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RECENT CHEMICAL SYNTHESES

DURING the Exhibition of Scientific Apparatus at South Kensington a few years ago one of the most interesting exhibits was the first specimen of Urea from Prof. Wöhler.

This substance and specimen may be said to be the first organic compound, or product of a living organism built up from its mineral elementary constituents, not certainly directly, but very nearly, by an ordinary chemical operation.

The importance of this discovery, made in 1828, was not, however, recognised for many years. Its importance and signification in a physiological sense were first perceived, but its formation is the earliest and best example of an action that plays an important part, and is probably the most interesting question in modern organic chemistry, namely, what the Germans call the "Umlagerung" of the atoms in a molecule or "intermolecular change."

Urea was obtained by Wöhler by simply heating the compound ammonium cyanate, NH_4CNO, in contact with water, whereby the arrangement of the atoms is so changed that the two nitrogen atoms become directly combined to hydrogen and only indirectly to the oxygen as shown in the chemical formula:

$$CO\begin{matrix}NH_2\\NH_2\end{matrix}$$

As long ago as 1773 this substance was discovered as a constituent of urine, and since then its importance as a final stage in the retrogressive metamorphosis of the animal tissues, or of albumenoids, has been pretty fully worked out and recognised.

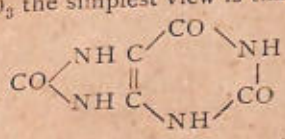
Although albumin has not yet been directly oxidised to urea in the laboratory, the descent takes place in the animal economy through several stages, as for instance, guanin, sin, kreatin, xanthin, allantoin, uric acid, &c., probably by simultaneous oxidation and hydration, or even reduction. Several of these intermediate substances yield, however, urea as a direct product of oxidation not only when taken into the organism but when submitted to ordinary oxidising agents. Even substances like asparagine, leucine, and glycine, which are very near to albumin in the products of retrogressive metamorphosis, may be considered as preliminary stages in the splitting up and oxidation of the tissue substance into more simple compounds until a truly *mineral* character is arrived at.

Although urea was synthesized from its mineral elements years ago, it has until quite recently contributed comparatively little to the syntheses of the more complex members of the class of bodies of which it is almost the final oxidation product. A great number of bodies have, however, been derived from urea by substitution. Probably the most important synthesis obtained by the aid of this body since Wöhler prepared it from its mineral constituents, is the one just announced as having been effected by Dr. Horbaczewski in the Vienna Chemical Institute.

The chemist has succeeded in proceeding a step backwards from urea to uric or lithic acid. The method followed, of which the details have been sent to us by Dr. Horbaczewski, [illegible] with glycocoll at a temperature of 200° until the mass fuses and bec[illegible]OOH, and Glycocoll is amic[illegible] be represented the reaction which[illegible] sented:—

$$CO\begin{matrix}NH_2\\NH_2\end{matrix}+(CH_2[illegible]OH_2+H_6.$$

The action as represented by this equation indicating conditions the reverse of those supposed to exist when uric acid is converted to urea. As to the structure of the group $C_5H_4N_4O_3$ the simplest view is that of Medicus—



It is somewhat remarkable that this reaction and synthesis has not been attempted or attained earlier, for the converse reaction, represented by the equation—

$$C_5H_4N_4O_3 + 5OH_2 = CH_2.NH_2.COOH + 3CO_2 + 3NH_3$$

has been known for a considerable time.

The same two substances have previously served as materials for an important synthesis, namely, that of hydantoïn or hydantoic acid (*Ber. Ber.*, p. 36).

This synthesis is mostly important as giving a step backwards towards that very complicated atomic group termed albumen.

That this will eventually be arrived at is exceedingly probable, and in the near future, for an even more complicated substance than uric acid has also been built up and its structure or intermolecular constitution settled very conclusively by the method of synthesis employed by Erlenmeyer and Lipp. This substance is tyrosine, a product of the decomposition of albumen in the animal system, and also by putrefactive decomposition and by heating with alkalies or acids.

The method is somewhat more complicated than the one employed by Dr. Horbaczewski. Starting with phenethyl-aldehyde they proceeded by conversion into phenyl-alanin and nitration to the amide compound—

$$C_6H_4\begin{matrix}NH_2\\CH_2\end{matrix}—CH(NH_2).COOH$$

paranitrophenylalanine, a substance very similar, as will be seen on comparison of formulæ in its nature to the amido acetic acid or glycocoll employed in the uric acid synthesis. On treating this body with nitrous acid the following reaction takes place:—

$$C_6H_4\begin{matrix}NH_2\\CH_2\end{matrix}:CH.NH_2.COOH + NO^2H = H_2O + N_2 + C_6H_4\begin{matrix}OH\\CH_2\end{matrix}.CH.NH_2.COOH.$$

According to this method of building up, tyrosine is a para-hydroxy phenyl *a* alanine.

Both reactions are similar in this respect: the end is attained by the splitting away of hydrogen from nitrogen groups NH_2 partly in the form of water.

All these syntheses are really approaches to that of albumen, and in this connection some work lately done and published in brochure form by MM. Loew and Bokorny of Munich gains in importance.

These investigators have proved the presence of alde-

hyde groups in living plasma, and are of opinion that albumen is a product of the condensation of a relatively simply-constituted molecular group.

These simple groups are what are termed aldehydic groups and ammonia or amide groups.

Their idea is that a group *CHOH*, which, however, has not yet been isolated, combines and condenses somewhat as shown :—

$$4CHOH + NH_3 = H_2N.\begin{matrix}CH\ .COH\\ |\\ CH_2.COH\end{matrix} + (OH_2)_2$$

This more complex group acting again as an independent individual and yielding a still more complex body, $C_{12}H_{17}N_3O_4$, with expulsion of water.

$$3\left(\begin{matrix}H_2NCH\ COH\\ |\\ CH_2COH\end{matrix}\right) = C_{12}H_{17}O_4N_3 + {}^2H_2O.$$

A further similar condensation under conditions where it could take up additional hydrogen and some sulphur, conditions easily attainable in living organisms, yield albumen direct :—

$$6.(C_{12}H_{17}N_3O_4) + SH_2 + {}^6H_2 = C_{72}H_{112}N_{18}S.O_{22} + {}^2H_2O.$$

This is the formula for albumen, assuming sulphur as an essential constituent. A simpler would be $C_{72}H_{114}N_{18}O_{24}$, and would be a direct product of such condensation.

Both in the fall of this complicated molecule through less and less complicated groupings of atoms to the so-called mineral groups into which they are finally resolved, and in the so far only partial building-up process, the peculiar aptitude of certain elementary substances to combine into very stable groups or individuals is well shown. Carbon and nitrogen compounds exhibit this *par excellence*, but there is no reason to suppose that such a property is confined to them alone. It may be that the range of existence of these compounds are more within our reach than in the case of other so-called elements.

As elements imprint generally their most characteristic property on the compounds they form, it is perhaps not unreasonable to suppose that these elements whose compounds we see so readily group up or polymerise, may themselves be also, in the condition in which we take them to be elementary, in a state of great atomic complexity.

THE BUTTERFLIES OF INDIA

The Butterflies of India, Burmah, and Ceylon. A descriptive Handbook of all the known Species of Rhopalocerous Lepidoptera inhabiting that Region, with Notices of Allied Species occurring in the Neighbouring Countries along the Border; with Numerous Illustrations. By Major G. F. L. Marshall, R.E., and L. de Nicéville. Part I. Royal 8vo. (Calcutta, 1882.)

THE first part of this anxiously-expected book, by Major Marshall and Mr. de Nicéville, has just arrived, and will, I am sure, be gladly welcomed, not only by the naturalists *in esse* of Europe, but by a great number of naturalists *in posse* of our Indian Empire.

For though, thanks to the labours of Hodgson, Blyth, Jerdon, Hume, Blanford, Godwin-Austen, Day, Theobald, and many others, we have excellent handbooks, and a very fairly complete knowledge of the mammals, birds, reptiles, fishes, and land shells of India, we have absolutely nothing to assist the entomologist or collector in identifying and studying the lepidoptera. How many weary hours of hot weather on the plains, how many dreary evenings in camp, and tedious marches in mountains and forests will be made interesting and profitable by this book no one but residents in India have any idea, but I feel sure that its appearance will give such an impulse to the collection and study of the lepidoptera of India that in ten years we shall have as many working entomologists in India as we have had ornithologists since the publication of Jerdon's Birds of India.

Considering the magnitude of the work, and the many risks and chances of life in India, it is specially fortunate that the work has been undertaken by two gentlemen, of whom one is already known as an ornithologist of repute and both of whom have excellent opportunities for bringing together the immense amount of material necessary to bring the work to a conclusion.

The little we know at present of the butterflies of India is gathered from the scattered descriptions of Indian species by old authors and from the numerous papers and descriptions in various publications by a few modern entomologists, of whom Mr. F. Moore holds by far the most distinguished place. Unfortunately, however, many of these papers are of a bare and misleading character and so far from making the work of discriminating the species easier, only confuse it.

The carelessness which has been shown by some writers about the habitat and distribution of species, and about their allied forms, is deplorable in many ways, and shows an entire want of appreciation of the physical geography of India, and of the vastly different zoological regions which it includes; but new light is sure to be thrown on the subject by men who understand and appreciate these facts, and who have personal and local knowledge of the country whose insects they describe. The form of the work, which is printed and published by the Calcutta Central Press Company, 5, Council House Street, Calcutta, is a large octavo; both print and paper are good, and likely to stand the hard wear to which no doubt the work will be subjected. The price is not mentioned in the first part, but will no doubt depend on the number of illustrations which are found necessary. These are of three kinds, viz. chromolithographs, of new and remarkable species by West, Newman, and Co., London, of which one appears as frontispiece, and is very superior to some illustrations of a similar character; autotypes by the Autotype Company of London, of which nine are given in the first part, illustrating dissections, types, larvæ, and pupæ, and fifteen species of Danainæ; these are well executed, and suitable to their purpose, though perhaps they will hardly be suitable to illustrate the Lycenidæ. The woodcuts, by George Pearson, of which three are given with the text, are not quite so good, but will serve their purpose very fairly. The illustrations are drawn by Babu Behari Lall Dass, and Babu Cris Chunder Chuckerbutty, of Calcutta, under the superintendence of Mr. Wood Mason, and seem to be faithful to nature as the drawings of good native artists generally are.

The preface and introduction show that the authors thoroughly appreciate the difficulties before them, and are determined to spare no pains to make their work as useful as possible; and though they have, from their inability to examine the types, been obliged temporarily to adopt many species about which they evidently have grave doubts, yet a new edition will no doubt enable these supposed species to be relegated to their proper position. The authors' opinion on this important question may be quoted as follows:—

"With regard to species and varieties we have found it convenient to describe where there is any room for doubt under its own distinctive name, every form that has been separately characterised, the question whether any particular form represents a species or a variety of a species can at present be decided in this country only as a matter of conjecture; for a knowledge of the life-history in all its stages is essential to the authoritative settlement of such questions; at the same time the evidently or apparently allied species are carefully grouped together, and the nature of the variety is indicated as closely as our present knowledge will allow."

With regard to the scope of the work we may again quote the preface as follows:—

"This book does not attempt a life-history of each or any of the insects. The time has not arrived for such a work. The details required for a life-history cannot be gathered until a knowledge of the nomenclature is far more widely diffused. It is simply designed as a handbook of reference, as complete as possible in itself, for the convenience of naturalists in the field, who have no access to libraries. Where necessary full extracts from the works not generally available are given, and where possible and advisable the description of the species are given in the words of the original describers, supplemented by any further details necessary to complete them. For the genera the admirable descriptions by Westwood in the 'Genera of Diurnal Lepidoptera' have been followed as closely as possible.

"The book will comprise detailed descriptions of every genus and species known to occur within the limits of India, British Burmah, and Ceylon, and short descriptions will be added in smaller type of species from neighbouring countries on the border, such as Malacca, Siam, Yunnan, Tibet, South Turkestan, Afghanistan, and Beluchistan, which, though not yet recorded from within Indian limits, may very probably subsequently be found to occur within our border."

If the authors mean to follow out this course it is to be hoped that their descriptions will be of a comparative and not of a general nature. Nothing can be more laborious, more unsatisfactory, and often more useless than wading through long descriptions, when a few words indicating in what character the species in question differs from its nearest allies, are often far more useful. It is just because authors have in many cases been unwilling or unable to make this comparison that they have described species without good cause, and it is frequently found that when such comparison is attempted, the want of distinctive characters is shown at once, whereas in a long wordy description it may easily be concealed. In conclusion, we wish the book success and plenty of supporters, so that it may be completed quickly, and mark the commencement of a new era in Indian entomology.

H. J. ELWES

OUR BOOK SHELF

Winners in Life's Race; or the Great Backboned Family. By Arabella Buckley, Author of *Life and her Children*, &c. With Numerous Illustrations. (London: Edward Stanford, 1882.)

LIFE, the title of Miss Buckley's thoughtful work now before us would suggest, once it became materially existent, went ever forward, striving after diverse fashions to adapt her children to the best methods of fighting and winning. She felt her way onward in several directions, and in several of these she attained to a fair share of perfection, from shapelessness to symmetry, from a simpleness in structure to a wonderful differentiation thereof; from a mere manifestation of vitality to a high state of instinct, almost of intellect; but there was to all of these a limit all too speedily attained—and it is now plain that no arrangement of epidermis, or muscle, or nerve, no alteration of blood, or alimentary system could get the uppermost in the struggle. It was only with the appearance of a quite new structure—the back-bone of this volume—that Life felt she had acquired a new power, and those of her children who were thus endowed went on gallantly until, Winners in the race, they were left without a rival. The record of their humble beginning was still very incomplete but a few years ago, and there was no clue thereto. Now as the reader will learn in the clearest manner from chapter I., we know of such forms as the Lancelet, and those strange Ascidia who "once tried to be backboned, and yet as they grew fell back into the lap of Invertebrates."

Commencing with these Ascidia, this new volume of Miss Buckley proceeds to tell of those "Winners in Life's Race," which are supposed to culminate in our very selves. It does this in a way that most young people and every fairly educated person can understand as well as with a carefulness in detail and a caution in the statement of facts, most pleasing and grateful to the advanced student of Nature. Ably as this little volume is written, and admirable as, in our mind, is the judgment shown in the selection of details, yet it hardly comes to us with that captivating freshness that made the author's story of "Life and Her Children" so welcome. Why this is so, we can scarcely suggest; but this record of the battle over, of the fight won, seems to have been the result of a more tiresome labour than the author's previously published records of those other legions which led on so steadily to what was but a forlorn hope. Perhaps this is because there is a wondrous charm surrounding the mysterious beginnings of life which is not felt in the same degree as we approach the consideration of those beings who would seem to be the final product of life's genesis. Still, nothing that we thus write about the contrast between these volumes can lead us for a moment to overlook the fact that we know of no book in our language, which for the general reader approaches this, as an introduction to those animals (fish, reptiles, birds, and mammals) to whom the victory in life's race has been vouchsafed.

E. P. W.

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 ensure the appearance even of communications containing interesting and novel facts.*]

Weather Forecasts

I AM glad that my letter on this subject has been the means of eliciting the letter of the Rev. W. Clement Ley, printed in your number of November 9. I have also received more than

one private communication; and by the courtesy of Mr. Scott I have been permitted to see all the evidence received at the Meteorological Office on the day preceding the great storm of October 24.

The painful conclusion is forced upon my mind that some of the difficulties which lie in the way of a surer and safer forecast of dangerous storms might be removed by a simple increase of expenditure upon the machinery available for meteorological purposes.

Mr. Ley writes: "On the whole, to the minds of many students of the subject it will appear rather strange that the Office, *with the materials at its disposal* [the italics are used by Mr. Ley] does not more often fail to furnish satisfactory warnings of the more serious of our gales. It is easy to say, in view of occasional failures, 'the system itself must be at fault;' it is still easier to reply 'Better it!' If the country cares enough for the welfare of 'fishermen and others' to do so, let it provide the necessary funds for a system of night telegrams, and, if possible, for a system of oceanic stations. If it does not, it must be content with things as they are."

Again, a private correspondent writes to me:—"The weather cannot be treated as though it went to bed at night and tucked itself in under a blanket of cumulus. It unfortunately does nothing of the kind; and while the director and his subordinates are quietly sleeping, atmospheric changes are going on with a rapidity which a constant influx of telegrams must afford the only means of meeting. Yet still in spite of all these we go on, satisfied with having only *two* reports sent in every twenty-four hours. The result is that every now and then a disastrous failure such as that of Tuesday *must* occur."

It must seem, therefore, that without the important assistance of a new class of observations, dependent upon the motions of the higher clouds, much might be done by such an extension of an existing system as common sense seems to demand. At present we appear to be acting upon a method somewhat parallel to that which would be adopted upon our railways, if the companies should send their signalmen to bed at 8 p.m., but with the night-traffic all the same. Collisions of the first magnitude would probably abound under such a system.

I write not as a meteorologist, but as a citizen. Surely if the position of things be such as has been described, and if an important improvement in the forecasting of storms could be ensured by the expenditure of a somewhat larger sum of public money, there could be no difficulty in bringing the matter in such a way under the notice of the Government as to secure the necessary funds.

H. CARLISLE

Rose Castle, November 13

The Comet

IT may perhaps interest you to know that a most brilliant comet has been visible here for about three weeks. I saw it for the first time on the morning of September 29; at 4.40 a.m. of that day it bore from a house on the ridge overlooking Victoria E. ¼ N. true (nearly), the nucleus being then about three degrees above the horizon; an imaginary line drawn from Rigel through Sirius met the nucleus.

The approximate length of the tail was nearly equal to the distance between Rigel and Betilguex, and its greatest breadth nearly equal to the distance between the two outer stars in the belt of Orion. The tail appeared brighter on the southern than on the northern side.

The following particulars, which may also prove of interest, were communicated to me by Capt. Metcalf, of the White Star Company's steam ship *Oceanic*.

"Monday, September 25—observed a large comet rise about 4.30 a.m., position at the time lat. 30° 18′ N., long. 128° 40′ E. September 26, at 5h. 17m. a.m., apparent time at ship (September 25, 9h. 01m. 13s. G.M.T.), altitude of comet, 7° 20′, distance from Sirius 63° 21′, tail extending nearly in a line from sun to Orion's belt., lat. 27° 52′ N., long. 124° 10′ E. September 27 (at 9h. 02m. G.M.T. September 26), comet's distance from Sirius 62° 32′. At 5h. 32 a.m., altitude of comet 13° 22′, bearing true S. 80° E., lat. 25° 16′ N., long. 119° 56′ E., tail about 7° to 8° long. Comet rose bearing S. 86° E. (true). September 28—distance from Sirius 61° 49′. October 3 (in the Victoria Harbour)—distance of comet from Sirius 58° 43′."

As the comet is still visible I may possibly be able to give you some further information about it by next mail.

The following extract is from the *China Mail* of the 7th inst.:—

A Melbourne despatch, dated September 16, says—"The comet is now extremely bright, being visible through the telescope at noon, a circumstance unprecedented in the experience of the officers of the observatory."

If it is not trespassing too much on your time I should be very much obliged if you would kindly inform me what observations would be useful (which could be taken by an ordinary sextant) should we be visited by another comet.

In conclusion I may add that for the past week the weather has been unusually hot, and although the barometer has fluctuated considerably, no atmospheric disturbance has taken place.

According to M. Dechevrens, S.J., Director of the Zi-ka-wei Observatory, no less than *twenty* typhoons visited the China and Japan seas last year, but up to date of the present year only *three* have been reported.

J. P. MCEWEN, R.N.,
Assistant Harbour Master

Hong Kong, October 9

I THINK there must have been some mistake about Major J. Herschel's observation, as recorded in NATURE, vol. xxvii. p. 5. As other observers have shown, the comet appears quite bright in moonlight. On the morning following his observation I was perhaps as much astonished as he was, only in the opposite direction; for I was very much surprised to find then (the 31st ult., at 5 a.m.), that the tail was longer than on any other occasion when I have seen it, viz. 33°. The following observations will also show the brightness of the comet in moonlight and twilight. On the 26th, at 5.25 a.m., nine hours before full moon, and in brightish twilight, the tail was visible through fog and thin cloud to a distance of 13½°. On the 29th, at 5.37 a.m., it was fully 23° long. This morning, at 6.9 a.m., in bright twilight, it was very faint, but still above 18° long. I think Major Herschel can not have looked low enough down, or his view must have been otherwise obstructed.

The wisp, or horn, that he represents on the 23rd, was certainly a very striking feature at that time. Though not exactly like the drawing in vol. xxvi. p. 622, it was nevertheless very definite, and part of it was brighter than the adjacent part of the comet between it and the head. There appeared that morning to be also two other knots of light, much less conspicuous—one almost a continuation of the "horn," following it, and a little further north; the other, in the *n* branch of the "fish-tail."

T. W. BACKHOUSE

Sunderland, November 7

P.S. November 8.—The "horn" was this morning still a marked feature of the comet, though much less definite than formerly. Its origin (at the point where it begins from the northern branch) is still brighter than the neighbouring portions of the tail for a considerable distance in all directions. It occurs to me that this comet offers a very favourable opportunity of testing theories of the motions of tails; its features are so definite that if careful observations are, and have been, made of the positions of different points, they must throw much light on the subject.

T. W. B.

ON the 10th inst., at 5 a.m., the length of the nucleus was 110″, its breadth 12″, and its position angle 112°·5. The length seems fast increasing judging from previous measures. The tail was still about 15° long, but the first glimpse of daylight completely masked it.

GEO. M. SEABROKE

Temple Observatory, Rugby, November 14

THE great comet was again a magnificent object in our south-eastern sky, at 5.10 this morning. The startlingly sharp definition of October 23 had given place to a softer outline; but the apparent length of the tail was at least as great, and the nucleus surprisingly bright, with a distinct scintillation, even in comparison with two near stars. Major J. Herschel's experience of finding himself gazing at the comet without seeing it, in a clear sky, differs from mine, as I have on two occasions, since October 23, seen it perfectly visible, though wan, in bright moonlight, and when the sky at that elevation above the horizon was not free from haze. On October 23 I saw the strong apparent shadow spoken of by one of your correspondents, but here it was much blacker below the bright convex line of the tail than between the cleft at the end of clear definition. It did not seem to me the effect of contrast merely; but like that blackness through which the stars shone darkly in the recent southward display of aurora borealis.

