, over 1000 metres in thickness, constitute the most important stage of this system, being largely developed in the roadstead of Brest and forming the northern crest of the Black Mountains. *Homalonotus* sp., *Rhynchonella pailleni*, and *Grammysia davidsoni*, are amongst the few fossils. Above these come beds recalling the Taunusian, Coblenzian, and Eifelian, for the most part fairly fossiliferous. As no higher ones are mentioned, we may presume that the Middle and Upper Devonian are absent.

[1] See *Geological Magazine*, 1883, p. 274.

Carboniferous.—The physical history of Brittany during this period was one of oscillation between terrestrial and marine conditions; it was a period of extensive eruptions and of great earth-movements. Hence a considerable portion of the sediments, especially towards the base, are of volcanic origin. The mass of the formation is comprised in what Dr. Barrois calls the "schists of Châteaulin," an alternation of schists, slates, and sandstones with *Spirifer striatus*, *Strophomena rhomboidalis*, *Phillipsia derbyensis*, and *Productus semireticulatus*; they also contain poor impressions of plants. In some respects this description reminds us of the Culm of Devonshire. This group rests unconformably on the various Devonian beds. The actual Coal-Measures form three small and distinct basins in Finistère of little economic value.

It is interesting to note that the volcanic phenomena in this region are referred to the Carboniferous rather than to the Devonian epoch, and this serves to recall the controversy as to the precise geological age of the rocks in the Brent Tor district—a doubt which is applicable to a large area of Palæozoic rocks lying to the north-west of Dartmoor. Since, in Brittany, the Carboniferous rocks are unconformable to the Devonian, while the intermediate deposits consist in many places of porphyritic tuffs, it is evident that the chief deposit of ashes and other volcanic material represent formations intermediate in respect of time. Why may they not in part be Middle and Upper Devonian? To the Carboniferous period also are referred the porphyroid granites of Rostrenan and other places, and the numerous veins of quartz porphyry, which are so apt to follow the synclinal folds of the sedimentary rocks, the prevailing direction being a little to the north of east. The eruptions, according to Dr. Barrois, must have commenced after the Devonian, and continued during the whole of the Lower Carboniferous. The most important development of quartz diorite, which follows the southern foot of the Black Mountains, he regards as posterior to the Devonian and anterior to the Carboniferous.

Lastly, Dr. Barrois speculates on the earth-movements that have helped to fashion the country of Finistère, which may be said to possess a radiate structure in consequence of the numerous flexures undergone by the rocks; the general orientation is east to west, but with a tendency to converge towards west. These directions correspond to axes of a complete series of synclinals and anticlinals. The eruptive rocks of the region have been affected at the same time as the sedimentary rocks, whose foldings they have followed; they made their appearance chiefly at two epochs, during the Archæan (*terrain primitif*) and during the Carboniferous, thus affording two periods of maximum eruptive force. The principal periods of flexing appear to have been five in number, and correspond in the main to the breaks in the great systems already detailed. The fifth and greatest flexure took place after the Upper Coal-Measures: it has left its mark on all the formations, and since that period Finistère has been in a condition of *terra firma*.

W. H. H.

TEMPERATURE IN RELATION TO FISH.

THE influence of temperature exerts itself to such a marked degree upon the habits, food, reproduction, and migration of fish, that observations upon the subject are essential in determining the relations of certain forms to their surroundings. The National Fish-Culture Association have for some time past made investigations into the temperature of the ocean, not only at the surface, but also at the bottom, and the Council will shortly publish the results. In order to ascertain its effect upon fish maintained under artificial conditions, Mr. W. August Carter, of that body, has compiled the following statistics, showing the influence of temperature upon fish at the late South Kensington Aquarium, where the average depth of the tanks was 4½ feet. The statistics are derived from observations made daily during a period of three years by noting the temperature of the water in the tanks, and the death-rate prevalent at certain seasons of the year. By observing the degrees of temperature at which certain fish succumbed from time to time, Mr. Carter has drawn an average, showing the temperature adapted to various fish, and their capacity, in some instances, for withstanding extremes of heat and cold.

It must be borne in mind that the temperatures recorded are applicable only to fish in confinement, and living therefore under

the *Dryas* leaves was undoubtedly obtained. Some samples of this tufa show a relatively rapid precipitation, the needles and pieces of bark themselves being sometimes found intact on the cleaving of the tufa. In this layer are also found remains of a species of broad-bladed grass, and Herr Carlson has further found in it the imprint of a feather. Uppermost, at all events in certain spots, mosses only are found. The calcareous tufa, the greatest thickness of which is hardly more than 3 feet, is in turn covered with peat.