HENRY CECIL.

Bregner, Bournemouth, November 10

Magnetic Arrangement of Clouds

THERE is a small literature on the above subject (dating back to the time of the publication of Humboldt's *Cosmos*) which seems to have escaped the attention of Mr. Romanes. He will find a large number of observations similar to those mentioned in NATURE, vol. xxvii. p. 31, recorded in a paper in the *Phil. Mag.* for July, 1853, by Mr. W. Stevenson, of Dunse. Similar observations have been made by Mr. Birt, *Met. Mag.* January, 1876, and by several others in this country. M. André Poëy also deals with the subject at some length in his work, "Comment on observe les Nuages," chap. iv.

The apparent arrangement of cirri-form clouds "round two opposite poles" is simply the optical effect of the parallelism of the belts of ice-cloud, or "cirrus-bands," as Humboldt designated them. These belts are coincident in direction with what were, at the time of the formation of the clouds, lines of equal pressure in that horizontal plane in which the clouds float; or, in other words, their direction is normal to that of the atmospheric gradient at the cirrus-level. Their position, and therefore that of their vanishing points, has never been proved to have any relation to the position of the magnetic poles. It is true that in Europe a direction coincident with the magnetic meridian is slightly more common than a direction transverse thereto. But this is explained by the fact that the formation of the bands requires somewhat steep gradients in the regions of the cirrus, and that, with us, the steepest gradients in those regions are commonly the north-eastward, being those which prevail in front of and between the cyclonic disturbances at the earth's surface, which travel towards north-east. Thus, the best defined cirrus-bands most commonly stretch from north-west to south-east.

A detailed explanation of the formation of the belts, which bears some similarity to that given by Lamarck, and which is in many, but perhaps not in all points satisfactory, will be found in a paper by Max Möller in the "Annalen der Hydrographie und Maritimen Meteorologie. Organ des Hydrographischen Amtes und der Deutschen Seewarte," 1882, heft iv. pp. 212-226.

The attempts which have been frequently made to apply the terms "polarisation," "polar bands," &c., to the cirrus belts have proved unsuccessful, and will not, it is to be hoped, be renewed.

W. CLEMENT LEY

November 11

"A Curious Halo"

THE phenomenon described in NATURE (vol. xxvi. pp. 268, 293, xxvii. p. 30) is far from being unknown in Europe, where it generally receives the title of "*Rayons du Crépuscule*"; although I do not think that it ever presents the brilliant appearance described by Father Marc Dechevrens as noticeable in China. In England it is more common in the winter than in the summer months, and does not appear to occur especially in warm weather, although I do not know that it has been noticed during frost. The furrows between the bands of light are not, so far as I have observed, rapidly movable in the sky in England, and they seem to be traceable to hills beneath the horizon, rather than to cumuli. I have never noticed them where the sun sets beneath a sea horizon.

W. CLEMENT LEY

The phenomenon described by M. Dechevrens as often witnessed in China, I have several times seen in this country, namely, beams or spokes in the eastern sky about sunset, springing from a point due opposite to the sun. The appearance is not very strongly marked, and I used to think I must have been mistaken, till I came to see the true explanation, which was the same as that furnished by your correspondent.

There seems no reason why the phenomenon should not be common, and perhaps if looked out for it would be found to be. But who looks east at sunset? Something in the same way everybody has seen the rainbow; but the solar halo, which is really commoner, few people, not readers of scientific works, have ever seen at all. The appearance in question is due to cloud-shadows in an unusual perspective and in a clear sky; now shadow may not only be seen carried by misty, mealy, dusty, or smoky air near the ground, but even on almost every bright day, by seemingly clear air high overhead. Therefore, if this sunset phenomenon is much commoner in China, there must one would think, be some other reason for it than that the sky of England is not heavily charged enough with vapour to carry shadow. Rather it is too much charged, and the edge of the shadow becomes lost with distance and with the thickening of the air towards the horizon before the convergence of the beams eastwards is marked enough to catch the eye.

I may remark that things common at home have sometimes first been remarked abroad. The stars in snow were first observed in the polar regions; it was thought that they only are there, but now everyone sees them with the naked eye on his coatsleeve.

GERARD HOPKINS

Stonyhurst College

Priestley and Lavoisier

I AM sorry that Mr. Rodwell should have thought it necessary to revive the old oxygen quarrel, and the more so, as he has taken an unpatriotic part against Priestley, and indorsed the complacent statement of Wurtz, that chemistry is a French science founded by Lavoisier; forgetting, perhaps, that the title, "La Chimie Française," was invented by Fourcroy, and objected to by Lavoisier.

The fact is, that chemistry has no nationality. It belongs to the universal republic of Nature, and had no proper existence for us until Dalton discovered its laws.

In the scientific democracy, to use Lord Bacon's expression, discoverers are mutually dependent, and it would perhaps be impossible to find any one capable of standing alone. It has even been charged against our great Newton that his astronomical discoveries are to be found in Kepler; but, as Dr. Whewell well remarks, it required a Newton to find them there.

That the compound is always equal to the sum of its elements, was known long before Lavoisier, and so early as 1630 Rey gave the true explanation of the increase of the weight of metals by calcination. Lavoisier's note of 1772 was, as he admitted, based upon Priestley's earlier experiments, begun in 1744; while the acceptance of Lavoisier's doctrine was mainly due to the capital discovery of the composition of water by Cavendish, in 1784.

If at this advanced period we are required to put in national claims, then surely our own countrymen must share largely in the honours which Mr. Rodwell reserves for Lavoisier alone. Black, Priestley, and Cavendish are the founders of pneumatic chemistry. Priestley discovered oxygen in 1774, Cavendish discovered hydrogen in 1784, while Davy abjured Lavoisier's *principe oxygène*, and by his numerous discoveries gave the chemical edifice so rude a shake, that it had to be taken down and rebuilt.

C. TOMLINSON

Highgate, N., November 4

Wire Guns

IN the last number of NATURE there is an interesting paper on "Wire Guns," and incidentally various methods of manufacturing guns is mentioned. *Apropos* of this permit me to relate a curious fact regarding gunmaking which came under my notice many years ago, and which supports the adage that there is nothing new under the sun. In the autumn of 1841 Sir H. Gough took the batteries of Chusan by a turning movement and thus spoiled the Chinese preparations. The force captured a large number of guns, some very fine bronze ones, but there were also a good many smaller iron ones, and as these were of no value they were ordered to be destroyed. The Royal Artillery tried to burst these without success at first, and only after sinking the muzzles in the ground did they succeed. It was then ascertained that the reason of the extreme strength of the gun arose from its strange manufacture. It had an inner tube of wrought iron, over which the gun was *cast*, anticipating by many years a somewhat similar plan by Palliser.

Cheltenham, November 3

W. H. C. B.

Palæolithic River Gravels

MR. C. EVANS, in NATURE, vol. xxvii. p. 8, wishes our anthropologists to furnish an explanation why the mortal remains of palæolithic man are not to be found amongst his "so-called 'flint implements.'"

The question is one that naturally occurs to any one whose practical acquaintance with anthropological "finds" is of a limited character; and it may fairly be presumed that the inquirer has not himself seen and handled such relics, else he would scarcely have imagined it within the range of possibility that they could have been "formed by natural causes," by which, I suppose, he wishes to infer that they were not made by *man*.

As I am a mere tyro myself, and therefore unbiassed in the matter, I beg leave to state, for the benefit of any whose acquaintance with the subject is of only a rudimentary nature—or less—what appears to be a reasonable explanation of the case.

1. The implements of foremost scientific interest are probably those which are found in the various well-known caves, in that they retain in the highest degree all the original sharpness of edge possible only under the slow and undisturbed circumstances of the formation of the stalagmitic rock, or silt deposit, in which they have become embedded above the surface of the ancient floor. All such specimens bear clear and unmistakable testimony to their nature and use as weapons.

2. The alternative hunting-grounds for flint implements are the wide-spread gravels which formed the beds and older banks of the ancient rivers, and which have been of late so thoroughly explored by Mr. Worthington Smith, as recorded by him in this journal, in so many interesting and valuable communications. Respecting these it is only natural that in some cases the specimens have been subjected to much detrition; but then a special value attaches to them on that very account. Of the river gravels as localities from which such evidences are obtainable it is quite unnecessary for me to use space in emphasising the importance of river-sides as a habitat of primitive man.

3. "The entire absence of the bones of man," is simply due to the rapid decomposition of the osseous frames of small-boned animals, and the speedy annihilation of which in the case of man—cremation and other means of disposal apart—is particularly noticeable.

Perhaps the position will be best understood by suggesting the question, "Do you imagine it at all probable that you could unearth any trace of a single bone of one of your pedigree ancestors, say only your great-great-grandfather?" If any of you should doubt the impossibility of such a thing, let proof be given by employing the first grave-digger—*out* of "Hamlet"—to bring the treasures to the light of day, and let the facts of the case be placed on careful record.

4. Any connoisseur can at once tell by the touch of a flint flake whether it has been worked or not, and the fracture always bears certain signs by which the operation may be known to have been performed.

It is somewhat remarkable that there should be any so faithless as to seek after signs so easily to be discerned, in opposition to the testimony of reliable authorities; and *it is surely time* that surrounded as we are with national museums and libraries full of patent facts appealing to all who cannot work for themselves, we should cease to throw discredit upon the evidence of many careful observers and honourable truth-seekers.

Highbury WM. WHITE

YOUR correspondent, Mr. C. Evans, raises the question, in your issue of November 2, whether the peculiarly-chipped flint found in the palæolithic gravels, and accepted as the work of man, may not be the result of natural causes.

Mr. Evans mentions "the presence of bones of *recent* and extinct Mammalia." If your correspondent has clear evidence of the presence of bones of *recent* mammalia with the chipped flints that evidence would prove that the flints in question have not been so chipped by Palæolithic man, but are either nature's work, or the product of man of more recent times, and the gravels in such case should not be called Palæolithic gravels.

St. John's Wood, November 7 T. KARR CALLARD

Aurora

A MAGNIFICENT aurora was observed here last night. I first detected quivering sheaves on the northern horizon about 5.40 G.M.T. About 5.47 a dull indigo base, on or against which "sheaves" and "streamers" were playing with great beauty, was noted, surmounted by an arch of light. Soon afterwards, sharply-defined "spines" and "spikes" of great brilliancy and in patches became developed, followed by five great tongues of light stretching towards the zenith. I especially noted streamers reaching towards Vega, and passing over Mizar in Ursa Major, and some of exceptional brilliancy to north-north-east. At 6.50 irregular horizontal belts of a dull indigo tint, alternated with *horizontal* tongues of light, the streamers having generally disappeared, except to north-north-east. At 8.6 p.m. a low indigo belt, surmounted by a bright golden band, fringed the horizon, o'ertopped again by belts of paler tints respectively, while detached brilliant streamers shot up fitfully towards Cassiopeia. At 11 p.m. auroral lights were still seen.

To-day I intend to examine the sun's disc, and expect to see signs of disturbance.

Fort William, November 14 CLEMENT L. WRAGGE

A Dredging Implement

I WAS much interested in reading, in the last number of NATURE, Prof. Milnes Marshall's account of his successful trial of a new dredging implement.

A few summers ago I constructed and used in Lamlash Bay, Arran, a somewhat similar machine, suggested, like Prof. Marshall's, by the Philippine Islander's dredge used in the *Euplectella* fishery. My implement was a rough copy of one brought from Cebu which I had seen at the *Challenger* office in Edinburgh. It had two slight wooden bars, 5 or 6 feet each in length, meeting at about a right angle to form the front of the apparatus, and having several cross-pieces connecting them further back. I attached large fish-hooks, not to cords hanging from the frame, as in Prof. Marshall's instrument, but to the long bars themselves (as in the Philippine Islanders' machine), and also to the cross-pieces. One weight was tied to a cross-piece near the centre of the frame-work, and a second was attached to the rope a few feet from the front of the instrument, so as to make the pull more horizontal, and so prevent the front end from tilting upwards.

The apparatus worked well and brought up quantities of Hydroids and Polyzoa; but as I was not dredging for Giant Pennatulids, after a few trials I gave it up and returned to the ordinary naturalist's dredge. In one case, however, I found my fish-hook apparatus serviceable. I wished to search a remarkably sea-weedy region, in a few fathoms of water, chiefly for Ascidians attached to the sea-weeds. The ordinary dredge I found almost invariably soon after reaching the bottom, got foul of a large *Laminaria* or some other Algæ, which stretched across the mouth and prevented anything entering. The frame-work with hooks, on the other hand, always brought up enormous masses of stuff, in many cases dragging the *Laminaria* up by the "roots," and hoisting also sometimes stones and shells to which the Algæ were attached, and on which were very frequently the Ascidians I was in quest of.

I should think this kind of apparatus would be most useful for obtaining Algæ on rocky ground, and its value in dredging Pennatulids is sufficiently shown by Prof. Marshall's experience at Oban. W. A. HERDMAN

University College, Liverpool

Forged Irish Antiquities

UP to the present we have had little reason to complain of forgeries among Irish antiquities. Shams have frequently been offered for sale, but they could scarcely be called forgeries, as they were so unlike genuine articles that persons of ordinary experience could scarcely be deceived by them. Lately, however, some very clever imitations have come under my notice. The objects imitated are those known as oval tool-stones, which were formerly very rare but are now offered in lots of two or three together. I believe the fabricated articles are produced somewhere about the Giant's Causeway, the ordinary black shore pebbles being used for the purpose. W. J. KNOWLES

Flixton Place, Ballymena, November 11

THE NEW NATURAL HISTORY MUSEUM

SINCE our previous notice of the great building which has been erected at South Kensington for the reception of the Natural History Collections of the British Museum (NATURE, vol. xxiii. p. 549, April 14, 1881), eighteen months have elapsed, and during that period great progress has been made in the transfer and arrangement of specimens. It may not be uninteresting to the readers of NATURE to receive some information concerning the present condition of affairs and the prospective arrangements in connection with the housing and exhibition of the priceless treasures of the national collections.

The first point which strikes a visitor at the present time is that a serious mistake has been made in the erec-

tion of a building with such elaborate and ornate internal decorations for museum purposes. Now that the cases are nearly all in position and the specimens are gradually being arranged in them, this incongruity between the style and objects of the building becomes more and more apparent. On the one hand, it is clear that the form, position, and illumination of the cases has in many instances been sacrificed to a fear of interfering with the general architectural effect; and on the other hand it is equally manifest that it will be impossible to make full use of the floor space, and especially the best-lighted portion of it, without seriously detracting from the artistic effects designed by the architect.

Thus we find the beautiful arcade formed by a series of pierced wall-cases in the Coral-gallery has its effect totally destroyed by the floor-cases, which it has been found necessary to place along the central line; and in the British gallery the vistas designed by the architect have been completely marred by the insertion of large cases in some of the arches. Again and again we find massive columns, beautiful in themselves perhaps, breaking up a line of cases, or throwing their contents into deep shade. The peculiar tint of the terra-cotta, too, is far from being suitable for making the objects of the Museum stand out in relief, and this is particularly manifest in the case of the palæontological collections, where a great majority of the specimens have a very similar colouring. When an attempt has been made to remedy this by giving the walls near the objects other tints; it is found that such tints do not harmonize well with the general colouring of the building. Nor is the wisdom apparent of bringing into close proximity natural-history objects with the conventional representations of them adopted by architects. The crowding together, on the same column or moulding, of representations on the same scale of microscopic and gigantic organisms, of inhabitants of the sea and of the land, and of the forms of life belonging to present and those of former periods of the earth's history, seems to be scarcely warrantable in a building designed for educational purposes.

Greatly as we admire the spacious hall, the grand staircase, the long colonnades, and the picturesque colouring of the whole building, we cannot but feel that the adoption of such a semi-ecclesiastical style was a mistake. We fear that in the future there will be a perpetual conflict between the views of the keepers of the Museum-collections and those of the architect of the building; for the erection of cases as they may be required in the most convenient and best-lighted situations cannot fail to detract from the striking and pleasing effects of the architecture.

Apart from this fundamental objection, however, we find nothing but what is praiseworthy in the arrangements which are being made to worthily exhibit to the public these grand collections, of which such large portions have been long buried at Bloomsbury. In a few months the whole of them will have been removed from their old places of exhibition (or more often of sepulture) to the new galleries, where the space available for their arrangement is so much greater. The cases in the Zoological Galleries are now almost completed and fitted, and the collections of osteology and shells with some of the stuffed animals, have been already removed to their new home—so that the public may hope to see the transfer of the whole of the specimens completed by next spring.

The keepers of the geological, mineralogical, and botanical collections, which are housed in the eastern wing and annexes of the building, have had a very difficult task to perform. They were called upon to remove these collections before the fitting of cases in the new buildings was completed, and in consequence of this the re-arrangement of the specimens, with the incorporation of the valuable material long packed away in the cellars at Bloomsbury owing to want of space, was rendered additionally laborious and troublesome. These difficulties have now, for the most part, however, been happily overcome.

The Geological collections, in spite of their vastness have been to a great extent arranged. The Mammalian and Reptilian Galleries are indeed almost completed, and much progress has been made with the Fish Gallery and the several rooms devoted to the exhibition of the invertebrata and the stratigraphical collections. The trustees have been fortunate in securing the services of such an experienced palæontologist as Mr. Etheridge to second the energetic efforts of Dr. Woodward in this department. By the insertion of drawings and tables, illustrative of the structure and classification of the fossil forms, the value of this part of the collection to students has been greatly enhanced.

In the Mineralogical Gallery everyone must be struck by the improvement in the cases, now that the specimens are no longer crowded together, as was the case in the old museum. At the end of the general gallery, and in the adjoining pavilion, there are a number of interesting special collections. First and foremost among these is the unrivalled series of meteorites, which is now displayed to much greater advantage than at Bloomsbury; with these are collections of crystals, both artificial and natural, of pseudomorphs and of rocks, or mineral aggregates—the latter being an entirely new feature in this department. Large specimens, illustrating the abnormal development, the mode of association, and the economic uses of minerals are here being arranged, and they make a very fine display. Working mineralogists will be thankful to Mr. Fletcher for his capital design of setting apart a case, in which new acquisitions to the collection are exhibited for awhile, before being incoporated with the general series.

The portion of the Botanical collection available for public exhibition is small, but Mr. Carruthers, the keeper, has brought together a capital series of examples of all the great divisions of the vegetable kingdom—illustrating the dried specimens, where necessary, by drawings and models.

There are two points, however, in connection with the establishment concerning which the readers of NATURE will naturally be especially desirous of information—first, as to the facilities to be afforded to students for examining the valuable types and rare specimens in which the collections are so rich, and secondly, with respect to the improvements which are sought to be made in the Museum, regarded from the point of view of an educational institution. The surest test of the efficiency of the administration of such a museum as this will be found in the manner in which these two great objects are attained by its keepers.

Close days for students having been now entirely abolished, the trustees of the Museum have provided galleries in each of the departments where scientific workers can pursue their studies undisturbed. We cannot help thinking that this plan is far better than the old one, which required original investigators to attend on those days of the week when the public were not admitted to the galleries—a restriction keenly felt by busy men in this country, and more especially by foreigners, who had perhaps come to this country with the sole object of devoting their time to the study of our national collections. As there are valuable reference libraries in each of the departments, and a general library of scientific journals for the whole establishment, the student has much greater facilities than formerly for carrying on his work, and nothing can exceed the courtesy with which persons actually engaged in scientific research are received and aided by the keepers and their assistants.

The publication of the series of well-known and valuable scientific catalogues is still proceeding. During the pressure of work caused by the removal of these vast collections, the trustees of the Museum have done wisely

to avail themselves of the aid of specialists from outside, in connection with certain of the collections. Thus the collection of the fossil foraminifera has been arranged by Prof. T. Rupert Jones, whose catalogue of the same has been recently published. Dr. Hinde has in the same way dealt with the grand collection of fossil sponges; and his illustrated catalogue of them is now in the press.

But while the purely scientific objects of the Museum are not being lost sight of, we are glad to find that the greatest efforts are being directed by the keepers to the development of the institution as a means of popular education. In addition to the three admirable guides, published at the low price of one penny each, other popular works in illustration of the collection are being prepared. Thus Mr. Fletcher has written a penny guide to the collection of meteorites, in which he has drawn up one of the best statements concerning the nature of these bodies, and of the grounds on which they are so greatly valued by scientific inquirers, that we ever remember to have read. Simple in its language and mode of treatment of the subject, this little guide is replete with the most valuable information—information which the student of the collection might ransack a library in vain to find.

Still more interesting is Dr. Woodward's venture in the same direction—an illustrated guide for the department of Geology and Palæontology. The woodcut illustrations of this work are in part original, and in part borrowed from various scientific manuals, the publishers of which have generously granted the use of them to the Museum authorities. By the aid of these woodcuts Dr. Woodward is able to call attention to the chief facts concerning the structure of some of the most remarkable fossils in the collection, and the guide forms an excellent introduction to the study of palæontology. At present the only part of this guide which is illustrated by woodcuts is that which deals with the fossil vertebrates, for these only are as yet fully arranged; but in subsequent editions, no doubt, Dr. Woodward will give equal attention to the description of the most important forms, among the invertebrates. The design is an excellent one, and there is every promise in the present instalment of the work of its being admirably carried out. Such work cannot fail to be the means of diffusing in the widest possible manner accurate notions on the subject of natural history among the people. We hope that its circulation may be as large as that of Prof. Oliver's admirably illustrated guide to Kew Gardens, which we are glad to see has passed through twenty-nine editions.