In the tufa are sometimes found, in layers, thin bands of remains of plants, chiefly of grasses and mosses, the vegetable substance of which is still preserved. In such a layer even a leaf of *Betula nana* was found. Besides the above-mentioned remains of plants may be mentioned leaves of at least three different kinds of Salices, one reminding of *S. cinerea*, one of *S. repens*, and one which most certainly cannot be referred to any of the varieties now found in Southern Sweden. In addition to those of *Betula nana*, imperfect leaves of a large birch-tree, probably *B. odorata*, have been found, and also a perfect leaf of one apparently corresponding with *B. intermedia*, although there is some probability that it may be a smaller leaf of *B. odorata*, it being generally impossible to define leaves varying so much as those of *Betula* and *Salix* from a single imprint.

Of the species just named, two at all events, viz. *Betula nana* and *Dryas octopetala*, are extinct near Vadstena. It is also probable that one of the varieties of *Salix* is now foreign to these parts. *Betula nana*, however, is still found in certain parts of Ostergötland, but the nearest spot in which *Dryas* grows is in the mountains around the valley Herjedalen, about 4° to the north-west of the lake Wettern, and we may safely assume that the presence of these two plants in the same locality clearly indicates that at the time of the deposition of the older layers of calcareous tufa the climate was much colder than that now prevailing there. For my own part, I am even disposed to consider this discovery of fossil *Dryas* near Wettern as a proof of a purely Arctic flora having prevailed in these parts at an age older than that represented by the calcareous tufa; studies of the same in the province of Jemtland in my opinion indicating that a true Arctic climate is not favourable to the development of calcareous tufa, this mineral being first deposited after the climate has become milder. In Jemtland we certainly find Arctic plants in the tufa, but generally together with remains of pine, and they must therefore be considered as the last remnants of an Arctic flora, which already then was in course of being supplanted by the pine and accompanying species. Its greatest significance lies, not only in the proof of an Arctic flora once having flourished in these parts, but also in the circumstance that it proves that an Arctic flora could exist at such a low elevation.

It will further appear from the above exposition that the Arctic flora in this locality was followed by a pine vegetation, the process thus entirely corresponding with what took place in Scania and Norrland. Information from other localities in these parts is, however, required before we can arrive at general conclusions.

Finally, it may not be out of place here briefly to refer to a question which to some extent may be considered to be affected by this discovery. In a paper read in 1860 before the Academy by Prof. Sven Lovén, "On some Crustacea found in the lakes Wettern and Wenern," the author pointed out that, as regards Wettern, this lake sheltered a fauna belonging to deeper waters, of originally marine and at the same time Arctic character. This fauna Prof. Lovén considered to be a relic from the time when Wettern, by way of the Baltic and Lake Ladoga, was connected with the Arctic Ocean. He said:—"Some few favoured species, those which in a higher degree than others were able to adapt themselves to the new medium, and which already in their former habitat, the less saline Arctic Ocean, had accustomed themselves to live for instance where melting glaciers diluted the sea-water, or at the mouth of rivers, would in one or another of the great lakes thrive longer than others, and finally be the only ones surviving. Such a lake is Wettern." It should be pointed out that the discovery of the fossil *Dryas* leaves on the shore of the lake Wettern is of considerable significance in view of the opinion thus expressed by Prof. Lovén. For the calcareous tufa referred to here having been deposited *since* the sea had already receded from these parts, and this tufa nevertheless containing Arctic plants, we may conclude that the lake Wettern became separated from the sea whilst the climate was still Arctic. A. G. NATHORST.

GEOLOGICAL STRUCTURE OF FINISTÈRE.

THIS article is founded upon the "Aperçu sur la constitution géologique du Finistère," prepared for a recent excursion of the Geological Society of France by Dr. Charles Barrois, of Lille.

Since the three great promontories of South Wales, Devon and Cornwall, and Brittany, are sharers in no small degree of a common geological history, English geologists can hardly fail to take an interest in the structure of the western extremity of Brittany. Dr. Barrois is very well known to many of us, and the fact that for some time past he has been engaged on the geological survey of Brittany renders his observations all the more valuable. From time to time he has furnished the annals of the Société Geologique du Nord with some of the results of his observations in that country. Of these we may mention "Le granite de Rostrenan (Côtes-du-Nord), ses apophyses et ses contacts," "Mémoire sur les schists métamorphiques de l'île de Groix (Morbihan)," "Mémoire sur les grès métamorphiques du massif granitique du Guéméné (Morbihan)," "Note sur la structure stratigraphique des Montagnes de Menez (Côtes-du-Nord)," and "Légende de la feuille de Châteaulin (Finistère)."