While on the subject of the means adopted by the Museum authorities to make the collections a means of diffusing correct ideas among the people, we cannot avoid referring to Prof. Owen's design of surrounding the great central hall of the building with an "Index Museum." The idea is most praiseworthy, but its execution will, we fear, be attended with serious difficulties. Prof. Owen proposes to devote the first of the six recesses on the western side of the central hall to the illustration of man, the two next to the other mammalia, the fourth to birds, the fifth to reptiles, and the sixth to fishes. On the other side three recesses are to be devoted to the invertebrata, and one each to botany, mineralogy, and geology. Few naturalists will agree with Prof. Owen that the points which distinguish man from the rest of the animal kingdom, are to the zoologist, of such importance as to necessitate the setting apart of a division of the Index Museum for their illustration; and the limited portion of the available space assigned to botany and geology will occasion much surprise. As structural alterations have interfered with the use of two of these recesses, and the lighting of some of them is far from being satisfactory, the project may perhaps have to be greatly modified. One of the recesses, that devoted to the birds, has been already arranged with instructive diagrams and well-selected specimens, and a penny guide to it, written by Prof. Owen in his well-known clear and attractive style, has been published. If the design is carried further, we hope the greatest care will be taken to make the classification and arrangement adopted in the Index Museum harmonise with that employed in the several galleries, for otherwise such a museum will not serve as an index to the great collection, but will be a source of confusion rather than of assistance to students.

Of the zoological collections we can say little at present. The birds will occupy the ground floor of the western wing of the building, and the mammals the floor above. The osteological collections belonging to these two departments are already arranged in the upper floor, and form a new and most valuable feature of the Museum. The articulated skeletons are exhibited on the floor and in glass cases, behind which cupboards are constructed for the reception of unarticulated skeletons. The Pavilion contains a special series of bones, which are reserved for purposes of study. The skeletons of whales are to be housed in the basement of the building.

Generally we find that the convenience of the public has been fully consulted in the arrangements of the building. The lavatories and cloak-rooms are all that can be desired, but we suspect that much disappointment will be felt with regard to the refreshment department as at present constituted. Small and inconvenient counters are being erected on the highest story of the building, outside the Botanical and Osteological Galleries respectively. The obstacle thus created to the ingress and egress of visitors to those departments, and the fact that mice will infallibly be brought to them, is enough to ensure condemnation of such a plan. We hope that the trustees may yet reconsider the question, and find themselves able to devote to the purpose of refreshment, a room in the building which is centrally situated, and at the same time entirely cut off from the collections.

THE COMET

WE take the following from the *Sydney Morning Herald* of September 19:—

Mr. H. C. Russell, Government Astronomer, sends us the following interesting particulars respecting the comet, under yesterday's date:—

The comet discovered on the 7th has developed in brilliance rapidly. When I first saw it on the 8th, the nucleus was equal to a bright star of the second magnitude; by the 11th it was brighter than a first magnitude star, and I was able to see it for eight minutes after sunrise on that day. Subsequently, the mornings were cloudy, and I could not see the comet either then or during the daylight, probably because of the sea haze, which is more or less part of the N.E. wind. The comet has, however, increased in brilliance so rapidly that Mr. Ellery was able to see the comet at noon, and telegraphed to me to that effect, and the air being clear it was found at once. I had not anticipated such a wonderful increase in its light, for now it is easily seen in the full glare of the sunshine, like a star of the first magnitude, even when viewed without a telescope, and it must be many times more brilliant than Venus when at maximum. In the large telescope the nucleus appears round and well defined, and measured three seconds in diameter; from it, extended on each side, the first branches of the coma, like two little cherub wings, and in front, the great body of the coma, forming a brilliant and symmetrical head, and thence turning to form the tail six minutes long. Under close scrutiny it was evident that the coma had one or more dark bands, curved like the outline, which made the form very interesting, but the glare of the sunlight made it very trying to the eyes. It is a splendid object, and it is to be regretted that no stars can be seen by means of which to fix

accurately the comet's position; but should the weather continue fine, it will be possible to do this with the transit instrument. My observations this afternoon show that the comet was moving away from the sun again, and should this be maintained, it will become a morning, not an evening object. At 1.15 p.m. to-day the comet was only 9m. 45s. west from the centre of the sun, and 7m. of declination south; by 5 p.m. the distance in right ascension had increased three minutes; the declination was slightly less. Unless some rapid change in the direction of the motion takes place before to-morrow (and now that the comet is so near the sun this may result), the comet will be seen without the aid of a telescope, about seven degrees west of the sun. History tells us of wonderful comets which outshone the sun; but it is usual to receive these statements after liberal discount. Nevertheless the great comet of 1843 was easily seen by spectators when it was only 1° 23′ from the sun (that is, about half the distance between the comet and sun to-day at 1 p.m.); and at Parma the observers standing in the shade of a wall saw the comet with a tail four or five degrees in length. In Mexico, also, the comet was seen near the sun like a star of the first magnitude. It is probable, therefore, that the comet of 1843, the brightest of this century, was brighter than the present one.

We are indebted to Mr. John Tebbutt, of the Private Observatory, Windsor, for the following communications respecting the comet:—

September 16.—I succeeded in obtaining pretty good observations of the comet on the mornings of the 9th and 10th instant, but since the latter date fog and cloud have prevented observation. The following are the positions secured:—September 8d. 17h. 54m. 52s., R.A.=9h. 37m. 7·50s., Declination S. =0° 57′ 46″·4; September 9d. 17h. 49m. 45s., R.A. 9h. 45m. 47·81s., Declination S. = 0° 53′ 36″·2. A third position will, of course be necessary for the approximate determination of the orbit. In the absence, however, of such a determination it may safely be stated that the comet is rapidly coming into conjunction with the sun, and near its ascending node. It is not at all improbable that the comet is passing between us and the sun, and that in consequence its tail will be pointed approximately towards the earth. As we do not at present know the exact apparent track of the stranger, it would be advisable to watch the sun's disc at intervals during the next few days for a possible transit, and to look out at night for any indications of the aurora consequent on a possible near approach of the earth to the tail. It will be remembered that our passage through the tail of the great comet of 1861 was marked by a general exhibition of auroral phenomena. It is highly probable that the comet will, towards the close of next week, become an imposing object in the west during the evenings. Like the recent Wells comet, this body will doubtless be well observed with the transit circle in full sunlight.

September 18.—The extraordinary interest which attaches to the comet now visible will, I trust, afford a sufficient apology for my again trespassing so soon on your valuable space. Supposing, from the rapid increase in the brilliancy of the comet that it would probably be seen in full daylight, I turned my attention to the immediate neighbourhood of the sun about 10h. a.m. yesterday. I at once found the comet without a telescope; it was visible about four or five degrees west of that luminary as a brilliant white dagger-like object. The head was beautifully distinct, and the tail could be readily traced for about twenty minutes of arc. I succeeded in obtaining eleven absolute determinations of position with the equatorial, the approximate right ascension and declination of the last observation, 11h. 25m. a.m., being respectively 11h. 22m. and 1° 10′ north. I attempted to observe with the transit instrument. The comet entered the field of the telescope and was at once bisected by the declination wire; but, unfortunately, just before it reached the first transit wire it was obscured by a passing cloud and remained so till just previously to its quitting the field, when it was still found to be bisected. I trust the Melbourne observers will not fail to avail themselves of every opportunity to observe with the transit circle. If my memory serves me well I believe the history of astronomy does not furnish any previous instance of a comet being seen near the sun with the unassisted eye since the appearance of the extraordinary and well-known comet of 1843. That body was seen at 3h. 6m. p.m. at Portland, U.S., by a Mr. Clark, and consequently in full sunlight, and its distance from the sun measured by him with an ordinary sextant. The present comet was still plainly to be seen without the telescope at 5h. p.m. yesterday. To-day it will probably be too nearly in a line with the sun to be seen; but on Tuesday and Wednesday it will, I think, again be visible. In the absence of any calculation I will here venture to offer one or two remarks. The comet appears, from a rough inspection of its apparent path, to be moving in a track somewhat resembling that which would be followed at this time of the year by the great comet of 1843 on its way to perihelion, and it is a significant fact that the earth is to-day almost exactly on the line of the comet's nodes, and on the ascending side of the sun. At Greenwich mean noon to-day the longitude of the earth will be 355½°, while that of the ascending node of the great comet of 1843 is about 358°. It will be remembered that at the time of the appearance of the great comet of 1880 the parabolic elements of that body were found to be almost precisely those of the great comet of 1843 (see my paper read before the Royal Society of New South Wales in July, 1880)—and it was therefore considered that the two bodies were identical. It will be remembered, too, that at a discussion at one of the Royal Astronomical Society's meetings it was suggested that although the period between the returns of the comet in 1843 and 1880 was 37 years, the time of revolution might be greatly shortened by the comet's passage through the sun's coronal atmosphere. The question therefore arises—Is the appearance of the present comet a return of the same body? Should the comet make its appearance in the west after sunset, it is quite certain that it cannot be identical with that of 1843 and 1880; but if it should now rapidly revolve round the sun, and make its appearance again west of that luminary, it must certainly be a comet of very small perihelion distance. Whether it is the comet of 1843 and 1880 time alone will decide. I dare say your readers will call to mind the speculation of Mr. Proctor on the probable return of the comet of 1843 and 1880.

P.S.—At 11h. 35m. a.m. to-day (September 18) I again detected the comet with the unassisted eye. It was then about three-quarters of a degree west of the sun's western limb, and apparently moving west. In this case the comet in a few days must be again looked for in the morning sky.

The *Herald* writes:—The comet discovered on the 7th instant has increased so greatly in brilliancy that it can be discerned in daylight with the naked eye. The fact was discovered by Mr. Ellery, Government Astronomer in Melbourne, at noon, and by him communicated to Mr. Russell; but the unusual phenomenon was observed by Mr. Tebbutt, of the private observatory, Windsor, at about 10 o'clock. The authorities seem to agree that the history of astronomy does not furnish any previous instance of a comet being seen near the sun, as this is, since the extraordinary and well-known visitant of 1843. It is probable, Mr. Russell states, that the comet may be seen about seven degrees west of the sun, from which luminary it is apparently, however, moving away; and, should this movement be maintained, it will become a morning and not an evening object.

So far the Sydney journal.

We are indebted to Sir H. Lefroy for an extract from

the *Eastern Star*, published at Grahamstown, Cape Colony, in which Mr. L. A. Eddie, F.R.A.S., draws attention to the duplication of the nucleus which appears to have been first remarked at the Royal Observatory, Cape of Good Hope, on September 30, and on the same date in the United States: a day or so later European observers very generally perceived it. On the morning of September 24, at 4h. 30m., Mr. Eddie, says: "A most glorious sight presented itself. The head of the comet had not yet risen, but a broad belt of golden light, about two degrees in breadth, streamed upwards from the horizon to about ten degrees; and from the northern margin of this again, a thin streak of less brilliant light extended upwards to about another twelve degrees, and when the head had fully risen above the horizon at 4h. 43m. a.m., there were about twenty-five degrees in length of intensely luminous matter, stretching upwards from a still more luminous head, and inclined to the horizon at an angle of 70°. . . . The head appeared as before, to consist of an apparently very solid though not very large nucleus, surrounded by a dense coma of no great extent, especially preceding the nucleus, and possessing no dark intervals, &c." The weather prevented further observation at Grahamstown till the morning of October 3, when, on directing his 9½-inch Calver upon the nucleus, Mr. Eddie saw not one round planetary disc, as he had last seen it, but "two distinct ellipsoidal nuclei in juxtaposition, each of them brighter on the interior edge, and drawn out, as it were, towards the comet's ulterior boundary, so that their conjugate axes were about double the transverse. They closely resembled, in the inverting telescope, the flames of two candles placed the one above the other, so that the uppermost part of the lower flame almost overlapped the lower portion of the other. There was a dark rift the breadth of the transverse axes of these nuclei, extending from the hindermost one into the tail. These two nuclei were not parallel with the axis of the comet, but the foremost was drawn, as it were, to the south, or nearer to the direction in which the comet is moving." Mr. Eddie further compares the two nuclei to the double-star α Centauri when viewed through a cloud with a low power. When daylight had advanced, they could be seen in the telescope perfectly free from the light of the surrounding coma. On the following morning the nuclei were distinctly divided with powers of 60 and 100 on the reflector: the preceding nucleus was larger and brighter than the other, but both were, if anything, smaller than previously.

The *Natal Mercury* of October 6 describes the imposing spectacle which the comet presented as it rose apparently from the Indian Ocean. The nucleus shone with a brilliancy rivalling Sirius, or even Venus, and the tail was slightly curved, and though, as dawn approached, a little diminished in length, appeared more concentrated and magnificent.

Observers who remember the great comet of 1843, as it presented itself in the southern hemisphere, are somewhat divided in opinion as to which body to give the palm on the score of brilliancy, though most of them appear inclined to favour the former. The Emperor of Brazil, who observed the comet of 1843 close to the sun on February 28, and on the following evenings, considers it was not so remarkable for the brightness of the nucleus as the present comet, but that the tail had a much greater extent.

At Santiago, Chile, the comet was visible on September 17, some minutes before sunrise, and on the next morning could be followed until 11h. 30m. with the greatest facility without the telescope; part of the tail near the nucleus was also visible, the northern border being much brighter than the other. On September 20, though the light of the comet had somewhat diminished, it was seen with the naked eye till 10h. 30m. M. Niesten, Chief of the Belgian expedition for the observation of the transit of Venus, observed the comet in Chile: he found the length of the tail (northern branch) 25° on September 22, and 22° on the following morning.

By the kindness of the Astronomer Royal, we learn that the comet was observed on the meridian at Melbourne on September 15, 16, and 17 civil reckoning; equatorial observations commenced on the morning of September 10: Mr. John Tebbutt observed the comet the previous morning at his private observatory, Windsor, N.S.W. The Melbourne meridian observations will be of great value in the determination of the elements of the orbit prior to the comet's rush through the solar coronal region, the last one having been made only fifteen hours before the perihelion passage.

Subjoined is an ephemeris of the comet for 18h. M.T. at Greenwich. It will be seen that it is now well observable on the meridian.

	Right Ascension.	Declination.	Distance from Earth.	Distance from Sun.
	h. m. s.	° ′		
Nov. 16	9 25 58	− 25 3·1	1·496	1·688
18	9 21 25	25 39·0		
20	9 16 40	26 13·5	1·500	1·762
22	9 11 43	26 46·4		
24	9 6 35	27 17·6	1·510	1·835
26	9 1 16	27 46·9		
28	8 55 47	− 28 14·2	1·514	1·906

The latest investigations on the motion of this comet tend to indicate, contrary to the expectation that was at first entertained by many astronomers, that it is not identical either with the great comet of 1843, nor with that which appeared with so great a resemblance in the elements of the orbit in 1880. Calculations by Messrs. Chandler, Wendell, and Hind, are so far in accord upon this point.

RECENT DYNAMO-ELECTRIC MACHINES

ELECTRICAL inventions of innumerable kinds have of late followed one another with bewildering rapidity; and the impetus to invention afforded by the present development of electric lighting, and by recent electrical exhibitions, is making itself felt in many ways. Most important, perhaps, of these is the production of improved types of machines for generating electric currents. Dynamo-electric machines, in fact, appear to be undergoing the same kind of evolution which the steam-engine has undergone; and just at present the tendency appears to be in the direction of producing larger and heavier machines than heretofore.

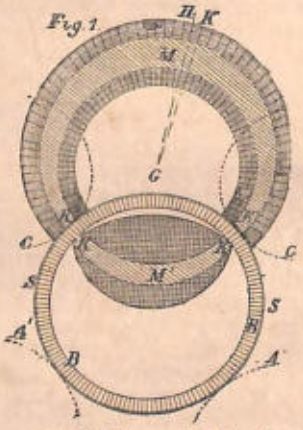
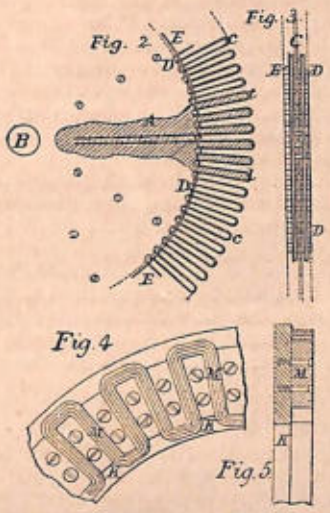


FIG. 1.—Sir W. Thomson's Roller Dynamo.

The readers of NATURE will be familiar with the description of Edison's large steam-dynamo, which first made its appearance in Paris in 1881, and of which two examples are now at work in the Edison installation at Holborn Viaduct. These monster dynamos, each requir-

ing from 120 to 150 horse-power to drive it, are capable of lighting from 1000 to 1300 incandescent electric lamps.

Six such machines have been also erected in New York to supply the central station of the Edison Light Com-



FIGS. 2–5.—Sir W. Thomson's Disk-Dynamo

pany. Here the unexpected difficulty has arisen that if one of the machines drops in speed the currents from the other machines short-circuit themselves through the one, and overpower the steam-engine that is driving it; a fault which will probably be remedied by a rearrangement of the governors supplying the steam to the engines.

New forms of dynamo-electric machine have been designed by Sir William Thomson, some of these being for direct currents, others for alternate, but all of them of peculiar construction. The first of them, shown in Fig. 1, may be described as a modification of Siemens' well-known machine, the drum-armature being, however, made up like a hollow barrel, of which BB is a sectional view, the separate staves being copper conductors insulated from one another. They resemble the longitudinal bars used by Siemens in the armatures of his electro-plating machines, and by Edison in his steam-dynamo. At one end of the hollow drum these copper bars are united to each other in pairs, each to the one opposite it. At the other end their prolongations serve as commutator bars. A similar mode of connecting to that adopted by Edison, is also possible. Inside this hollow drum armature is an internal stationary electro-magnet, KM'K, whose poles face those of the external field magnets. This internal magnet answers the purpose of intensifying the magnetic field, and making the magnetic system a "closed" one, as suggested long before by Lord Elphinstone and Mr. Vincent. This hollow armature Sir W. Thomson proposes to support on external antifriction rollers AA' CC', the lower pair AA being of non-conducting material, the upper pair being made up of conical cups of copper split radially, and serving, instead of the usual commutator "brushes" to lead away the current. The hollow armature may be driven either by the tangential force of one of the bearing rollers, or by an axle fixed into the closed end of it.

Another machine devised by Sir W. Thomson, and illus-

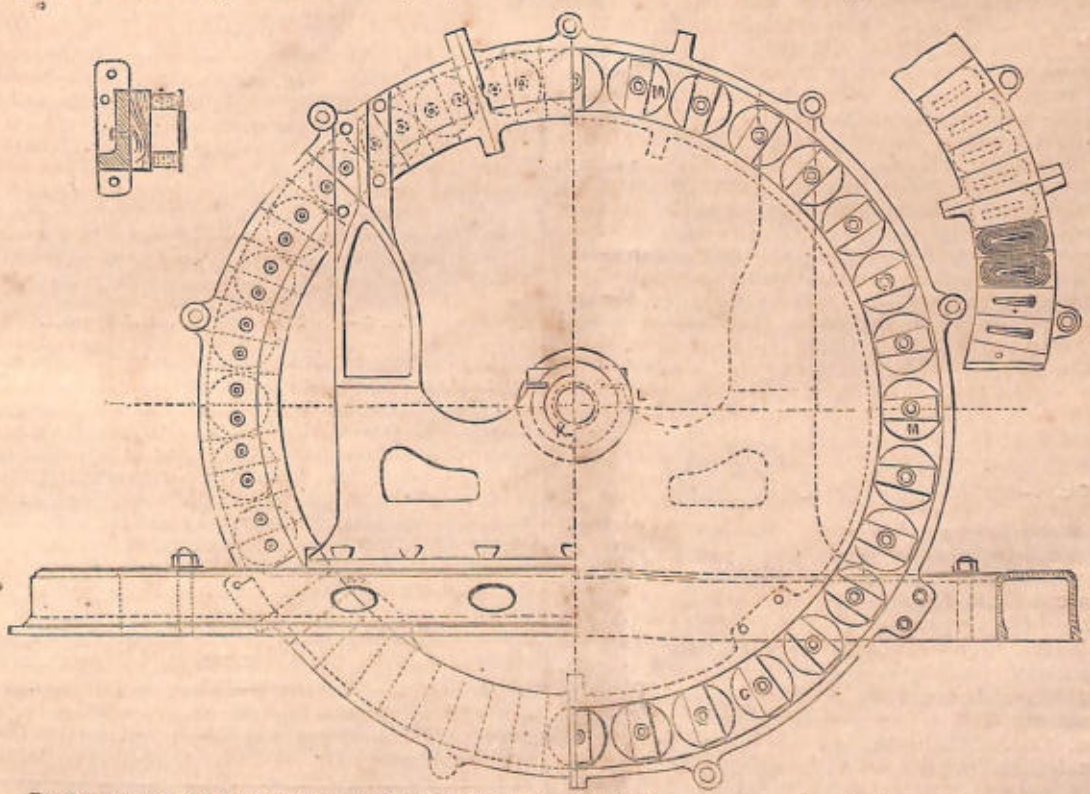


FIG. 6.—Elevation of Gordon's Dynamo, showing the rotating coils. The "taking-off" coils are shown in the top right hand corner.

trated in Figs. 2, 3, 4, and 5, is a disk-dynamo for generating alternate currents, and is therefore allied in certain aspects to Mr. Gordon's machine, described below. The rotating armature has no iron in it; it consists of a disk of wood having upon its sides projecting wooden teeth, as shown in Figs. 2 and 3, between which a wire or strip of copper is bent backwards and forwards, and finally carried to the axle B. This disk is rotated between field-magnets

having poles set alternately all round a circular frame. Figs. 4 and 5 show how this is carried out. A cast-iron ring having projecting iron pieces screwed into it is surrounded by zig-zag conductors which carry into it the current from a separate exciter. These currents pass up and down between the projecting cheeks, and excite those on both sides of them.

A still more recent, and still larger generator, is that designed by Mr. J. E. H. Gordon, whose "Physical Treatise on Electricity and Magnetism" is known to most of our readers. This machine, which is given in elevation in Fig. 6, and in end-elevation in Fig. 7, is more than 9 feet in height, and weighs 18 tons. It possesses several points of interest. The rotating armature differs from those of the well-known Gramme or Siemens' armatures, being in form a *disc*, constructed of boiler-plate, upon which the coils are carried. The machine, therefore, resembles in some respects the Siemens' alternate-current machine, though there are notable points of difference, the most important

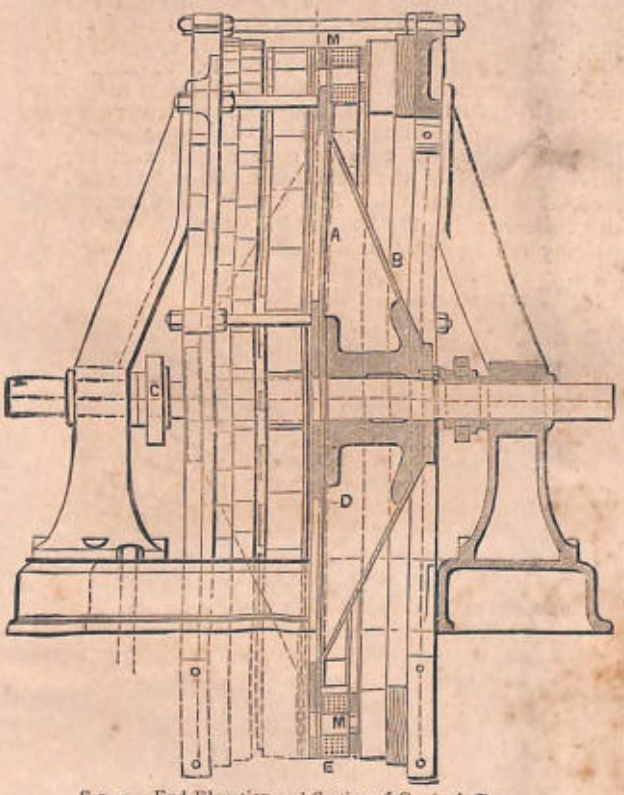


FIG. 7.—End Elevation and Section of Gordon's Dynamo.

being, that whereas in most dynamo-machines the inducing field-magnets are fixed, and the induced coils rotating, in Mr. Gordon's new machine the rotating coils are those which act inductively upon the fixed coils between which they revolve. The machine furnishes alternate currents, and therefore requires separate exciters. These exciters, two Burgin machines, send currents which enter and leave the revolving armature by brushes pressing upon rings of phosphor bronze placed upon the axis at either side. There are 64 coils upon the rotating disc, and double that number upon the fixed framework. These 128 "taking-off" coils, the form of which is shown in Fig. 8, are alternately connected to two circuits, there being 32 groups in parallel arc, each parallel containing 4 coils in series; thus bringing the total electromotive force to 105 volts when the machine is driven at 140 revolutions per minute. At this speed it actuates 1300 Swan lamps, but is calculated to actuate from 5000 to 7000 if the driving power is proportionately increased. The machine is now in operation at the Telegraph Construction and Maintenance Company's Works, East Greenwich.

A great deal has been said in certain quarters of late about another new dynamo, the invention of Mr. Ferranti, which, with one of those unscientific exaggerations which cannot be too strongly condemned, was pronounced to have an efficiency five times as great as that of existing dynamos. The construction of this machine has not yet been made known, but it is understood that it has no iron in the rotating armature. This is, however, no novelty in dynamos. It appears, also, that Mr. Ferranti has invented an alternate-current machine almost identical with that of Sir William Thomson described above.

Lastly, M. Gravier claims to have designed a form of dynamo in which there are neither commutators nor separate exciters, but in which continuous currents of electricity are produced in stationary coils by the passage near them of a rotating series of iron bars whose mag-

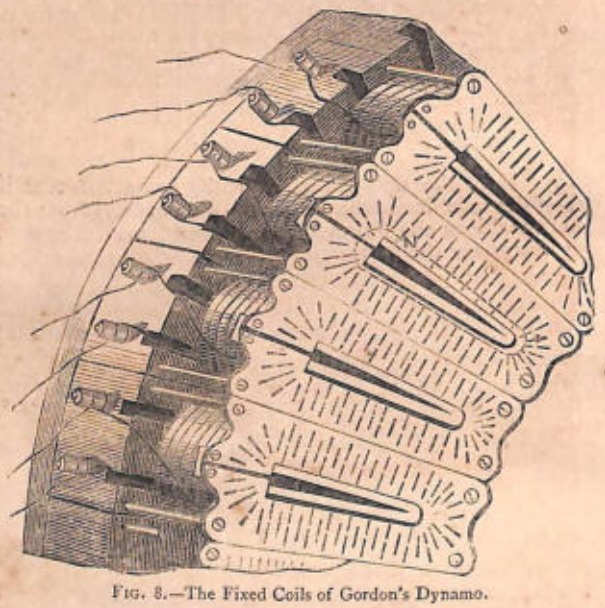


FIG. 8.—The Fixed Coils of Gordon's Dynamo.

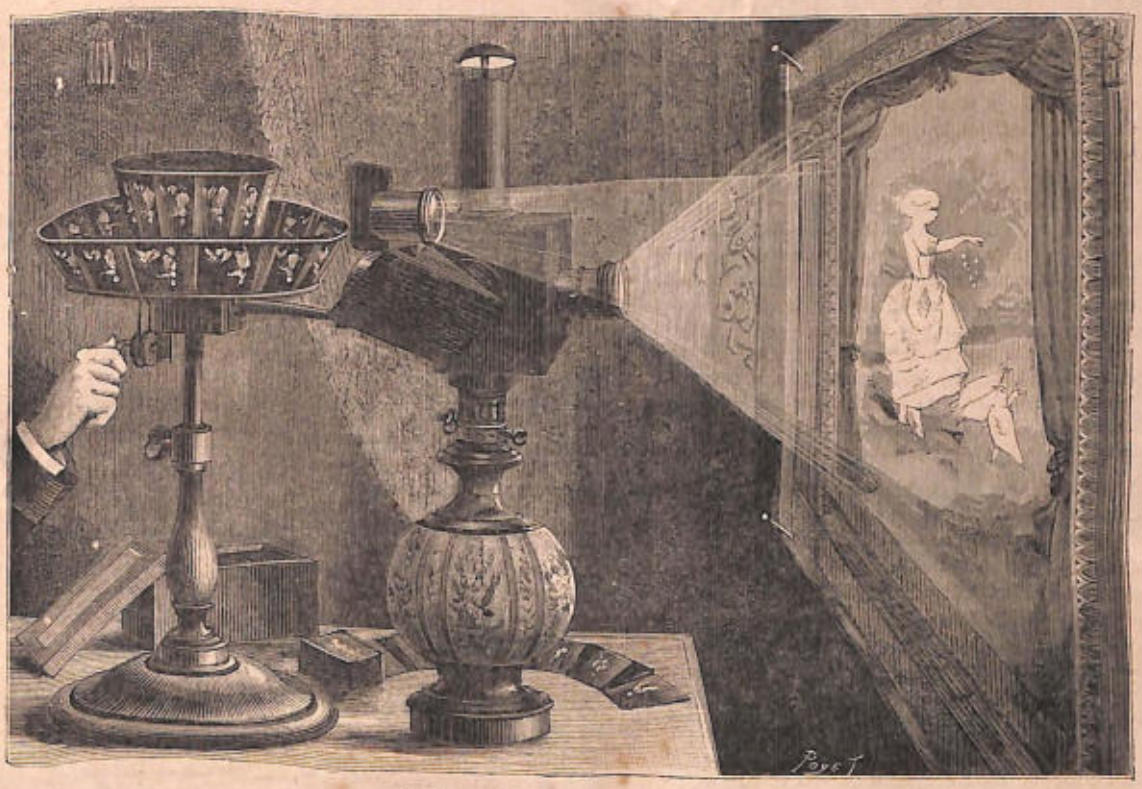
netism is changed, during their passage, by the reaction of the cores of the stationary coils themselves. M. Gravier has also designed a machine in which a Gramme-ring is wound with two sets of coils, a primary and a secondary, each set having its own commutator on opposite ends of the axis. A current from a separate exciting machine passes into the primary coils of the ring by one pair of brushes, and the secondary current is taken off by a second pair of brushes at the other commutator placed at right angles to the first pair. We are not aware that any practical machine thus constructed has yet been shown in action.

It is certain that there is yet abundant room for great improvement in the construction of dynamo-electric machines. But the inducements to improvement at the present time are so great that rapid progress toward the desired goal of perfect efficiency and simplicity of structure is more than assured.

THE PROJECTION PRAXINOSCOPE

M. GASTON TISSANDIER describes in *La Nature* an ingenious adaptation of the praxinoscope, under the above name, by means of which the images are projected on a screen, and are visible to a large assembly.

Our engraving will give an idea of the arrangement and the effect produced. By a modification of the "lampascope," M. Reynaud, the inventor, obtains by means of an ordinary lamp, at once the projection of the scene or background—by the object-glass which is seen at the side of the lantern—and of the subject, by another object-glass which is shown in front of and a little above the same lantern. For this, the positions or phases which form a subject are drawn and coloured on glass, and are connected in a continuous band by means of any suitable material. One of these flexible bands is placed in the wide crown of the praxinoscope, which is pierced with openings corresponding to the phases of the subject. To understand the course of the luminous rays which go to form the image, it is necessary to bear in mind the condensing lens which, placed near the flame of the lamp,



M. Reynaud's new projection-praxinoscope.

is not visible in the figure; then a plane mirror inclined 45°, which reflects the rays and causes them to traverse the figures filling the openings of the crown. These rays, reflected once more by the facets of the prism of mirrors, finally enter the object-glass, which transforms the vertical central image into a real image magnified on the screen. In making the two parts of the apparatus converge slightly, the animated subject is brought into the middle of the background, where it then appears to gambol. A hand-lever on the foot of the instrument allows a moderate and regular rotation to be communicated. This apparatus, with an ordinary moderator lamp, supplies well-lighted pictures and curious effects. It enables us to obtain, with the greatest ease, animated projections, without requiring any special source of light, by simply utilising the lamp in daily use.

NOTES

We take the following from the *Times*:—The council of the Royal Society have awarded the medals in their gift for the present year as follows: The Copley Medal to Prof. Cayley, F.R.S., for his researches in pure mathematics; the Rumford Medal to Capt. Abney, F.R.S., for his photographic researches and his discovery of the method of photographing the less refrangible part of the spectrum, especially the infra-red region; a royal medal to Prof. W. H. Flower, F.R.S., for his contributions to the morphology and classification of the mammalia and to anthropology; and a royal medal to Lord Rayleigh, F.R.S., for his papers in mathematical and experimental physics; the Davy Medal (in duplicate) to D. Mendelejeff and Lothar Meyer for their discovery of the periodic relations of the atomic weights. These medals will be presented at the anniversary meeting of the society on St. Andrew's Day.

The President and Council of the Geological Society hold a *conversazione* in the Society's rooms on Wednesday, the 29th inst. Fellows of the Society who have objects of interest suitable for exhibition are asked kindly to lend them for the occasion.

It is announced that General Pitt Rivers will be appointed Inspector of Ancient Monuments under the recent Act.

We announced last week the death, at the age of sixty-six years, of Prof. Johannes Theodor Reinhardt, Inspector of the Zoological Museum of the University of Copenhagen. Prof. Reinhardt was a well-known zoologist, author of an excellent memoir on the Birds of the Campos of Brazil, and of numerous papers in the scientific periodicals of Copenhagen, and will be regretted by many friends and correspondents in this country.

At the sitting of the Paris Academy of Sciences on November 13, M. Faye read letters from the captain of the *Niger*, French

war steamer, on the comet, stating that it was seen at Buenos Ayres, in the streets, on November 18, in close vicinity to the sun, and that the tail was seen for the first time on board the *Niger* on September 26. The expanse of the tail was then 28°, and its transversal dimension 26°. The quantity of light was so great that when the end of the tail began to become visible the officers and sailors witnessing the phenomenon were quite unable to understand the real nature of this splendid illumination.

MR. B. J. HOPKINS, of Dalston, sends us a drawing of the head of the comet, which he saw on November 8, 16h. 50m. Viewed with the naked eye, Mr. Hopkins states, the nucleus appeared equal to a second-magnitude star; the tail was distinctly visible, having a length of about 19°; it was straight for four-fifths its length; it then abruptly curved upwards and spread itself out in the shape of a fan, with a breadth of 4°. It was still brightest on the southern side. Observing at 17h. 30m. the nucleus—as seen with a 5-inch refractor—had the appearance of being double, there being two portions of equal brightness separated by a narrow space of less brightness, the whole being surrounded by a circular nebulosity. The line joining the two bright portions of the nucleus formed an angle with the axis of the tail; and the tail immediately following the nucleus was most clearly and sharply divided into two portions of unequal brightness, the southern, as before mentioned, being by far the most brilliant. The dark rift in the tail was not so conspicuous as on the 5th inst.

M. TRESCA presented to the Academy of Sciences on Monday the third part of his great work on measures taken during the Paris Electrical Exhibition. It relates to the analysis of electric candles, and will be followed by a similar work on incandescent lights. M. Mascart sent a paper on measures taken with the registering electrometer in compliance with the wish expressed by Sir William Thomson to test the relations of the state of the weather and the electrical properties of the air.

AT the same meeting M. Janssen read in the name of the Bureau des Longitudes a report on the observations which will be made during the total eclipse of the sun of May 6, 1883, which will be observed in the Pacific Ocean. He also read a paper on his work on solar spectroscopy, and on the observation of telluric rays. Admiral Mouchez read a letter from M. Henry, who has been sent to the Pic-du-Midi to observe the forthcoming transit of Venus and determine the possibility of establishing an astronomical observatory on the top of the mountain.

THE French *Journal Officiel* has published a decree of the President establishing a council for the Observatory of Mentone.

WE are informed that the contract for the construction and erection of the Forth Bridge has been let to Sir Thomas Tancred, Bart., Mr. J. H. Falkiner, and Mr. Joseph Phillips, Civil Engineers and Contractors, of Westminster, and Messrs. Arrol and Co. of the Dalmarnock Iron Works, Glasgow. Messrs. Tancred and Falkiner have already carried out about seventy miles of railway for Mr. Fowler, and are at present constructing the new line to Southampton. Mr. Phillips has had a very wide practical experience in bridge construction and erection, and Messrs. Arrol and Co. are contractors for the new Tay Bridge, so the works are in good hands. The contract sum is 1,600,000*l.*, which is within 5000*l.* of the engineer's parliamentary estimate. The tenders received ranged from 1,485,000*l.* to 2,300,000*l.*, most of the leading firms being represented.

AT the annual general meeting of the Cambridge Philosophical Society, a resolution recording the deep regret of the Society at the lamentable event which deprived them of their late president, Prof. F. M. Balfour, was carried unanimously, and a letter expressive of their feelings was directed to be sent to Mrs. Henry Sidgwick (Prof. Balfour's sister). The officers for the ensuing year were appointed as follows:—President, Mr. J. W. L. Glaisher, F.R.S.; Vice-Presidents: Profs. Babington, Newton, and Cayley; Treasurer, Dr. Pearson; Secretaries: Mr. J. W. Clark, Mr. Trotter, and Mr. W. M. Hicks; new Members of Council: Dr. Campion, Mr. E. Hill, and Mr. J. N. Langley.

WITH regard to the recent sad suicide of a girl by leaping from one of the towers of Nôtre Dame, Dr. Bronardeli's expressed view that asphyxiation in the rapid fall may have been the cause of death, has given rise to some correspondence in *La Nature*. M. Bontemps points out that the depth of fall having been about 66 metres, the velocity acquired in the time (less than four seconds) cannot have been so great as that sometimes attained on railways, *e.g.* 33 metres per second on the line between Chalons and Paris, where the effect should be the same; yet we never hear of asphyxiation of engine drivers and stokers. He considers it desirable that the idea in question should be exploded, as unhappy persons may be led to choose suicide by fall from a height, under the notion that they will die before reaching the ground. Again, M. Gossin mentions that a few years ago a man threw himself from the top of the Column of July, and fell on an awning which sheltered workmen at the pedestal; he suffered only a few slight contusions. M. Remy says he has often seen an Englishman leap from a height of 31 metres (say 103 feet) into a deep river; and he was shown in 1852, in the island of Oahu, by missionaries, a native who had fallen from a verified height of more than 300 metres (say 1000 feet). His fall was broken near the end by a growth of ferns and other plants, and he had only a few wounds. Asked as to his sensations in falling, he said he only felt dazzled.

DR. SLUNIN has published in Russian a work—"Materials for the Knowledge of Popular Medicine in Russia"—which will be received with interest, not only by medical men but also by ethnographers. Dr. Slunin gives a detailed account of all plants and drugs used not only in Russian popular medicine in the governments of Saratoff and Astrakhan, which he knows from many years' residence, but also in all Persian, Tartar, and Central Asian medicines (with their Arabian names) that have come to his knowledge. His remarks on popular pharmacies and on the popular medical literature which goes as far back as the epoch of the flourishing times of Arabian civilisation are of great interest.

THE Catalogue of the Reference Department of the Derby Free Library is of a handy size and excellent type. We are told it contains 60,000 references to works upon the library shelves; and, upon dipping into it, the minuteness of connection which will lead to a reference to publications of scarcely higher standing than a newspaper, is imposing. We grieve to add, however, that this holds good in both senses of the word. For looking more closely we find most important references are absent. As a sample, eight references are given to the name of Garrick, but neither is his life by Murphy or Davies quoted, nor is any reference made to Boswell's "Johnson," or Goldsmith's Poems; and the extraordinary explanation of this is found in the fact that neither of these works is in the library! And this absence of important works seems to be the rule rather than the exception, carried out also with the most even-handed fairness to all subjects. Looking through the letter B as a sample, we find no works of Babbage, Back, Barbauld, Barry (Sir C.), Baxter, Beale, Baden Powell, Brewster, Barrow (Isaac or Sir Jno.), Bayne, Beckmann, Blackie, Blackstone, Borrow, Boswell, Bowring, Bridgewater Treatises, Browning (Mrs.), Buckmaster, Buxton, Butler (Bp.), or Butler (S.). Among Dictionaries neither the Penny nor the English Cyclopædia is to be found.

Nor is it that a selection of certain writers has been made, for numerous authors of many well-known works are only credited with one or two in the Derby Library Catalogue. The letter B is not a specially unfortunate one. Ancient Geography refers only to *Nature* and the *Quarterly Review* (one reference each). Gladstone and Hugh Miller are equally unknown. Less than a column contains all the references to Geography, while Geology has nine columns allotted to it. Under Astronomy the inquirer is referred to numerous papers where notices may be found of each of the planets and of many of the planetoids, but only fifteen *works* on Astronomy are catalogued. There is no work at all upon the Moon! Moreover, the references to works which are in this library are made with no discretion. "Barbarossa" does not refer the reader to Gibbon; "Borgia" only refers him to one article—on Lucrezia—in the *Nineteenth Century*! The spelling is not only unscholarly, but the correcting of proofs is careless. It were endless to point out the blunders everywhere; we need only refer to the name of Prof. Haeckel, spelt in four different ways upon pp. 41, 42 only! If some little town struggling against the smallness of the *1d.* rate wishes to draw as much as possible from its Free Library with its motley collection of books contributed from various quarters, we can strongly recommend the *system* upon which this catalogue is drawn up. But that a place of the size and importance of Derby, whose rate also has been so helped by the munificence of Mr. Bass and others, should think it worth while to print and distribute a catalogue, displaying a knowledge and a collection of books in this rudimentary state, is beyond our comprehension.

THE population of Cascia (Italy) is being constantly disturbed by repeated subterranean shocks.

A VOLCANIC eruption is reported to have taken place from a mountain in the Caucasus, which has not shown any volcanic phenomena during historic times. It is the Karabetow mountain, near Temrink, in the government of Jekaterinodar (Caucasia). The subterranean noise was heard 4 versts away, the lava flowed for a distance of half a verst, and a large crater was formed.

NEWS from Belgrade states that some railway workmen have discovered a nearly perfect mammoth skeleton. It is being photographed on the spot, and will be handed over to the National Museum at Belgrade.

A NATURAL intermittent spring has recently formed in the Jachère (Hameau de l'Argentière, Hautes Alpes). At regular intervals of five and seven minutes it yields 10 litres of water each time. It is very remarkable that the first time it consists of lukewarm and colourless water, but the second of cold but wine-red water. MM. Chester and Hadley are now studying the phenomenon.

M. J. OLLER, the proprietor of the St. Germain racing establishment, is preparing to organise night races. He intends to build a central lighthouse, of which the rays will be directed on the contending horses, so that spectators sitting in the centre may follow the proceedings with as much accuracy as in open day.

AT the annual meeting for the distribution of prizes in Mason College, Birmingham, Prof. Tilden gave a sensible and interesting address on Technical Education, which has been published in a separate form.

THE Captain-General of the Philippines reports another destructive hurricane on November 5, and it is worthy of remark that since the previous hurricane, a few weeks ago, the cholera, which had been very bad, has nearly disappeared from Manila.

MESSRS. SONNENSCHEIN AND CO. announce the forthcoming publication of Dr. Coppinger's Notes of the four years' voyage from which the *Alert* has recently returned.

MR. MURRAY has issued a cheap edition of Dr. Blaikie's "Life of David Livingstone."

THE additions to the Zoological Society's Gardens during the past week include two Macaque Monkeys (*Macacus cynomolgus* ♂ ♂) from India, presented respectively by Mr. J. Knight and Mrs. Snell; a Sooty Mangabey (*Cercocebus fuliginosus* ♂) from West Africa, presented by Lady Stafford; two Globose Curassows (*Crax globicera* ♂ ♀) from British Honduras, presented by Mr. R. W. Ryass; a —— Buzzard (——) from Demerara, presented by Mr. G. H. Hawtayne, C.M.Z.S.; three Common Chameleons (*Chameleon vulgaris*) from Egypt, presented by Mr. W. J. Ford; a Hawk's-billed Turtle (*Chelone imbricata*) from West Indies, presented by Mr. W. Cross; a Pig-tailed Monkey (*Macacus nemestrinus* ♂) from Java, a Black Wallaby (*Halmaturus ualabatus* ♀) from New South Wales, a Greek Land Tortoise (*Testudo græca*), South European, deposited; an American Bison (*Bison americanus* ♀) from North America, a Capybara (*Hydrochærus capybara* ♀) from South America, two Eastern Goldfinches (*Carduelis orientalis*) from Afghanistan, two Brent Geese (*Bernicla brenta*), a Red-throated Diver (*Colymbus septentrionalis*), British, purchased; three Capybaras (*Hydrochærus capybara* ♂ ♂ ♀), a Bluish Finch (*Spermophile cærulescens*) from South America, received in exchange.