The department of Finistère is traversed from east to west by two parallel chains—on the south the Black Mountains, on the north the Mountains of Arrée. Between the first-named chain and the Atlantic lies the southern plateau of Brittany, whilst the northern plateau is situated between the Mountains of Arrée and the English Channel. Both plateaux are formed by Archæan (*primitifs*) and Cambrian rocks more or less injected by granite. The basin included between the two ranges presents a series of beds extending from the Silurian to the Carboniferous in parallel folds, and is evidently one of the most important physical features in the north-west of France.

The stratified rocks of the region present the following succession:—

Carboniferous.

Schists and Conglomerates of the Coal-Measures.
Schists and Sandstones of Châteaulin.
Porphyritic Tuffs.
Conglomerates and Porphyritic Tuffs.

Devonian.

Nodular Schists of Porsgruen.
Schists and Limestones of Néhou.
White Grit of Landévennec.
Schists and Quartzites of Plougastel.
Limestone of Rosan with *S. loviensis*.

Silurian.

Nodular Schists with *C. interrupta*.
Bituminous Schists with Graptolites.
White Sandstones.
Slates of Angers.
"Grès Armoricain."
Conglomerates and Red Schists of La Chèvre.

Cambrian.

Schists and Conglomerates of Gourin.
"Phyllades" of Douarnenez.

Archæan.

Schists of Groix.
Mica Schists of Audierne.
Granitic Gneisses of Pont-Scorff.

Archæan.—The most ancient group of rocks in Finistère consists of certain granitic gneisses and mica schists. The gneisses are devoid of white mica, consisting mainly of white and rose feldspar in large grains, with abundance of black mica, in foliations, sometimes replaced by hornblende in fragments, with granitoid and secondary quartz. These gneisses alternate with interstratified beds of mica schists and amphibolites, and pass into gneissic granites which penetrate them after the manner of an eruptive rock.

The injection of this *gneissic granite* may be explained in three different ways: (1) either it is contemporary with the gneiss and the mica schists, or (2) it may date from a later epoch, or (3) lastly, it may proceed directly from the gneisses by means of local recrystallisations under the action of a powerful general metamorphism. If we accept the first of these hypo-

Occultations of Stars by the Moon (visible at Greenwich).

July.	Star.	Mag.	Disap.	Reap.	Corresponding angles from vertex to right for inverted image.
			h. m.	h. m.	° °
6	π Capricorni	5	21 3	near approach	149 —
6	B.A.C. 7053	5½	21 49	22 53	37 280
6	σ Capricorni	5½	21 49	22 54	38 280
9	42 Aquarii	6	0 48	1 45	43 320

Variable Stars.

Star.	R.A. h. m.	Decl. ° ′			h. m.	
U Cephei	0 52·3	81 16	N.	July	7, 23 13	*m*
δ Libræ	14 54·9	8 4	S.	,,	9. 0 8	*m*
U Coronæ	15 13·6	32 4	N.	,,	9. 1 29	*m*
U Ophiuchi	17 10·8	1 20	N.	,,	6. 0 12	*m*
S Sagittarii	19 12·8	19 14	S.	,,	9.	*M*
T Capricorni	21 15·8	15 38	S.	,,	9.	*M*
δ Cephei	22 25·0	57 50	N.	,,	8. 1 0	*m*

M signifies maximum; *m* minimum.

GEOGRAPHICAL NOTES.

AT Monday's meeting of the Royal Geographical Society, Mr. J. T. Last gave a brief preliminary account of his recent explorations among the Namulli Hills, to the south-east of Lake Nyassa and along the River Rovuma. He found that, although the thermometer often falls below freezing-point, no snow exists on the Namulli Hills. At the same meeting, General Haig read an unusually interesting paper on a recent journey he made in the south-west corner of Arabia. He started from Hodeida, went inland to Sana'a, and south to Aden. He found himself in a region of mountains rising to over 10,000 feet, in many places terraced by the natives up to a height of 8000 feet. The scenery was often of the most magnificent and picturesque description, and the climate so comparatively temperate as to be suited for European settlement. The whole region of which this forms part, and indeed the entire southern portion of Arabia, including Hadramaut and Omân, is one that would richly repay serious exploration. General Haig made a journey of about fifty miles into the interior of Omân, and found that, while there was a rainfall of only 6 inches on the coast, at least 30 inches fell upon the hills of the interior.