GEOGRAPHICAL NOTES

AT the opening meeting of the Geographical Society on Monday Mr. A. R. Colquhoun gave an account of his recent adventurous journey, in company with the late Mr. Wahab, from Canton through Yunnan to Bhamo. Mr. Colquhoun's object was mainly to discover trade-routes between Burmah and China, but he collected some interesting information on Further Yünnan, parts of which have not before been visited by European travellers. Mr. Colquhoun describes Yünnan, which is the most westerly of the eighteen provinces of China, as a great uneven plateau, of which the main ranges trend north and south; those in the north reaching an elevation of from twelve to seventeen thousand feet, while in the south they sink to seven or eight thousand feet. In the south, and especially in the south-west, there are many wide fertile plains and valleys, some with large lakes in them. These plains are very rich and thickly populated, the number of towns and villages and the comfortable appearance of the peasantry being very remarkable. Fruits of all kinds—pears, peaches, chestnuts, and even grapes—are found in abundance, while roses, rhododendrons, and camelias of several varieties grow untended on the hill-sides. Minerals are found in great quantities. The travellers constantly passed caravans laden with silver, lead, copper, and tin in ingots; and gold is beaten out into leaf in Tali, and sent in large quantities to Burma. Coal, iron, silver, tin, and copper mines were frequently passed. Mr. Colquhoun also found that the celebrated Puerh tea, the most fancied in China, is not really a Chinese tea at all, but is grown in the Shan district of I-bang, some five days south of Puerh, the nearest prefectural town. In the south the temperature is moderate, and the rains by no means excessive; but the farther north the travellers went, the more sparse became the population, and the more sterile the country, until in the extreme north the hills were enveloped in almost perpetual fogs, rains, and mists, and were practically uninhabitable. The people themselves are mostly the old aboriginal tribes—Lolo, Pai, and Maio—the Chinese being mostly of the official class, and found only in the towns. These aborigines have a much more distinct physiognomy than the bullet-headed Celestial, and are remarkable for their frank and genial hospitality. The women do not crush their feet, and they adopt a picturesque dress not unlike that worn of old by Tyrolese and Swiss maidens. They have a novel way of making marriage engagements. On New Year's Day the unmarried people range themselves, according to sex, on either side of a narrow gully. The ladies in turn toss a coloured ball to the other side, and whoever catches it is the happy man. It is said they are so skilful in throwing the ball that the favoured man is always sure to catch it; which is reassuring. As in Marco Polo's days, the *couvade* still prevails in

some parts. When a child is born, the husband goes to bed for thirty days, and the wife looks after the work. At the conclusion of the paper, Lord Northbrook and Col. Yule paid a well deserved tribute to the late Capt. Gill, Prof. Palmer, and Lieut. Charrington. Capt. Gill, our readers may remember, had himself done some first-rate work on the South-East Chinese frontier, and described it in his "River of Golden Sand;" while Prof. Palmer's loss as an Arabic scholar is almost irretrievable.

SAMOYEDES report to Archangel that they have recently seen, south of Waigatz Island, the wreck of a large vessel crushed in the ice. If the statement be true, and if we remember their never-credited story of the unfortunate *Jeannette*, it is more than probable that the vessel is either the Danish exploring vessel the *Dijmphna*, with Lieut. Hovgaard's expedition, or the Norwegian steamer *Warna* with the Dutch meteorological expedition, bound for Port Dickson, both of which in September last froze in in the Kara Sea, from which place the ice may subsequently have carried the unfortunate vessel to where she now is stated to be. The last intelligence received from Lieut. Hovgaard was dated September 22, and addressed to Herr Aug. Gamil, of Copenhagen, the principal promoter of the expedition, from which it appears that all was then well with both vessels, but that the *Dijmphna* was, when caught in the ice, some considerable distance from shore, in fact in a spot where the whole force of the polar ice, when in drift, would strike her. Herr Aug. Gamil having telegraphed to the Russian Admiralty for any confirmation of the above report, has received a reply that no official information on the subject has been received at St. Petersburg; but that nevertheless instructions would be at once given to the officials on the north coast to scour the same, and gather further particulars. A search party is also being contemplated in Copenhagen, which will, if decided on, be led by M. Larsen, a Dane, who accompanied the American expedition in search of the crew of the *Jeannette*, as the special artist of the *Illustrated London News*.

THE German Government has raised the fund for the scientific exploration of Central Africa and other countries, which in 1882-83 was fixed at 75,000 marks (3750*l*.) to 100,000 marks (5000*l*.) for the financial year 1883-84.

THE AIMS AND METHOD OF GEOLOGICAL INQUIRY[1]

II.

IT will be observed that the results obtained by geologists could not have been arrived at had they confined themselves solely to the detection of resemblances and correspondences between the phenomena of the present and the past. The natural forces have always been the same in kind, if not in degree, and we can often watch the gradual development by their means of products which more or less closely resemble the rocks of our sections. But experimental evidence of this kind takes us only a short way, and we are sooner or later confronted by appearances, which are not reproduced by nature before our eyes. As another example of this I shall adduce one which, although it has far-reaching issues, has yet the merit of being readily comprehended without much preliminary geological knowledge. It is moreover instructive as showing how the imaginative faculty works in a mind trained to clear and steady observation of nature. The fact that a large proportion of the lakes of the world rest in rocky hollows or basins had been long known before it occurred to any one to ask how such rocky hollows had come into existence. The question was first asked and the answer given by Prof. (now Sir) A. C. Ramsay. He had pondered over the problem for years before its solution dawned upon him. None of the ordinary agents of geological change seemed capable of producing the phenomena. The most common of all denuding agents—water—certainly could not do so, for although it may dig long and deep trenches through rocks, water could not scoop out a basin like that occupied by Loch Lomond, or any of our Highland lakes. The tendency of water is, on the contrary, to silt up and to drain such hollows, by deepening the points of exit at their lower ends. Did the hollows in question occupy areas of depression—had they, in short, been formed by unequal subsidences of the ground? Some considerable inland seas, as for example the Dead Sea, and doubtless many larger and smaller sheets of water, owe their origin to local movements of this kind. But it is incredible that all the numerous lakes and lakelets of Northern Alpine regions could have originated in this way. In many cases these lakes are so abundant that it is hard to say of some countries, such as Finland, and large parts of Sweden, and even of our own islands, whether it is land or water that predominates. If all these numerous and closely aggregated rock-basins represent so many local subsidences, then the hard rocks in which most of them appear must have been at the time of their formation in a condition hardly less yielding than dough or putty. It was suggested that the lakes of the Alps and other hilly regions might have been caused, not by local sinkings confined to the valleys themselves, but by a general depression of the central high-grounds and water-sheds. The subsidence of the central mountains would of course entail depression in the upper reaches of the mountain-valleys, and in this way the inclination of those valleys would be reversed—each being converted into an elongated rock-basin. But a little consideration showed that before the lakes of such a region as the Alps could have been produced in this manner, those mountains must have been some 15,000 feet higher than at present. Or to put it the other way, in order to obliterate the Alpine lakes and restore the slopes of the valleys to what, if this hypothesis were true, must have been their original inclination, the Alps would need to be pushed up until they attained twice their present elevation. Now, we are hardly prepared to admit that the Swiss mountains were 30,000 feet high before the glacial period. If our Alpine and Northern lake-basins cannot be attributed to movements of depression, still less can they be accounted for by any system of fractures;—they lie neither in gaping cracks nor on the down-throw sides of dislocations. In a word, a study of the structure, inclination, and distribution of the rock-masses in which our lake-basins appear throws no light upon the origin of those hollows. We probably find in many cases that the position and form of a basin have been influenced in some way by the character of the rocks in which it lies—but we detect no evidence in the rock-masses themselves to account for its production. It is not necessary, however, that I should on this occasion mention each and every cause which has been suggested for the origin of rock-bound hollows. Some of these suggestions are unquestionably well founded. For example, there can be no doubt that certain lakes have been produced by the sudden damming-up of a valley in consequence of a fall of rock from adjoining slopes or cliffs; others, again, occupy holes caused by the falling in of the roofs of caves and subterranean tunnels; while yet others have been formed by a current of lava flowing across a valley and thus ponding back its stream, just as many a temporary sheet of water has been brought into existence in a similar way by the abnormal advance of a glacier. In these and other ways lakes have doubtless originated again and again, but the causes just referred to are all more or less exceptional, and manifestly incapable of producing the phenomena so conspicuous in the lake-regions of Britain, Scandinavia, and the Alps.

Ramsay, to whom the varied phenomena of glacier-regions had been long familiar, was struck by the remarkable fact that fresh-water lakes predominate in Northern and Alpine countries, while they are comparatively rare in regions further south and outside of mountainous districts. The great development of lakes in Finland finds no counterpart in the low grounds of southern latitudes. It is in regions where glacial action formerly prevailed that rock-basins are most numerous, and this suggested to Ramsay that in some way or other the lakes of the Alps and the North were connected with glaciation. The final solution of the problem flashed upon him while he was studying the glacial features of Switzerland. His scientific imagination enabled him to reproduce in his own mind the aspect presented by the Alps during the glacial period, when the great mountain-valleys were choked with glacier-ice, which flowed out upon the low grounds of Germany, France, and Northern Italy, so as to cover all the sites of the present lakes. He saw that under such conditions enormous erosion must have been effected by the ice, by means of the rocky rubbish which it dragged on underneath, and that this erosion, other things being equal, would be most intense where the ice was thickest and the ground over which it advanced had the gentlest inclination. Such conditions, he inferred, would be met with somewhere in the lower course of a valley between the steeper descent of its upper reaches and the

[1] The Inaugural Lecture at the opening of the Class of Geology and Mineralogy in the University of Edinburgh, October 27, 1882, by James Geikie, LL.D., F.R.S. L. and E., Regius Professor of Geology and Mineralogy in the University. Continued from p. 46.

termination of the glacier. This inference was suggested by the consideration that pressure and erosion would be least when the glacier was flowing upon a steep slope, while at the base of such a slope where the valley flattened out, the ice would tend to heap up, as it were, and produce the maximum amount of pressure and erosion. Thereafter, as the ice continued to flow down its valley, it would become thinner and thinner until it reached its termination—and pressure and erosion would diminish with the gradual attenuation of the glacier. Such conditions, after some time, would necessarily result in the formation of elongated rock-basins, sloping in gradually from either end, and attaining their greatest depth at some point above a line drawn midway between the upper and lower ends of a hollow. There are many other details connected with this most ingenious theory which I cannot touch upon at present. It will be sufficient to say that the observed facts receive from it a simple and satisfactory explanation. Like all other well-based theories, it has been fruitful in accounting for many other phenomena, a study of which has developed it in various directions, and enabled us to understand certain appearances which the theory as at first propounded seemed hardly adequate to explain. As a proof of the soundness of Ramsay's conclusion that ice is capable of excavating large rock-basins, I may mention that his theory has led to the prediction of facts which were not previously known to geologists. He had pointed to the occurrence, in many of the sea-lochs of Western Scotland, of deep rock-bound hollows, which he concluded must have been formed by great valley-glaciers in the same way as the hollows occupied by fresh-water lakes in this and other similarly glaciated countries. Some years later, having discovered that the Outer Hebrides had been glaciated across from side to side by a *mer de glace* flowing outwards from the mainland, and having been satisfied as to the truth of the glacial-erosion theory, I was led by it to suppose that deep rock-basins ought to occur upon the floor of the sea along the inner margin of most of our Western Islands. This expectation was suggested by the simple consideration that those islands, presenting, as they for the most part do, a steep and abrupt face to the mainland, must have formed powerful obstructions to the out-flow of the *mer de glace* in the direction of the Atlantic. This being so, great erosion, I inferred, must have ensued in front of those islands. The lower part of the *mer de glace* which overflowed them would be forced down upon the bed of the sea by the ice continually advancing from behind, and compelled to flow as an under-current along the inner margin of the islands, until it circumvented the obstruction, and resumed the same direction as the upper portion of the *mer de glace*. A subsequent careful examination of the Admiralty's Charts of our western seas, which afford a graphic delineation of the configuration of the sea-bottom, proved that the deduction from Ramsay's theory was perfectly correct. Were that sea bed to be elevated for a few hundred feet, so as to run off the water, and unite the islands to themselves and the mainland, we should find the surface of the new-born land plentifully diversfied with lakes—all occupying the positions which a study of the glaciation of the mainland and islands would have led us to expect. Among the most considerable would be a chain of deep lakes extending along the inner margin of the Outer Hebrides, while many similar sheets of water would appear in front of those islands of the Inner Group that face the deep fiords of our western shores.

The few examples now given of geological methods of inquiry may suffice to show that the process of reading and interpreting the past in the light of the present necessitates not only accurate observation, but an extensive acquaintance with the mode in which the operations of Nature are carried on. They also serve to show that just as our knowledge of the past increases, so our insight into the present becomes more and more extended. For if it be true that the present is the key to the past, it is not less certain that without that unfolding of the past which a study of the rocks has enabled us to accomplish, we should not only miss the meaning of much that we see going on around us, but we should also remain in nearly complete ignorance of all that is taking place within the crust of our globe. Thus, although our science may be correctly defined as an inquiry into the development of the earth's crust and of the faunas and floras which have successively clothed and peopled its surface—yet that definition is somewhat incomplete. For, as we have seen, this inquiry into the past helps us to understand existing conditions better than we should otherwise do. In this respect it is with geology as with human history. The philosophical historian seeks in the past to discover the germ of the present. He tells us that we cannot hope to understand the complicated structure and relations of a society like ours without a full appreciation of all that has gone before. And so it is in the case of geological history. The present has grown out of the past, and bears myriad marks of its origin, which would either be unobserved or remain totally meaningless to us, were the past a sealed book. No student of physical geography, or of zoology and botany, therefore can afford to neglect the study of geology, if his desire be to acquire a philosophical comprehension of the bearings of those sciences. For it is geology which reveals to us the birth and evolution of our lands and seas—which enables us to follow the succession of life upon the globe, and to supply many of the missing links in that chain, which, as we believe, unites the beginning of life in the far distant past with its latest and highest expression in man. By its aid we track out the many wanderings of living genera and species which have resulted in the present distribution of plants and animals. But for geology, indeed, that distribution would be for the most part inexplicable. How, for example, could we account for the often widely separated colonies of arctic-alpine plants which occur upon the mountains of Middle and Southern Europe? How could these plants possibly have been transferred from their head-quarters in the far north to the hills of Britain, and Middle Germany, to the Alps and the Pyrenees? Not the most prolonged and laborious study of the botanist could ever have solved the problem. But we learn from the geologist that the apparent anomalous distribution of the flora in question is quite what his study of the rocks would have led him to expect. He now, indeed, appeals to the occurrence of those curious colonies of arctic-alpine plants as an additional proof in support of his view that during a comparatively recent period our continent experienced a climate of more than arctic severity. He tells us that at that time the reindeer, the glutton, the arctic fox, the musk ox, and other arctic animals migrated south into France, while a Scandinavian flora clothed the low grounds of Middle Europe. By and by, when the arctic rigour of the climate began to give way, the northern species of plants and animals slowly returned to the high latitudes from which they had been driven. Many plants, however, would meet with similar conditions by ascending the various mountains that lay in the path of retreat, and there they would continue to flourish long after every trace of an arctic-alpine flora had vanished from the low ground. This explanation fully meets the requirements of the case. It leaves none of the facts unaccounted for, but is in perfect harmony with all. But as if to make assurance doubly sure, Dr. Nathorst, a well-known Swedish geologist, recently made a search in the low grounds of Europe for the remains of the arctic-alpine flora, and succeeded in discovering these in many places. He detected leaves of the arctic willow and several other characteristic northern species in the glacial and post-glacial deposits of Southern Sweden, Denmark, England, Germany, and Switzerland, and thus supplied the one link which might have been sidered necessary to complete a chain of evidence already almost perfect.

From this and many similar instance that might be given we learn that the reconstruction of the past out of its own ruins is not mere guess-work and hypothesis. The geologist cannot only demonstrate that certain events have taken place, but he can assure us of the order in which they succeeded one after the other, during ages incalculably more remote than any with which historians have to deal. The written records out of which are constructed the early history of a people cannot always be depended upon—allowance must be made for the influences that may have swayed the chroniclers, and these are either unknown or can only be guessed at. It follows therefore that events are seldom presented to us in a consecutive history exactly as they occurred. They are always more or less coloured, and that colouring often depends fully as much upon the idiosyncrasies of the modern compiler as upon those of the contemporaneous recorder. The geologist has at least this advantage over the investigator of human history, that his records, however fragmentary they may be, tell nothing more and nothing less than the truth. Any errors that arise must be due either to insufficient observation or bad reasoning, or to both, while the progress of research and the penetrating criticism which every novel view undergoes must sooner or later discover where the truth lies. In this way the history of our globe is being gradually reconstructed—to an extent, indeed, that the earlier cultivators of the science could not have believed possible. But although

many blanks in the records have been filled up, and our knowledge will doubtless be yet greatly increased, it must nevertheless be admitted that this knowledge must always bear but a very small proportion to our ignorance. In this, however, there is nothing to discourage us, as we may be quite sure that the work remaining to be done will far exceed all the energies of many generations to accomplish.

It is sometimes objected to Geology that its results are not always so exact as those which are obtained by an experimental science like chemistry. We are reproached with the fact that our theoretical conceptions undergo frequent modification, and are even often abandoned, to be succeeded by others which, after flourishing for a time, are in like manner overturned and thrown aside. But the same reproach, if it be one, might be brought against other sciences. Each advancing science has its problems and speculations. And we cannot often feel assured that the solution now given of those problems will in all cases stand the test of time. Our theoretical conceptions of the ultimate constitution of matter, for example, have within comparatively few years undergone considerable change, and yet no one values chemistry the less. Let our theories be what they may, they do not and cannot overturn the results obtained by verified observation and often repeated and varied experiment. It remains for ever true that water is composed of oxygen and hydrogen, let our views of the atomic theory change as they may. And so it is not less certain that strata of conglomerate and sandstone containing marine or fresh-water fossils are of aqueous origin, however much our theoretical conceptions may vary as to the uniformity in degree between the past and present operations of Nature. It is true we did not see the conglomerate and sandstone in process of formation, but we know by observation that these rocks exactly resemble deposits of gravel and sand which are now being accumulated in water. Nature in this case makes the experiment for us, whereas the chemist has to do this for himself. The latter, having well ascertained by varied experiments the composition of certain samples of water, henceforth concludes that all water is made up of the same two gases in definite proportions. But this conclusion of his is just as much an assumption as the inference of the geologist that strata containing marine or freshwater fossils are aqueous accumulations. It is when we come to the larger generalisations of our science that we are more likely to go astray. The problems we have to solve demand not only an accurate knowledge of widely scattered phenomena, but a ready command of logical analysis. The facts may be sufficiently abundant, but if we reason badly we of course miss their meaning. Or, on the other hand, the evidence may be more or less imperfect. There are blanks which we fill up with conjecture—which can do no harm so long as we do not treat our conjectures as if they were facts. But when the gaps in the evidence are numerous, each theoriser will fill them up after his own fashion, and very various results will thus be obtained. Even in cases of this kind, however, a rigorous application of logical analysis will enable us to detect the fallacies which may underlie all the competing theories; and we are thus prepared to frame a new explanation for ourselves, and to set about searching for additional facts to prove or disprove our notions. In all such investigations it is obviously the duty of a careful observer and theoriser to see well to his premises—to be absolutely sure as to his facts, and to distinguish clearly between what is substantial knowledge, and what is mere conjecture. He will thus be in a position to judge whether his conclusions are based on a solid foundation or not. In a science of observation like geology, theory is necessarily often in advance of the facts. Some, indeed, have insisted that all conjectural explanations are quite a mistake; that it would be better to avoid theorising altogether, and to wait patiently until the chain of evidence had completed itself. I am afraid that, were it possible to follow this advice, we might often have to wait a very long time. After all, a heap of bricks is only a potential house: it will not grow up into walls without the aid of architect and builder. Discoveries in science have no doubt been made occasionally by isolated and haphazard observations; but that is exceptional, and we should not be where we are now had the examination of Nature been always conducted after such a fashion. If additional evidence be required, we must first have some notion where to look for it. In other words, it is essential to progress that we should have preconceived opinions or theories, which enable us to arrange the facts we already possess, and to point out the directions in which further evidence may be looked for. We cannot be too careful, however, that our preconceived notions do not lead us to colour the evidence or to blind us to facts that tell against our views. Every theory should be considered provisional until its truth has been fully demonstrated by an overwhelming array of testimony in its favour. Until this consummation is arrived at we must be constantly testing its truth, and be ready to abandon it at once whenever the evidence shows it to be erroneous. The failure of one theory after another need not disconcert or discourage us; for each failure, by reducing the number of possible explanations, must necessarily bring us nearer to our goal—the truth. I cannot but deem it a strong point in favour of geology as a branch of education that it not only cultivates the faculty of clear and continuous observation, but abounds in unsolved problems which are ever suggesting new ideas and thus stimulating that imagination which is one of the noblest gifts of our race. It is no reproach that the progress of our science is marked by the modification and abandonment of numerous hypotheses and theories. On the contrary, these afford a measure of the rate at which geology advances—just as this last yields the strongest testimony to the good results that accrue from having some provisional view by which to direct the course of our observations.

It is unavoidable that in the onward march of a science the facts become at last so numerous as to task all the energies of its votaries to keep abreast of their time. When a beginner first surveys the wide field embraced by geological inquiry, he may not unnaturally experience a feeling akin to despair. How is it possible, he may think, that I can master all these manifold details—how can I test the truth of all those numerous inferences and conclusions—and yet have sufficient leisure and energy left to undertake original observation? Well, no one can hope to advance the science in all its departments. When we reflect that in order to obtain a complete comprehension and mastery of the existing condition of things we should require to be adepts in physics, mechanics, chemistry, and every branch of natural science, it is obvious that such a perfect knowledge is beyond attainment. It is needless, therefore, that we should strive to become "admirable Crichtons" in this nineteenth century, and no beginner need be discouraged by the greatness of the science which he desires to cultivate. It is only by division of labour that so much has been accomplished; and the results are now so systematised that it is quite possible for any intelligent inquirer to gain a thorough comprehension of the principles of the science. But this it is absolutely necessary to acquire, and the student, therefore, should at first devote all his energies to learn as much as he can of those principles and their application. When he has progressed so far, he is then ready to set out as an explorer in the well-assured hope that if he be true to the logical methods which have hitherto succeeded so well, he will not fail to reap his reward in the discovery of new truths. But to secure success we must be content to be specialists. In other words, we must concentrate our energies upon some particular lines of inquiry, and do our utmost to work these out in all their details. At the same time we should make a great mistake if we did not always keep in mind the broader bearings of our science, and endeavour to maintain as wide a knowledge as we can of all its branches. Each of these, we may be sure, has something to tell which will aid us in our own special inquiries. We cannot, therefore, afford to neglect the side-lights which are thrown upon our path from the lamps of others who are working in adjacent fields. One cannot help thinking that many specialists would have given us more and better work if they had not allowed themselves to be cramped and narrowed by continuing too long in one rut or groove. They dig so deep that they get into a hole out of which it is sometimes difficult to climb, and thus not infrequently the work being done by fellow-labourers, escapes them, and they miss the suggestions which a knowledge of that work might otherwise have yielded them.

I have said nothing as to the practical applications of our science—that branch of our subject which is termed economic geology—not because I consider it the less important, but because its value is generally recognised and need not now be insisted upon. Many, I do not doubt, enter upon their geological studies with a distinct view of obtaining from the science such help as it can afford them in the practical pursuits of life. To such inquirers it will be my pleasure not less than my duty to give every assistance that is in my power. But I would point out to them that there is no short cut to the attainment of the knowledge they are in quest of. The study

of economic geology cannot be separated from that of the recognised principles and methods of inquiry which must be followed by the scientific investigator. On the contrary, the more thoroughly we devote ourselves to the prosecution of geology for its own sake the better able shall we be to appreciate its economic bearings.

In beginning the duties of this Chair, if I enjoy certain advantages over my predecessor, I also at the same time labour under considerable disadvantages. The Class Museum formed by him, and the other appliances and aids to teaching which he laboriously gathered together have been generously handed over to the Chair—and this, I need not say, has greatly smoothed my path. But, on the other hand, he has left behind him a reputation which must bear hard upon me. He has not only sustained but increased the fame of what has been termed the Scottish School of Geology, and I feel that it will task all my energies to emulate the high standard he maintained as a teacher. It is not without diffidence, therefore, that I commence this course; but my hope is that the love of science, which has hitherto carried me over many years of a laborious occupation, may at least succeed in warming and sustaining the enthusiasm of those who come here to study with me what geology has to reveal concerning the past and present.

A METHOD FOR OBSERVING ARTIFICIAL TRANSITS[1]

AS many astronomers who intend to observe the coming transit of Venus have neither the time nor means for making the necessary arrangements to practice on artificial transits, the simple method here proposed may be advantageously employed. Instead of observing an artificial sun and planet placed at a distance of several thousand feet from the observer, I would suggest that the real sun be observed, and the planet Venus to be represented by a circular disk, held, in the common focus of the objective and eye-pieee, by means of a narrow metallic arm fastened to the eye-piece.

The relative motion of the sun and Venus can then be produced by so adjusting the rate of the driving-clock that the angular motion of the telescope on the hour-axis shall exceed the diurnal motion of the sun by seventeen seconds of time per hour. In this way, as the atmospheric disturbances of the sun's limb are real, a near approach to the phenomena observed during an actual transit will result. If a light-shade glass is employed, the opaque disk will be seen before it comes into apparent contact with the sun. The observer can, however, by an exercise of the will, confine his whole attention to the sun's limb.

By using a heavier shade-glass the disk will not be seen until it is projected against the image of the sun. The angular diameter of Venus at the time of transit being about 65″, the diameter of the opaque disk should be $65 \cdot f \cdot \sin 1'' = 0{\cdot}00031\,f$, f being the focal length of the telescope used. The position angle of the point of contact can be changed at will by simply moving the telescope in declination.

ELECTRIC LIGHTING, THE TRANSMISSION OF FORCE BY ELECTRICITY[2]

HAVING received the honour of being elected Chairman of the Council of the Society of Arts for the ensuing year, the duty devolves upon me of opening the coming Session with some introductory remarks. Only a few months have elapsed since I was called upon to deliver a presidential address to the British Association at Southampton, and it may be reasonably supposed that I then exhausted my stock of accumulated thought and observation regarding the present development of science, both abstract and applied; that, in fact, I come before you, to use a popular phrase, pretty well pumped dry. And yet so large is the field of modern science and industry, that, notwithstanding the good opportunity given me at Southampton, I could there do only scanty justice to comparatively few of the branches of modern progress, and had to curtail, or entirely omit, reference to others, upon which I should otherwise have wished to dwell. There is this essential difference between the British Association and the Society of Arts, that the former can only take an annual survey of the progress of science, and must then confide to individuals, or to committees, specific inquiries, to be reported upon to the different sections at subsequent meetings; whereas the Society of Arts, with its 3,450 permanent members, its ninety-five associated societies, spread throughout the length and breadth of the country, its permanent building, its well-conducted *Journal*, its almost daily meetings and lectures, extending over six months of the year, possesses exceptionally favourable opportunities of following up questions of industrial progress to the point of their practical accomplishment. In glancing back upon its history during the 128 years of its existence, we discover that the Society of Arts was the first institution to introduce science into the industrial arts; it was through the Society of Arts and its illustrious Past President, the late Prince Consort, that the first Universal Exhibition was proposed, and brought to a successful issue in 1851; and it is due to the same Society, supported on all important occasions by its actual President, the Prince of Wales, that so many important changes in our educational and industrial institutions have been inaugurated, too numerous to be referred to specifically on the present occasion.

Amongst the practical questions that now chiefly occupy public attention are those of Electric Lighting, and of the transmission of force by electricity. These together form a subject which has occupied my attention and that of my brothers for a great number of years, and upon which I may consequently be expected to dwell on the present occasion, considering that at Southampton I could deal only with some purely scientific considerations involved in this important subject. I need hardly remind you that electric lighting, viewed as a physical experiment, has been known to us since the early part of the present century, and that many attempts have, from time to time, been made to promote its application. Two principal difficulties have stood in the way of its practical introduction, viz., the great cost of producing an electric current so long as chemical means had to be resorted to, and the mechanical difficulty of constructing electric lamps capable of sustaining, with steadiness, prolonged effects. The dynamo-machine, which enables us to convert mechanical into electrical force, purely and simply, has very effectually disposed of the former difficulty, inasmuch as a properly conceived and well constructed machine of this character converts more than ninety per cent. of the mechanical force imparted to it into electricity, ninety per cent. again of which may be re-converted into mechanical force at a moderate distance. The margin of loss, therefore, does not exceed twenty per cent., excluding purely mechanical losses, and this is quite capable of being further reduced to some extent by improved modes of construction; but it results from these figures that no great step in advance can be looked for in this direction. The dynamo-machine presents the great advantage of simplicity over steam or other power-transmitting engines; it has but one working part, namely, a shaft which, revolving in a pair of bearings, carries a coil or coils of wire admitting of perfect balancing. Frictional resistance is thus reduced to an absolute minimum, and no allowance has to be made for loss by condensation, or badly fitting pistons, stuffing boxes, or valves, or for the jerking action due to oscillating weights. The materials composing the machine, namely, soft iron and copper wire, undergo no deterioration or change by continuous working, and the depreciation of value is therefore a minimum, except where currents of exceptionally high potential are used, which appear to render the copper wire brittle.

The essential points to be attended to in the conception of the dynamo-machine, are the prevention of induced currrents in the iron, and the placing of the wire in such position as to make the whole of it effective for the production of outward current. These principles, which have been clearly established by the labours of comparative few workers in applied science, admit of being carried out in an almost infinite variety of constructive forms, for each of which may be claimed some real or imaginary merits regarding questions of convenience or cost of production.

For many years after the principles involved in the construction of dynamo-machines had been made known, little general interest was manifested in their favour, and few were the forms of construction offered for public use. The essential features involved in the dynamo-machine, the Siemens armature (1856), the Pacinotti ring (1861), and the self-exciting principle (1867), were published by their authors for the pure scientific interest attached to them, without being made subject matter of letters patent, which circumstance appears to have had the contrary effect of what might have been expected, in that it has retarded the introduction of this class of electrical machine, because no person or firm had a sufficient commercial interest to undertake

[1] By Prof. J. M. Schaeberle, Ann Arbor, Michigan. From the *American Journal of Science*.

[2] Address by Dr. C. W. Siemens, F.R.S., Chairman of the Society of Arts, November 15.

the large expenditure which must necessarily be incurred in reducing a first conception into a practical shape. Great credit is due to Monsieur Gramme for taking the initiative in the practical introduction of dynamo-machines embodying those principles, but when five years ago I ventured to predict for the dynamo-electric current a great practical future, as a means of transmitting power to a distance, those views were still looked upon as more or less chimerical. A few striking examples of what could be practically effected by the dynamo-electric current such as the illumination of the Place de l'Opera, Paris, the occasional exhibition of powerful arc lights, and their adoption for military and lighthouse purposes, but especially the gradual accomplishment of the much desired lamp by incandescence in vacuum, gave rise to a somewhat sudden reversion of public feeling; and you may remember the scare at the Stock Exchange affecting the value of gas shares, which ensued in 1878, when the accomplishment of the sub-division of the electric light by incandescent wire was first announced, somewhat prematurely, through the Atlantic cable.

From this time forward electric lighting has been attracting more and more public attention, until the brilliant displays at the exhibition of Paris, and at the Crystal Palace last year, served to excite public interest, to an extraordinary degree. New companies for the purpose of introducing electric light and power have been announced almost daily, whose claims to public attention as investments were based in some cases upon only very slight modifications of well-known forms of dynamo-machines, of arc regulators, or of incandescent carbon lights, the merits of which rested rather upon anticipations than upon any scientific or practical proof. These arrangements were supposed to be of such superlative merit that gas and other illuminants must soon be matters simply of history, and hence arose great speculative excitement. It should be borne in mind, however, that any great technical advance is necessarily the work of time and serious labour, and that when accomplished, it is generally found that so far from injuring existing industries, it calls additional ones into existence, to supply new demands, and thus gives rise to an increase in the sum total of our resources. It is, therefore, reasonable to expect that side by side with the introduction of the new illuminant, gas lighting will go on improving and extending, although the advantage of electric light for many applications, such as the lighting of public halls and warehouses, of our drawing-rooms and dining-rooms, our passenger steamers, our docks and harbours, are so evident, that its advent may be looked upon as a matter of certainty.

Our Legislature has not been slow in recognising the importance of the new illuminant. In 1879, a Select Committee in the House of Commons instituted a careful inquiry into its nature and probable cost, with a view to legislation, and the conclusions at which they arrived were, I consider, the best that could have been laid down. They advised that applications should be encouraged tentatively by the granting of permissive Bills, and this policy has given rise to the Electric Lighting Bill, 1882, promoted by Mr. Chamberlain, the President of the Board of Trade, regarding which much controversy has arisen. It could, indeed, hardly be expected that any act of legislation upon this subject could give universal satisfaction, because while there are many believers in gas who would gladly oppose any measure likely to favour the progress of the rival illuminant, and others who wish to see it monopolised, either by local authorities, or by large financial corporations, there are others again who would throw the doors open so wide as to enable almost all comers to interfere with the public thoroughfares, for the establishment of conducting wires, without let or hindrance.

The law as now established takes, I consider, a medium course between these diverging opinions, and, if properly interpreted, will protect, I believe, all legitimate interests, without impeding the healthy growth of establishments for the distribution of electric energy for lighting and for the transmission of power. Any firm or lighting company may, by application to the local authorities, obtain leave to place electric conductors below public thoroughfares, subject to such conditions as may be mutually agreed upon, the terms of such license being limited to seven years; or an application may be made to the Board of Trade for a provisional order to the same effect, which, when sanctioned by Parliament, secures a right of occupation for twenty-one years. The license offers the advantage of cheapness, and may be regarded as a purely tentative measure, to enable the firm or company to prove the value of their plant. If this is fairly established, the license would in all probability be affirmed, either by an engagement for its prolongation from time to time, or by a provisional order which would, in that case, be obtained by joint application of the contractor and the local authority. At the time of expiration of the provisional order, a pre-emption of purchase is accorded to the local authority, against which it has been objected with much force by so competent an authority as Sir Frederick Bramwell, that the conditions of purchase laid down are not such as fairly to remunerate the contracting companies for their expenditure and risk, and that the power of purchase would inevitably induce the parochial bodies to become mere trading associations. But while admitting the undesirability of such a consummation, I cannot help thinking that it was necessary to put some term to contracts entered into with speculative bodies at a time when the true value of electric energy, and the best conditions under which it should be applied, are still very imperfectly understood. The supply of electric energy, particularly in its application to transmission of power, is a matter simply of commercial demand and supply, which need not partake of the character of a large monopoly similar to gas and water supply, and which may therefore be safely left in the hands of individuals, or of local associations, subject to a certain control for the protection of public interests. At the termination of the period of the provisional order, the contract may be renewed upon such terms and conditions as may at that time appear just and reasonable to Parliament, under whose authority the Board of Trade will be empowered to effect such renewal.

Complaints appear almost daily in the public papers to the effect that townships refuse their assent to applications by electric light companies for provisional orders; but it may be surmised that many of these applications are of a more or less speculative character, the object being to secure monopolies for eventual use or sale, under which circumstances the authorities are clearly justified in withholding their assent; and no licenses or provisional orders should, indeed, be granted, I consider, unless the applicants can give assurance of being able and willing to carry out the work within a reasonable time. But there are technical questions involved which are not yet sufficiently well understood to admit of immediate operations upon a large scale.

Attention has been very properly called to the great divergence in the opinions expressed by scientific men regarding the area that each lighting district should comprise, the capital required to light such an area, and the amount of electric tension that should be allowed in the conductors. In the case of gas supply, the works are necessarily situated in the outskirts of the town, on account of the nuisance this manufacture occasions to the immediate neighbourhood; and, therefore, gas supply must range over a large area. It would be possible, no doubt, to deal with electricity on a similar basis, to establish electrical mains in the shape of copper rods of great thickness, with branches diverging from it in all directions; but the question to be considered is, whether such an imitative course is desirable on account either of relative expense or of facility of working. My own opinion, based upon considerable practical experience and thought devoted to the subject, is decidedly adverse to such a plan. In my evidence before the Parliamentary Committee, I limited the desirable area of an electric district in densely populated towns to a quarter of a square mile, and estimated the cost of the necessary establishment of engines, dynamo-machines, and conductors, at 100,000*l.* while other witnesses held that areas from one to four square miles could be worked advantageously from one centre, and at a cost not exceeding materially the figure I had given. These discrepancies do not necessarily imply wide differences in the estimated cost of each machine or electric light, inasmuch as such estimates are necessarily based upon various assumptions regarding the number of houses and of public buildings comprised in such a district, and the amount of light to be apportioned to each, but I still maintain my preference for small districts.

By way of illustration, let us take the parish of St. James's, near at hand, a district not more densely populated than other equal areas within the metropolis, although comprising, perhaps, a greater number of public buildings. Its population, according to the preliminary report of the census taken on the 4th April, 1881, was 29,865, it contains 3,018 inhabited houses, and its area is 784,000 square yards, or slightly above a quarter of a square mile.

To light a comfortable house of moderate dimensions in all its parts, to the exclusion of gas, oil, or candles, would require about 100 incandescent lights of from 15 to 18-candle power each, that being, for instance, the number of Swan lights em-

ployed by Sir William Thomson in lighting his house at Glasgow University. Eleven-horse power would be required to excite this number of incandescent lights, and at this rate the parish of St. James's would require 3,018 × 11 = 33,200-horse power to work it. It may be fairly objected, however, that there are many houses in the parish much below the standard here referred to, but on the other hand, there are 600 of them with shops on the ground floor, involving larger requirements. Nor does this estimate provide for the large consumption of electric energy that would take place in lighting the eleven churches, eighteen club-houses, nine concert halls, three theatres, besides numerous hotels, restaurants, and lecture halls. A theatre of moderate dimensions, such as the Savoy Theatre, has been proved by experience to require 1,200 incandescent lights, representing an expenditure of 133 horse power; and about one-half that power would have to be set aside for each of the other public buildings here mentioned, constituting an aggregate of 2,926-horse power; nor does this general estimate comprise street lighting, and to light the six and a half miles of principal streets of the parish with electric light, would require per mile, thirty-five arc lights of 350-candle power each, or a total of 227 lights. This, taken at the rate of 0·8-horse power per light, represents a further requirement of 182-horse power, making a total of 3,108-horse power, for purposes independent of house lighting, being equivalent to one-horse power per inhabited house, and bringing the total requirements up to 109 lights = 12-horse power per house.

I do not, however, agree with those who expect that gas lighting will be entirely superseded, but have, on the contrary, always maintained that the electric light, while possessing great and peculiar advantages for lighting our principal rooms, halls, warehouses, &c., owing to its brilliancy, and more particularly to its non-interference with the healthful condition of the atmosphere, will leave ample room for the development of the former, which is susceptible of great improvement, and is likely to hold its own for the ordinary lighting up of our streets and dwellings.

Assuming, therefore, that the bulk of domestic lighting remains to the gas companies, and that the electric light is introduced into private houses, only, at the rate of, say twelve incandescent lights per house, the parish of St. James's would have to be provided with electric energy sufficient to work (9 + 12) 3,018 = 63,378 lights = 7,042-horse power effective; this is equal to about one-fourth the total lighting power required, taking into account that the total number of lights that have to be provided for a house are not all used at one and the same time. No allowance is made in this estimate for the transmission of power, which, in course of time, will form a very large application of electric energy; but considering that power will be required mostly in the day time, when light is not needed, a material increase in plant will not be necessary for that purpose.

In order to minimise the length and thickness of the electric conductor, it would be important to establish the source of power, as nearly as may be, in the centre of the parish, and the position that suggests itself to my mind is that of Golden-square. If the unoccupied area of this square, representing 2,500 square yards, was excavated to a depth of twenty-five feet, and then arched over so as to re-establish the present ground level, a suitable covered space would be provided for the boilers, engines, and dynamo-machines, without causing obstruction or public annoyance; the only erection above the surface would be the chimney, which, if made monumental in form, might be placed in the centre of the square, and be combined with shafts for ventilating the subterranean chamber, care being taken of course to avoid smoke by insuring perfect combustion of the fuel used. The cost of such a chamber, of engine power, and of dynamo-machines, capable of converting that power into electric energy, I estimate at 140,000*l*. To this expense would have to be added that of providing and laying the conductors, together with the switches, current regulators, and arrangements for testing the insulation of the wire.

The cost and dimensions of the conductors would depend upon their length, and the electromotive force to be allowed. The latter would no doubt be limited, by the authorities, to the point at which contact of the two conductors with the human frame would not produce injurious effects, or say to 200 volts, except for street lighting, for which purpose a higher tension is admissible. In considering the proper size of conductor to be used in any given installation, two principal factors have to be taken into account; first, the charge for interest and depreciation on the original cost of a unit length of the conductor; and, secondly, the cost of the electrical energy lost through the resistance of a unit of length. The sum of these two, which may be regarded as the cost of conveyance of electricity, is clearly least, as Sir William Thomson pointed out some time ago, when the two components are equal. This, then, is the principle on which the size of a conductor should be determined.

From the experience of large installations, I consider that electricity can, roughly speaking, be produced in London at a cost of about one shilling per 10,000 Ampère-Volts or Watts (746 Watts being equal to one horse-power) for an hour. Hence, assuming that each set of four incandescent lamps in series (such as Swan's, but for which may be substituted a smaller number of higher resistance and higher luminosity) requires 200 volts electromotive force, and 60 Watts for their efficient working, the total current required for 64,000 such lights is 19,200 ampères, and the cost of the electric energy lost by this current in passing through 1-100th of an ohm resistance, is 16*l*. per hour.

The resistance of a copper bar one quarter of a mile in length, and one square inch in section, is very nearly 1-100th of an ohm, and the weight is about 2½ tons. Assuming, then, the price of insulated copper conductor at 90*l*. per ton, and the rate of interest and depreciation at 7½ per cent., the charge per hour of the above conductor, when used eight hours per day, is 1½*d*. Hence, following the principle I have stated above, the proper size of conductor to use for an installation of the magnitude I have supposed, would be one of 48·29 inches section, or a round rod eight inches diameter.

If the mean distance of the lamps from the station be assumed as 350 yards, the weight of copper used in the complete system of conductors would be nearly 168 tons, and its cost 15,120*l*. To this must be added the cost of iron pipes, for carrying the conductors underground, and of testing boxes, and labour in placing them. Four pipes of 10 inch diameter each, would have to proceed in different directions from the central station, each containing sixteen separate conductors of one inch diameter, and separately insulated, each of them supplying a sub-district of 1,000 lights. The total cost of establishing these conductors may be taken at 37,000*l*., which brings up the total expenditure for central station and leads to 177,000*l*. I assume the conductors to be placed underground, as I consider it quite inadmissible, both as regards permanency and public safety and convenience, to place them above ground, within the precincts of towns. With this expenditure, the parish of St. James's would be supplied with the electric light to the extent of about 25 per cent. of the total illuminating power required. To provide a larger percentage of electric energy would increase the cost of establishment proportionately; and that of conductors, nearly in the square ratio of the increase of the district, unless the loss of energy by resistance is allowed to augment instead.