SOME further steps have been taken in Australia for the prosecution of Antarctic exploration. The Antarctic Committee appointed by the Royal Society of Victoria and the Royal Geographical Society of Australia have memorialized the Premier of Victoria on the propriety of stimulating Antarctic research by the offer of bonuses. They recommend that a sum of £10,000 be placed on the Estimates for this purpose, and that tenders be solicited from shipowners for the performance of services in connexion with Antarctic exploration. It is stipulated that shipowners whose tenders are accepted shall provide, free of charge, cabin accommodation in each ship for two gentlemen, who will act as the scientific staff; and a second cabin as instrument-room and office. The master of the ship must afford these gentlemen every facility for observing natural phenomena. The master will receive special bonuses for every hundred tons of oil from fish caught south of 60° S. The special services desired are as follows:—A flying survey of any coast-lines lying within the Antarctic Circle, and not laid down upon the Admiralty charts; the discovery of new waterways leading towards the South Pole, and of harbours suitable for wintering in. Opportunities must be afforded to the scientific staff to add to our knowledge of the meteorology, oceanography, terrestrial magnetism, natural history, and geology of the region. Special bonuses will be given for passing 70° S., and also for establishing on shore a temporary observing camp. Two ships are wanted, and both must be in Port Philip Bay and ready to start on October 15. The Premier of Victoria, we are glad to say, has promised to place £10,000 on the next Estimates for these purposes, on condition that the other colonies will join in the enterprise; this they no doubt will do.

THE Russian Government has decided to establish Chairs of Geography in the Universities of the empire. The first appointment will be to the University of St. Petersburg in the autumn of the present year.

MR. MCCARTHY, the Government Surveyor of Siam, has just returned to this country, with a very fine set of maps of that country, embodying the results of seven years' survey work. These he is working out at the Royal Geographical Society.

MR. W. J. STEAINS has just returned from Central Brazil, where he has spent a considerable time among the Botocudos, a savage people, concerning whom our information is exceedingly scanty. Mr. Steain's has collected much information concerning these people, and brought home some two hundred sketches, which he will probably publish soon in some form.

ONE of the public lectures at the Manchester Meeting of the British Association will be by Sir Francis De Winton, late Governor of the Congo Free State. Sir Francis, we believe, will illustrate his lecture with a series of maps (perhaps thrown on the screen) showing the progress of our knowledge of Central Africa from the time of Ptolemy down to the present day.

DISCOVERY OF FOSSIL REMAINS OF AN ARCTIC FLORA IN CENTRAL SWEDEN.

FOR the first time fossil remains of an Arctic flora have been discovered in the great stretch of land between Scania and Norrland. The discovery was made in a part where it was least expected, viz. just north of the town of Vadstena, close to the shore of the lake Wettern. The soil in the vicinity of Vadstena greatly resembles that of South-Western Scania, being mostly formed of moraine clay or clayey moraine sand, whilst marine formations appear to be absent in the former place; they are, however, found further to the north-east, but I have as yet been unable to ascertain the limits of the two districts. With n the moraine clay are found here and there little cavities or depressions, occupied by peat bogs or alluvial formations. Close to the shore of the lake Wettern, barely a third of a kilometre north-east of Vadstena, such a depression occurs, occupied by a peat bog. This peat bog continues to the north-east bey the depression, a little way up the rising ground, caused by the existence here of some strong wells, around which in remote times considerable quantities of calcareous tufa have formed. My attention was drawn to this locality by Dr. J. Jönsson, who had noticed the tufa under some work effected for the Geological Survey of Sweden, but not having closely examined the fossil remains of plants in the same, he was only able to inform me that he had found mosses therein.

On examining the collection of specimens of the tufa obtained, I found at the back of one some well-preserved leaves of *Dryas octopetala*, L., other fossil remains in the same fragment, besides mosses, being branches of *Empetrum* and leaves of *Vaccinium uliginosum*, L. In consequence of this discovery, I decided to visit the spot myself, partly in the hope of discovering some more specimens of *Dryas*, and partly in order to study the adjacent layers of earth and the strata containing the fossil plants. But although I spent a whole day in examining loose blocks and the accessible parts of the strata I did not succeed in finding any more leaves of *Dryas*.

The calcareous tufa is, as I have stated, deposited on a declivity and around a well, and the latter, whose flow is rather strong, is now exposed through the removal of the peat (a couple of feet in thickness) which covered it, along with the tufa immediately round the well. The latter appears to have rested immediately on clayey moraine *débris* or moraine clay (bottom moraine), whilst nearest the well the lower layers are sinter-formed without distinct remains of plants, though probably containing such pine needles and mosses as are found in the upper layers. The mosses are in the upper part of the tufa in certain places common, and form sometimes separate layers consisting solely of such. The composition of the bed seemed to be as follows:—Lowest, the lime had formed round growing grass or Juncaceæ, the leaves of which are indicated by more or less perpendicular holes. Next above this appears a more distinctly stratified tufa, containing leaves and exterior bark of the pine, but, judging from the fragments thrown up in the vicinity, the layer containing *Betula nana* should be placed between these two. As a proof of such a layer are the mosses, leaves of *Vaccinium uliginosum*, *Empetrum*, and even needles of pine, although more seldom than in the true pine layer. From the layer containing remains of dwarf-birch the piece of tufa with

ZOOLOGICAL GARD

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