It may surprise uninitiated persons to be told that to supply a single parish with electric energy necessitates copper conductors of a collective area equal to a rod of eight inches in diameter; and how, it may be asked, will it be possible under such conditions to transmit the energy of waterfalls to distances of twenty or thirty miles, as has been suggested? It must indeed be admitted that the transmission of electric energy of such potential (200 volts) as is admissible in private dwellings would involve conductors of impracticable dimensions, and in order to transmit electrical energy to such distances, it is necessary to resort in the first place to an electric current of high tension. By increasing the tension from 200 to 1,200 volts the conductors may be reduced to one-sixth their area, and if we are content to lose a larger proportion of the energy obtained cheaply from a waterfall, we may effect a still greater reduction. A current of such high potential could not be introduced into houses for lighting purposes, but it could be passed through the coils of a secondary dynamo-machine, to give motion to another primary machine, producing currents of low potential to be distributed for general consumption. Or secondary batteries may be used to effect the conversion of currents of high into those of low potential, whichever means may be found the cheaper in first cost, in maintenance, and most economical of energy. It may be advisable to have several such relays of energy for great distances, the result of which would be a reduction of the size and cost of conductor at the expense of final effect, and the policy of the electrical engineer will, in such cases, have to be governed by the relative cost of the conductor, and of the power at its original source. If

secondary batteries should become more permanent in their action than they are at the present time, they may be largely resorted to by consumers, to receive a charge of electrical energy during the day time, or the small hours of the night, when the central engine would otherwise be unemployed, and the advantage of resorting to these means will depend upon the relative first cost, and cost of working the secondary battery and the engine respectively. These questions are, however, outside the range of our present consideration.

The large aggregate of dwellings comprising the metropolis of London covers about seventy square miles, thirty of which may be taken to consist of parks, squares, and sparsely inhabited areas, which are not to be considered for our present purpose. The remaining forty square miles could be divided into say 140 districts, slightly exceeding a quarter of a square mile on the average, but containing each fully 3,000 houses, and a population similar to that of St. James's.

Assuming twenty of these districts to rank with the parish of St. James's (after deducting the 600 shops which I did not include in my estimate) as central districts, sixty to be residential districts, and sixty to be comparatively poor neighbourhoods, and estimating the illuminating power required for these three classes in the proportion of 1 to ⅔ to ½, we should find that the total capital expenditure for supplying the metropolis with electric energy to the extent of 25 per cent. of the total lighting requirements would be—

$$\begin{aligned} 20 \times \quad & 177{,}000 = 3{,}540{,}000l. \\ 60 \times \tfrac{2}{3} \times & 177{,}000 = 7{,}080{,}000l. \\ 60 \times \tfrac{1}{2} \times & 177{,}000 = 3{,}540{,}000l. \end{aligned}$$

$$14{,}160{,}000l.$$

or say 14,000,000*l.*, without including lamps and internal fittings, and making an average capital expenditure of 100,000*l.* per district.

To extend the same system over the towns of Great Britain, and Ireland would absorb a capital exceeding certainly 64,000,000*l.*, to which must be added 16,000,000*l.* for lamps and internal fittings, making a total capital expenditure of 80,000,000*l.* Some of us may live to see this capital realised, but to find such an amount of capital, and, what is more important, to find the manufacturing appliances to produce work representing this value of machinery and wire, must necessarily be the result of many years of technical development. If, therefore, we see that electric companies apply for provisional orders to supply electric energy, not only for every town throughout the country, but also for the colonies, and for foreign parts, we are forced to the conclusion that their ambition is somewhat in excess of their power of performance; and that no provisional order should be granted except conditionally on the work being executed within a reasonable time, as without such a provision the powers granted may have the effect of retarding instead of advancing electric lighting, and of providing an undue encouragement to purely speculative operations.

The extension of a district beyond the quarter of a square mile limit, would necessitate an establishment of unwieldy dimensions, and the total cost of electric conductors per unit area would be materially increased; but independently of the consideration of cost, great public inconvenience would arise in consequence of the number and dimensions of the electric conductors, which could no longer be accommodated in narrow channels placed below the kerb stones, but would necessitate the construction of costly subways—veritable *cava electrica*.

The amount of the working charges of an establishment comprising the parish of St. James's would depend on the number of working hours in the day, and on the price of fuel per ton. Assuming the 64,000 lights to incandesce for six hours a day, the price of coal to be 20*s.* a ton, and the consumption 2lbs. per effective horse power per hour, the annual charge under this head, taking eight hours' firing, would amount to about 18,300*l.*, to which would have to be added for wages, repairs, and sundries, about 6,000*l.*, for interest with depreciation at seven-and-a-half per cent., 13,300*l.*, and for general management say, 3,400*l.*, making a total annual charge of 41,000*l.*, or at the rate of 12*s.* 9½*d.* per incandescent lamp per annum. To this has to be added the cost of renewal of lamps, which may be taken at 5*s.* per lamp of sixteen candles, lasting 1,200 hours, or to 9*s.* per annum, making a total of 21*s.* 9½*d.* per lamp for a year.

In comparing these results with the cost of gas-lighting, we shall find that it takes 5 cubic feet of gas, in a good argand burner, to produce the same luminous effect as one incandescent light of 16-candle power. In lighting such a burner every day for six hours on the average, we obtain an annual gas consumption of 10,950 cubic feet, the value of which, taken at the rate of 2*s.* 8*d.* per thousand, represents an annual charge of 29*s.*, showing that electric light by incandescence, when carried out on a large scale, is decidedly cheaper than gas-lighting at present prices, and with the ordinary gas-burners.

On the other hand, the cost of establishing gas-works and mains of a capacity equal to 64,000 argand burners would involve an expenditure not exceeding 80,000*l.* as compared with 177,000*l.* in the case of electricity; and it is thus shown that although it is more costly to establish a given supply of illuminating power by electricity than gas, the former has the advantage as regards current cost of production.

It would not be safe, however, for the advocates of electric lighting to rely upon these figures as representing a permanent state of things. In calculating the cost of electric light, I have only allowed for depreciation and 5 per cent. interest upon capital expenditure, whereas gas companies are in the habit of dividing large dividends, and can afford to supply gas at a cheaper rate, by taking advantage of recent improvements in manufacturing operations, and of the ever-increasing value of their by-products, including tar, coke, and ammoniacal liquor. Burners have, moreover, been recently devised by which the luminous effect for a given expenditure of gas can be nearly doubled by purely mechanical arrangements, and the brilliancy of the light can be greatly improved.

On the other hand, electric lighting also may certainly be cheapened by resorting, to a greater extent than has been assumed, to arc lighting, which though less agreeable than the incandescent light for domestic purposes, can be produced at less than half the cost, and deserves on that account the preference for street lighting, and for large halls, in combination with incandescent lights. Lamps by incandescence may be produced hereafter at a lower cost, and of a more enduring character.

Considering the increasing public demand for improved illumination, it is not unreasonable to expect that the introduction of the electric light to the full extent here contemplated, would go hand in hand with an increasing consumption of gas for illuminating and for heating purposes, and the neck-to-neck competition between the representatives of the two systems of illumination, which is likely to ensue, cannot fail to improve the quality, and to cheapen the supply of both, a competition which the consuming public can afford to watch with complacent self-satisfaction. Electricity must win the day, as the light of luxury; but gas will, at the same time, find an ever-increasing application for the more humble purposes of diffusing light.

In my address to the British Association I dwelt upon the capabilities and prospects of gas, both as an illuminant and as a heating agent, and I do not think that I was over-sanguine in predicting for this combustible a future exceeding all present anticipations.

I also called attention to the advantages of gas as a heating agent, showing that if supplied specially for the purpose, it would become not only the most convenient, but by far the cheapest form of fuel that can be supplied to our towns. Such a general supply of heating separately from illuminating gas, by collecting the two gases into separate holders during the process of distillation, would have the beneficial effects—

1. Of giving to lighting gas a higher illuminating power.
2. Of relieving our towns of their most objectionable traffic—that in coal and ashes.
3. Of effecting the perfect cure of that bugbear of our winter existence—the smoke nuisance.
4. Of largely increasing the production of those valuable by-products, tar, coke, and ammonia, the annual value of which already exceeds by nearly 3,000,000*l.* that of the coal consumed in the gas-works.

The late exhibitions have been beneficial in arousing public interest in favour of smoke abatement, and it is satisfactory to find that many persons, without being compelled to do so, are now introducing perfectly smokeless arrangements for their domestic and kitchen fires.

The Society of Arts, which for more than 100 years has given its attention to important questions regarding public health, comfort, and instruction, would, in my opinion be the proper body to examine thoroughly into the question of the supply and economical application of gas and electricity for the purposes of lighting, of power production, and of heating. They would

thus pave the way to such legislative reform as may be necessary to facilitate the introduction of a national system.

If I can be instrumental in engaging the interest of the Society in these important questions, especially that of smoke prevention, I shall vacate this chair next year with the pleasing consciousness that my term of office has not been devoid of a practical result.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—In the Higher Local Examination, in which the majority of the candidates are women, there was a notable falling off this year in the number of candidates in the Natural Science group of subjects. In 1880 there were 99, and 26 failed; in 1881 there were 89, and 17 failed; in 1882, only 39, and 9 failed. The total number of candidates increased from 882 in 1881 to 961 in 1882. The examiners' reports do not indicate any special falling off in the attainments shown by the candidates. In the elementary paper (including Physics, and Biology) the results were not particularly satisfactory. Confusion in the use of terms was common, and the inability to use chemical formulæ was very marked in some cases. In Physiology mistakes were made with regard to subjects of great practical interest, and many of them might have been avoided by reference to every-day experience. In Chemistry the theory was better understood than practical laboratory details.

A supplementary local examination was held in September, for the benefit of candidates seeking exemption from the Previous Examination, and of others desiring to become medical students, &c. Nineteen intending medical students entered, none of whom satisfied the requirements of the General Medical Council.

The Fellows elected at St. John's College last week included Prof. W. J. Sollas, 1st class in the Natural Science Tripos, 1873, Professor of Geology in University College, Bristol, and author of many valuable geological and palæontological memoirs; Mr. J. S. Yeo, Second Wrangler and Second Smith's Prizeman, 1882.

Dr. Hans Gadow will conduct an advanced class in the Morphology of the Vertebrata at the New Museums during the remainder of the present term.

The Members appointed by the Senate on the General Board of Studies, on which much important work will henceforth devolve, are Messrs. Bradshaw (University Librarian), J. Peile, Prof. Cayley, Aldis Wright, Dr. Parkinson, Coutts Trotter, Dr. Phear (Master of Emmanuel College), and Prof. Stuart.

The special Boards of Studies relating to Natural Sciences have selected the following representatives on the General Board of Studies:—Medicine, Prof. Paget; Mathematics, Dr. Ferrers; Physics and Chemistry, Prof. Liveing; Biology and Geology; Music, Mr. Sedley Taylor.

Prof. Stuart has issued his address as the liberal candidate for the University, in succession to the Right Hon. Sir H. Walpole, who proposes to resign.

SCIENTIFIC SERIALS

The American Journal of Science, October.—Notes on physiological optics, No. 5.—Vision by the light of the electric spark, by W. L. Stevens.—Crystals of monazite from Alexander county, North Carolina, by E. S. Dana.—Occurrence and composition of some American varieties of monazite, by S. L. Penfield.—Irregularities in the amplitude of oscillation of pendulums, by C. S. Peirce.—The Deerfield dyke and its minerals, by B. K. Emerson.—Occurrence of *Siphonotreta scotica* in the Utica formation near Ottawa, Ontario, by J. F. Whiteaves.—A recent species of *Heteropora*, from the Strait of Juan de Fuca, by the same.—Notes on interesting minerals occurring near Pike's Peak, Colorado, by W. Cross and W. F. Hillebrand.

Journal of the Asiatic Society of Bengal, vol. 4, part 2, No. 1 (August 31, 1882), contains: On a collection of Japanese Clausiliæ made by Surgeon R. Hungerford in 1881, by Dr. O. F. von Möllendorff (plate 1); out of 21 species, 10 are described as new. Also, by the same author, on *Clausilia nevilliana*, a new species from the Nicobars, and descriptions of three new Asiatic Clausiliæ.—Second list of Diurnal Lepidoptera from the Nicobars, by J. Wood-Mason and L. de Nicéville (plate 3).—On some new or little-known Mantodea, by J. Wood-Mason

Bulletin de l'Académie Royale des Sciences de Belgique, No. 8.—On the new note of M. Dupont concerning his re-vindication of priority of M. Dewalque.—On the means proposed for calming the waves of the sea, by M. Van der Mensbrugghe.—On the dilatation of some isomorphous salts, by M. Spring.—Notes of comparative physiology, by M. Fredericq.—On some brominated derivatives of camphor, by M. de la Royère.—On the central bone of the carpus in mammalia, by M. Lebourcq.—Action of chlorine on sulphonic combinations, and on organic oxysulphides, by MM. Spring and Wissinger.

Verhandlungen der Naturforschenden Gesellschaft in Basel, Theil 7, Heft 1, 1882, contains: Studies on the history of the deer family, No. 1.—The skull structure, by L. Rütimeyer.—Studies on *Talpa europæa*, by Dr. J. Kober. The literature is given in detail, followed by notes on the mole's place in the order, its local names and habits, and on its anatomy and development (plates 1 and 2, chiefly relating to dentition and embryos).—First supplement to the Catalogue of the Collection of Reptiles in the Basle Museum, by F. Müller. Notes are appended to some of the rarer species, and a new genus and species (*Tropidocephalus azureus*) are indicated for a form allied to *Leiodera chilensis*, Gray, taken in Uruguay; it is figured on plate 3. The register of the collection to December, 1881 indicates 933 species.—On the hail-storm of June 29, 1879, by E. Haigenbach-Bischoff and others.—On the explosive powers of ice and on the Gletscherkorn, by E. H. Bischoff.—Meteorological Report for 1881, with reports by L. Rütimeyer on the comparative anatomy collections, and by F. Burckhardt and R. Holtz, on the map collection of the Society.

SOCIETIES AND ACADEMIES

LONDON

Mathematical Society, November 9.—Mr. S. Roberts, F.R.S., president, in the chair.—After the reading of the Treasurer's and Secretaries' reports, the Chairman briefly touched upon the loss the Society had sustained during the recess, by the death of Prof. W. Stanley Jevons, F.R.S.—After the ballot for the Council of the ensuing session had been taken, Prof. Henrici, F.R.S., the newly elected president, took the chair, and called upon Mr. Roberts to read his address, which was entitled, "Remarks on Mathematical Terminology and the Philosophical Bearing of Recent Mathematical Speculations concerning the Realities of Space."—Mr. W. M. Hicks was admitted into the Society.—The following communications were made:—On in- and circumscribed polyhedra, Prof. Forsyth.—Note on quartic curves in space, Dr. Spottiswoode, P.R.S.—Note on the derivation of elliptic function formulæ from confocal conics, Mr. J. Griffiths.—On the explicit integration of certain differential resolvents, Sir J. Cockle, F.R.S.—On compound determinants, Mr. R. F. Scott.—On unicursal twisted quartics, Mr. R. A. Roberts.

Geological Society, November 1.—J. W. Hulke, F.R.S., president, in the chair.—Prof. Louis Lartet, of Toulouse, was elected a Foreign Correspondent of the Society.—The following communications were read:—The Hornblendic and other schists of the Lizard District, with some additional notes on the Serpentine, by Prof. T. G. Bonney, M.A., F.R.S., Sec. G.S. The author described the metamorphic series, chiefly characterised by hornblendic schist, which occupies the southern portion of the Lizard and an extensive tract to the north of the serpentine region, besides some more limited areas. He found that this series was separable into a lower or micaceous group—schists with various green minerals (often a variety of hornblende), or with brownish mica; a middle or hornblendic group, characterised by black hornblende; and an upper or granulitic group, characterised by bands of quartz-felspar rock, often resembling in appearance a vein-granite. These are all highly metamorphosed; yet the second and third occasionally retain to a remarkable extent indications of the minuter bedding structures, such as alternating lamination and current bedding of various kinds. They form, in the author's opinion, one continuous series, of which the uppermost is the thinnest. The general strike of the series, though there are many variations, is either north-west or west-north-west. The junctions of the Palæozoic with the metamorphic series at Polurrian and at Porthalla were described. These are undoubtedly faulted: and the two rocks differ greatly, the former being a slate like any ordinary Palæozoic rock, the other a highly metamorphosed schist. Moreover,

fragments of the hornblende schist and a kind of gneiss occur in a conglomerate in the former, south of Nare Point. The author considers the metamorphic series (the microscopic structure of which was fully described) undoubtedly Archæan, and probably rather early in that division. The rocks of the micaceous group have considerable resemblance in the greenish and lead-coloured schists of Holyhead Island and the adjoining mainland of Anglesey, and of the Menai Strait. Two outlying areas of serpentine, omitted in his former paper, were described—one at Polkerris, the other at Porthalla. The latter shows excellent junctions, and is clearly intrusive in the schist. The author stated that he had re-examined a large part of the district described in his former paper, and had obtained additional evidence of the intrusion of the serpentine into the sedimentary rock with which it is associated. This evidence is of so strong a nature that he could not conceive the possibility of any one who would carefully examine the district for himself, entertaining a doubt upon the matter.—Notes on some Upper Jurassic Astrorhizidæ and Lituolidæ, by Dr. Rudolf Häusler, F.G.S.

PARIS

Academy of Sciences, November 6.—M. Blanchard in the chair.—The following papers were read:—On the comparative observation of telluric and metallic lines as a means of estimating the absorbent powers of the atmosphere, by M. Cornu. He selects telluric lines (caused by aqueous vapour, and varying in intensity with the amount of it) near D, the scale being four times as large as Angström's. Metallic lines, for comparison, are indicated; also a method of deducing the total quantity of vapour.—Results of experiments made at the exhibition of electricity, &c. (continued), by M. Allard and others. Three more systems are here discussed.—On M. Siemens' new theory of the sun, by M. Hirn. The recombination of the elements dissociated in space could occur only at a notable distance from the sun's photosphere, and on falling into this they must be anew entirely dissociated, an action which would cost the heat developed by combination. Again, the work done by solar radiation in dissociation must reduce the intensity of radiation; so that the brightness of the sun, stars, and planets should diminish much more rapidly than inversely as the square of the distances. M. Hirn also supports M. Faye's objections by numerical examples.—On the functions of seven letters, by M. Brioschi.—The earthquake of the Isthmus of Panama, by M. de Lesseps. The phenomena (of which he gives a scientific account) seem to have been much exaggerated. The character of comparative immunity of the isthmus (as compared with regions near) is not seriously affected; and in any case, the construction of a maritime canal without locks is justified. There is no ground for apprehension as to the banks of the canal.—M. Peligot presented a "Treatise of Analytical Chemistry applied to Agriculture," and indicated its scope.—MM. de la Tour du Breuil addressed a further note regarding their process for separation of sulphur; they have modified the process so that it is applicable either to resistant or to pulverulent ores.—On the comet observed in Chili in September, by M. de Bernardières.—On the great southern comet observed at the Imperial Observatory of Rio de Janeiro, by M. Cruls. *Inter alia*, he refers to the aspect of the tail as of a current of extremely bright light, in which were distinct bright lines. Behind the nucleus was a dark space, and one was reminded of a bridge-pile in a strong current. The tail extending a length of 12°, seemed suddenly interrupted, and the extension for 15° beyond was of much less width and brightness. Sodium and carbon lines were observed in the spectrum.—On the functions of the genus zero and of genus one, by M. Laguerre.—On a result of calculation obtained by M. Allégret, by M. MacMahon.—On the relation between the electromotive force of a dynamo-electric machine and its velocity of rotation, by M. Levy.—Spectrophotometric measurements of different points of the solar disc, by MM. Gouy and Thollon. They could measure separately the 200,000th part of the solar disc, and the thousandth part of the spectrum. The figures obtained show the decrease of radiation on approaching the limb (greater the more refrangible the rays). The method is also applied to spots.—On the comparison of mercury thermometers with the hydrogen thermometer, by M. Crafts. Fifteen Paris thermometers examined (the crystal containing 18 per cent. lead oxide) behaved like the thermometers of ordinary glass studied by Regnault, but very unlike those of Choisy-le-Roy crystal (with nearly twice as much oxide). A German thermometer of soda-glass gave a curve much nearer the mean than many others of Paris crystal.—On a hydrate of molybdic acid, $MoO_3 2HO$, by M. Parmentier.—On the transformation, in cold, of the blood of animals into solid and inodorous manure, by a new ferric sulphate, by M. Marguerite-Delacharlonny. This sulphate has the formula $Fe_2O_3 4SO_3$. With it the elimination of the water attains nearly one-half. It forms a hydrate which crystallises easily, and dissolves readily in heat. On adding a solution of the sulphate to fresh blood, the latter forms in a few seconds a firm elastic paste. It is then treated in a hydraulic press, and forms a sort of cake.—Researches on the passage of alcoholic liquor through porous bodies, by M. Gal. His experiments show the influence of the surrounding atmosphere on the alcoholic strength of liquids in bladders (an influence that has been too much overlooked).—On the reduction of sulphates by living beings, by MM. Etard and Olivier. The authors proved experimentally the reduction of sulphates, by Beggiatoa, and found at least three other algæ capable of the same action.—On mono-chlorised allylic alcohol and $CH_2=CCl-CH_2(OH)$ and its derivatives, by M. Henry.—Chemical studies on white beet of Silesia (continued), by M. Leplay.—On the reduction of nitrates in arable land (continued), by MM. Deheraine and Maquenne. *Bacillus amylobacter* is probably the reducing agent.—Direct fermentation of starch; mechanism of this metamorphosis, by M. Meriano. Diastase is a product of the vital activity of the microbe of maize, which produces it incessantly as it traverses the envelopes of the starch grains, thus favouring its action on the stratified granulose. The microbe is that which causes the fermentation of sugar-cane juice.—On the *rôle* of earthworms in propagation of charbon, and on the attenuation of the virus, by M. Feltz. His experiments confirm the views of M. Pasteur as against those of M. Koch.—On the disinfectant and antiseptic action of copper, by M. Burcq. He suggests treatment of infectious diseases with salts of copper, injection of the wood of huts with copper sulphate, also applications of copper to infected furniture, clothing, &c.—Analysis of the reflex of C. Loven, by M. Laffont.—On the venomous apparatus and the poison of the scorpion, M. Joyeux-Laffuie. The poison should be placed among poisons of the nervous system (Bert) and not among blood-poisons (Jousset de Bellesme).—Researches on the genital organ of oysters, by M. Hoek.

VIENNA

Imperial Academy of Sciences, October 5.—E. v. Brueeke, vice-president, in the chair.—The following papers were read:—L. Ditscheiner, on Guebhard's rings.—L. Pebal, note on the mechanical separation of minerals.—H. Schwarz, on new bodies obtained from coal-tar, isomerides of pyrocressol.—F. Schroeckenstein, geological leisure hours; a contribution to the petrography of crystalline rocks.

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THURSDAY, NOVEMBER 23, 1882

THE CHALLENGER REPORTS

Reports on the Scientific Results of the Voyage of H.M.S. "Challenger" during the years 1873-1876, under the Command of Capt. Sir George Nares, R.N., F.R.S., and Capt. F. T. Thomson, R.N. Prepared under the Superintendence of Sir C. Wyville Thomson, F.R.S., and John Murray. Zoology—Vols. II., III., and IV. (Published by Order of Her Majesty's Government, 1881-1882.)

SINCE our last notice of these Reports, three more volumes of the zoological series have made their appearance. In vol. ii. published in 1881, and prepared under the superintendence of the late Sir C. Wyville Thomson, the first Report is by Prof. Moseley: On Certain Hydroid, Alcyonarian and Madreporian Corals procured during the Voyage. The great interest and importance of Mr. Moseley's investigations into the structure of the Hydrocorallinæ, and on the Helioporidæ and their allies, justified a previous publication, chiefly in the *Philosophical Transactions*, of the chief results of the author's work. The third part, describing the Deep Sea Madreporaria appears now for the first time. It ought to be noted that the memoirs forming the first two parts have been recast, and contain both additions and alterations. Mr. Moseley's history of *Millepora nodosa* will be acknowledged by all capable of judging, as a most solid contribution to our knowledge of the Hydrocorallinæ. So long ago as 1859, Agassiz announced that the structure of the polyps of Millepora showed that they belonged not to the corals, but to the Hydroids; but although this view was confirmed by others, especially by Pourtales, who once got an imperfect view of the expanded dactylozooids, still it remained for Prof. Moseley to settle this question of affinity beyond a doubt, which he has done by his painstaking dissections. He acknowledges his indebtedness to his colleague, Mr. Murray, who saw the zooids of *Millepora nodosa* in a living and expanded state upon the reefs of Tahiti. This species forms tubercular and irregular masses, often encrusting and overgrowing the dead fronds of *Lophoseris cactus*, which is a principal component of the Tahitian reefs. While fresh, the growing tips of the lobes have a bright gamboge yellow colour, fading off into a yellowish brown; the expanded zooids have the appearance of a close-set pearly white down upon the surface of the mass. Sometimes the encrusting film is very thin. When, as at Bermuda, *M. alcicornis* is found attached to glass bottles thrown into the harbour, this film will not be more than from $\frac{1}{3}$th to $\frac{1}{4}$th of a millimetre in thickness, and no doubt, now that attention is called to such specimens, they will be studied with the object of telling us more of the life history of these forms.

The Stylasteridæ, now definitely determined to be Hydroids, as was first strongly suggested by G. O. Sars, are described in great detail, and this portion of the report is accompanied by many splendid plates, and a list of all the species of Stylasteridæ at present known is given. Mosely places the group as a separate family, along side of the Milleporidæ, in the sub-order Hydrocorallinæ.

The second part of the report is on Helioporidæ and their allies, in which *Heliopora coerulea* is described from living specimens, and a detailed account of its structure and mode of growth is given. We have also an extremely valuable description of a species of Sarcophyton, almost certainly *S. lobatum*, from the Admiralty Islands, and the conclusion now so well known is come to that Heliopora is without doubt an Alcyonarian.

The third part comes as a quite fresh work, for the preliminary catalogue of the deep-sea Madrepores, was necessarily most imperfect. But here we have extended descriptions of the entire series of species dredged during the voyage, with sixteen plates and also numerous woodcuts intercalated throughout the text. No less than thirty-three species are described for the first time.

These deep-sea Madrepores would appear to be very widely distributed, some, as for example, *Bathyactis symmetrica*, having a world-wide range. At present the only genera which seem restricted in range are Stephanophyltia and Sphenotrochus, which have as yet only been obtained from the seas of the Malay Archipelago, and in comparatively shallower water, and the genus Leptopenus, which has been dredged throughout all the great oceans, but only south of the equator. The wide range of the species in depth has now become a well-known fact, though none the less interesting for that, the world distributed species above-mentioned ranging in depth from 70 to 2900 fathoms. The occurrence of the genera as fossils in Secondary and Tertiary deposits is also not without interest, but the deep-sea forms are not to be regarded as of greater geological antiquity than those found in shallow water.

The report on the birds collected during the voyage is by Dr. P. L. Sclater. The collection embraced about 900 specimens in skins, besides which there was a considerable series of sea-birds in salt and spirits, and a collection of eggs. The collection was formed under the superintendence of Mr. John Murray, who placed at Dr. Sclater's disposal his ornithological note-book, which contained the history of every individual specimen. It will be remembered that the main object of the expedition was the exploration of the depths of the ocean, and that the collecting of land birds formed no part of the original plan, so that the comparative smallness of the collection is not surprising. The author of the report expresses his indebtedness to his friends, the late Marquis of Tweeddale, Dr. Otto Finsch, Prof. Salvadori, Mr. Howard Saunders, Mr. W. A. Forbes, and Mr. Osbert Salvin, for the assistance they gave him in preparing this report, which is accompanied by thirty coloured plates. Many of the notes appended to the description of the penguins are taken from Mr. Moseley's published accounts of the voyage, and are doubtless already well known to our readers.

Vol. iii., published towards the close of 1881, opens with a most elaborated and magnificently illustrated report by Prof. Alexander Agassiz, on the Echinoidea. The importance of this report has already been called attention to in a special notice (*vide* NATURE, vol. xxv. p. 41).

The second and concluding report in the volume is on the Pycnogonida, by Dr. P. P. C. Hoeck. The collection of these forms was very rich in species. Of the 120 specimens dredged during the voyage, there were no less

than 36 species, and of these 33 are described as new to science. Five other species found during the cruise of the *Knight Errant* are also included in the report. These species are referred to 9 genera, of which three are described as new. Those genera which range over the widest area, are also those which range most in depth—while there are some species peculiar to deep-sea areas. No truly generic types seem to be thus characterised. Dr. Hoeck considers that the Pycnogonidæ form a distinct and very natural group or class of Arthropods. Their common progenitor must have been a form with three jointed mandibles—multi-jointed palpi and ovigerous legs, with numerous rows of denticulate spines on the last joints. In the most primitive condition the eye of the Pycnogonid consists of a rounded transparent part of the integument, the inner surface of which is furnished with some small ganglia and nerve-fibres issuing from the integumentary nerve-bundle. The highly-developed eye of the shallow-water species show ganglionic cells, distinct retinal rods, and a lens consisting of a thickened part of the chitinous skin of the animal. Those eyes which have lost their pigment and their retinal rods are rudimentary. Dr. Hoeck, treating of the affinities of this class writes: "about the relation in which the Pycnogonida stand to either the Crustacea or the Arachnida, we know as much or as little as we do about the relation in which these two classes of Arthropoda stand to each other."

Vol. iv. opens with an important contribution to anatomical science in the Report on the Anatomy of the Petrels (Tubinares) collected during the voyage. It is from the pen of Mr. W. A. Forbes, Fellow of St. John's, Cambridge.

The group of Petrels is one that up to the present date can scarcely be said to have been anatomically investigated. It is difficult at all times to procure specimens in the flesh—and some of the species are so large as to render their preservation a matter of considerable trouble. At the suggestion of the late A. H. Garrod, the naturalist staff of the *Challenger* made a fine collection of these oceanic birds in spirits, which contained 74 specimens belonging to 31 species and 22 genera. Prof. Garrod had scarcely commenced to work at this series before he was struck by the lingering illness which ended in his lamented and premature death, and his friend, Mr. W. A. Forbes, undertook to draw up the report which here appears. This report is of a very thorough character. Commencing with an account of the previous literature on the anatomy and classification of the group; we then have a complete sketch of the comparative anatomy of the group—the external characters, pterylosis and visceral anatomy are first described—these are succeeded by an account of the myology—to which follows a description of the tracheal structures and of certain other points in the anatomy of the soft parts, while an account of the osteology concludes the report. Some of the modifications, described by the author, "are of great physiological and morphological interest, whilst the numerous differences in points of detail displayed in the different sections and genera of the Petrels, lead one to expect that the future study of systematic ornithology will be not a little elucidated by the labours of the anatomist wherever he has material, as in the present case, at his command, sufficient for an adequate study of a natural group on the basis of structural differences more important than those that can be discerned from the superficial inspection of an ordinary skin." This report is illustrated by very numerous woodcuts and seven plates of anatomical details. In treating of the affinities of the group, Mr. Forbes declares it to be a difficult task to assign to it any satisfactory position in any arrangement of the class of birds.

The second report in the volume is on the Deep-sea Medusæ, by Prof. Ernst Haeckel. They form one of the smallest and least important groups of the rich and remarkable deep-sea fauna discovered during the voyage of the *Challenger*. The number of species described does not exceed eighteen, of which half are *Craspedotæ* and half *Acraspedæ*. These new species were briefly diagnosed in the "System der Medusen, 1879," but they are here described at great length and with a most splendid series of illustrations. The descriptive portion of the memoir is prefaced by a very elaborate sketch of the comparative morphology of the medusæ, which is illustrated by many woodcuts.

It would seem by no means certain that all the eighteen species of deep-sea medusæ here described are constant inhabitants of the deep sea. The method of capture by the tow-net by which such delicate and fragile organisms are brought from great depths is still imperfect, and it seems probable that the greater number of medusæ brought up apparently from the greater depths really swim in shallower water, and are only taken in during the "hauling-in" of the net. But Prof. Haeckel counts that those medusæ which have either adapted themselves by special modifications of organisation to a deep-sea habit of life, or which give evidence by their primitive structure of a remote phylogenetic origin, may with great probability be regarded as permanent and characteristic inhabitants of the depths of the sea; and as such he regards fourteen out of the eighteen described. With regard to the magnificent illustrations the author states: "It is of course impossible, from the imperfect state of preservation of the spirit specimens, to expect that they should be absolutely true to nature. I rather considered it my duty here, as in those figures in my 'System der Medusen,' which were drawn from spirit specimens, to take advantage of my knowledge of the forms of the living Medusæ to reconstruct the most probable approximate image of the living forms, I was greatly assisted in my efforts in this direction by the skilful hand of my lithographer, Adolf Giltsch." It seems hardly necessary to make any scientific criticisms on this straightforward statement.

The third and concluding memoir is by Hjalmar Théel, and contains the first part of his report on the Holothuroidea. It is altogether devoted to the holothuroids of the new order Elasipoda, which name has been with advantage substituted for that of Elasmopoda used in the Preliminary Report. Seven years have scarcely elapsed since the discovery in the Kara Sea of the form for which this family was established, and now over fifty species are known. These species of Elasipods are true deep water forms, and they may with all the more reason be said to characterise the abyssal fauna, as no single representative as far as is at present known has been found to exist at a depth less than 58 fathoms. Only one form,

Elpidia glacialis, has been dredged at this inconsiderable depth, and even this was dredged in the Arctic Ocean, where true abyssal forms are to be met with at comparatively shallow depths. This species too can exist at immense depths, one from Station 160 having been dredged at a depth of 2600 fathoms, the greatest depth at which any Holothuroid has to this been dredged being 2900 fathoms. Among the more remarkable and distinguishing characteristics of this order Mr. Théel mentions the agreement in several important details—both in their internal anatomy and outer forms—of the adult and larval forms, an agreement more close than occurs in any previously known Holothuroid. He does not agree with Danielssen and Korren in placing the Elasipods low in the series of the Holothuroids; nay in some respects he regards them as having attained to a higher development than all the other Echinoderms, because, among other facts, their bodies are distinctly bilaterally symmetrical, with the dorsal and ventral surfaces distinct and often with a cephalic region well marked. Only the ventral ambulacræ are subservient to locomotion; these latter show a tendency to appear both definite as to place and number. The dorsal appendages are so modified as to perform functions different from the ventral ones. This memoir contains forty-six plates, which give full details of the forms and structure of all the new species.

LIGHT

Light: A Course of Experimental Optics chiefly with the Lantern. By Lewis Wright. (London: Macmillan and Co., 1882.)

THIS is a book by a worker whose work in his own line is of a very high order, and whose experience will be of correspondingly high value to others who are working at the same subject. In all those departments of experimental optics in which the lantern is employed for the demonstration of actual experiments to an audience, Mr. Wright is a master hand: and his book, as might be expected, is consequently a valuable repertory of useful information and of suggestive hints. Of books on Light there are already enough and to spare. Of standard treatises and text-books in the department of Geometrical Optics the supply is more than could be desired. In Physical Optics there is still room for a good elementary mathematical text-book. In Physiological Optics also there is, save for the great treatise of Helmholtz, a void. But the work before us stands apart from all these, both in aim and in character. Indeed so well does it carry out the ideal of a work "on experimental optics chiefly with the lantern," that there was really no need to prefix to the title the word "Light." True it is that Mr. Wright does not confine himself to the mere working of lanterns and their accessories. He deals in a simple and practical way with the laws of reflexion and refraction, and with ordinary optical instruments: but he always adds something of practical interest to the teacher of optics. To illustrate the laws of reflexion and refraction he describes a simplified form of the apparatus so well known in Prof. Tyndall's lectures on Light; and the mechanical illustrations of wave-motion, &c., are also new in several respects. The chapter on Spectrum Analysis is brief and sketchy, but includes almost all the experiments which can be projected on to the screen with the lantern. Amongst these we notice very careful instructions for exhibiting the spectrum of Newton's rings and of other interference phenomena.

Nearly one-half of the book is devoted, and well devoted, to experimental work on Double-Refraction and Polarisation. In this section there are a number of beautiful experiments described which we do not remember having seen before in any treatise in the English language. Amongst these are some with compound mica plates built up of a series of films of definite thickness and united by Canada balsam. A series of twenty-four superposed mica films, each producing a retardation of one-eighth of a wave-length and each one-sixteenth of an inch shorter than the one beneath it, is in this way made to reproduce exactly the first three orders of colours of Newton's rings, but divided into the precise tints over narrow strips. A detailed account is also given of the combinations devised by Norremberg and Reusch for reproducing the phenomena of uniaxial crystals and of quartz by the superposition of thin films of mica crossed in various ways. Plates illustrative of these combinations contribute much to the value of the descriptions and explanations of the text. Mr. Wright also gives some account of his own researches upon the spiral figures produced by the introduction of quarter-undulation plates into the polariscope in which crystal sections are being examined by convergent light. There is a penultimate chapter on the polarisation of the sky and of minute particles, followed by a final chapter—wholly out of place in such a work—in which, so far as it is intelligible, there appears to be an attempt made to connect the undulatory theory of light with the trinitarian theory of theology. With the exception of this last, and with a few occasiona inelegancies of style, there is little fault to find with the book. The mathematical student of optics will without doubt grumble when he takes up the work, because the mathematical aspect of the subject is conspicuous by its absence. The author does not profess to be a mathematician: or he would hardly have pronounced in favour of Brewster's views on the theoretical polarising angle, as he does on p. 223. This, however, is a minor matter in a book whose great aim is to assist manipulation. The numerous illustrations, a large proportion of which are original, add greatly to its value. The coloured plates of polariscopic phenomena are, it should be added, of singular excellence. S. P. T.

OUR BOOK SHELF

Practical Chemistry, Analytical Tables, &c. By J. Campbell Brown, D.Sc. (London: Churchill, 1882.)

NOTHING perhaps is more remarkable than the great increase during the past few years in the number of books on practical chemistry and analysis. This has no doubt to some extent been caused by the prominence given generally to the teaching of chemistry in the laboratory.

The books to which we refer consist with few exceptions of tabular statements of reactions of acids and bases and methods of detection of the same in simple salts or mixtures. They all appear to be on the same "type" and with the same intention of putting students through a course of drudgery in qualitative analysis according to a fixed "table." The book before us is no worse than others of its class, but attempts rather too much by giving

condensed tables for alkaloids and gases, which are, however, in themselves very good ones. It is to be feared that these practical books tend to make students mere analytical machines in a small way, without giving them much real practical notion of chemistry. It is questionable whether a student who has worked through the modern tabular system of practical chemistry would be able, for instance, to state the reason for the employment of bricks in preference to chalk for the back of an ordinary fireplace or some equally simple practical question.

Elementary Chemical Arithmetic. By Sidney Lupton. (London: Macmillan and Co., 1882.)

THIS little book with its modest preface will be recognised by all teachers of chemistry, especially in large laboratory classes, and also by students as a really useful adjunct.

Unfortunately in large public laboratories a considerable proportion of the students have been very much neglected in the matter of their elementary mathematical education, or it has been of such a nature that they are not able to apply it to the solution of ordinary chemical problems, thus entailing, in many cases, a large amount of extra work and loss of time on the part of the teacher in giving instruction in elementary arithmetic. This book fits into its place exactly. It is divided into two main portions; an introduction, consisting of short but very understandable explanations of arithmetical processes in common demand in chemistry and physical chemistry of a practical and elementary nature, the second portion being problems divided under the headings of the different elements. Regarding these it may perhaps be said that they do not err on the side of being too chemical, and in one or two cases more attention has been given to the question as a question than to its absolute chemical correctness, but these are mere details that in no way detract from the utility of the book for its purpose.

What is required of the mass of chemical students is that they should be able to apply methods of reasoning founded on experimental facts in the science to the solution of concrete and abstract problems; and working through this book will certainly conduce to bring about an improvement in that direction.

The Watch and Clockmaker's Handbook. By F. J. Britten. (London: Kent and Co., 1881.)

THIS little book has been written, we are informed, chiefly for the instruction of country watchmakers. It cannot fail to be agreeable to them: it contains a great deal of useful practical information, and some is given of a higher quality, such as workmen are, to their credit, eager for now-a-days. To another and wider circle there is also much of a character to be interesting. The book is a proper supplement to the more popular horological treatises. There are good descriptions and pleasing diagrams of the various watch escapements; there is a chapter upon the art of springing; the mechanism of chronographs, repeating watches, and calendars is shown, but almost too briefly. Lastly, we find pictures and a short reference to the various tools which watchmakers employ, and some serviceable memoranda are added. Upon the whole the author has and deserves our praise.

H. DENT GARDNER

Heroes of Science. Botanists, Zoologists, and Geologists. By Prof. P. Martin Duncan, F.R.S., F.L.S. (London: The Society for Promoting Christian Knowledge, 1882.)

THIS little volume contains brief sketches of the lives of a few botanists, zoologists, and geologists, for the most part acknowledged compilations from well-known sources. No doubt the work will serve the purpose for which it is evidently intended—that of interesting young people in science.

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 ensure the appearance even of communications containing interesting and novel facts.*]

Physics of the Earth's Crust

ON March 23 last Prof. Green sent to NATURE some remarks upon Mr. Hill's review of my "Physics of the Earth's Crust." More lately the third edition of his "Physical Geology" has appeared, in which he has repeated the substance of a part of what he then wrote. On account of the great weight which his authority will carry, I think I should offer some reply.

He truly says at p. 674, that I claim to have proved that the contraction of the earth through cooling cannot have caused the amount of squeezing and elevation which has taken place, and that the hypothesis is therefore insufficient to explain the facts which it professes to account for; but he then adds: "What Mr. Fisher has really done is this. His calculations go far to prove that, provided the earth cooled in the way assumed by Sir Wm. Thomson, contraction would not suffice to produce anything like the compression and elevation that has actually occurred. But this is quite another thing from disproving the contraction hypothesis. Mr. Fisher's investigations tend rather to establish a strong probability that the earth did not cool in the way supposed by Sir Wm. Thomson,"—that is, that it became solid throughout in a comparatively short space of time. But of course my calculations do not establish any probability against this way of cooling, unless we begin by assuming that contraction through cooling has been the cause of the elevations. And that seems to be begging the question. What the calculations prove is that the contraction hypothesis will not account for the elevations if the earth has cooled as a solid.

But there may have been another way of cooling which, on geological grounds, I believe to have beeen the true one. The earth may not have become solid throughout in a short space of time, and may not be solid even now. In that case the crust, whose corrugations we have to account for, must have floated on a denser liquid substratum. Under these circumstances every elevation above the mean level must have had a corresponding protuberance answering to it below. This is necessary, as was long ago pointed out by Sir G. B. Airy. I have, then, proved that, this being so, if the crust beneath the ocean is of the same density as beneath the continents, on what I conceive to be reasonable assumptions regarding the thickness and density of the crust and the density of the substratum, a shortening of the earth's radius by less than 700 miles would not have sufficed to produce the existing inequalities. I can imagine no theory of the constitution of the interior that would admit of so large an amount of contraction taking place, after the whole had become sufficiently cool for a crust to have begun to be formed, as to cause such an amount of shortening as this.

If, however, we suppose that the crust beneath the oceans is denser than that which forms the continents (and I have given several reasons for believing such to be the case), then a much smaller amount of radial shortening would suffice. I have estimated it at about forty-two miles. Still, anything near this shortening is far beyond what any reasonable amount of contraction from cooling could produce. For if there be a liquid substratum this must be of nearly equable temperature throughout, and that cannot be much above the temperature of solidification; so that it does not appear how a much greater contraction can be got out of the gradual solidification, and incorporation of the upper parts of the liquid layer with the crust, than could be obtained on the former supposition of a cooling solid globe; and I have shown that, in that case, the radial shortening would be less than two miles.

Thus, then, I claim to have disproved the contraction-hypothesis under the two alternative hypotheses (1) of a solid globe, and (2) of a liquid substratum.

Capt. Dutton, of the United States Geological Survey, has said of this part of my work, "First and foremost he has rendered most effectual service in utterly destroying the hypothesis, which attributes the deformations of the strata and earth's crust to interior contraction by secular cooling. No person, it seems to me, can sufficiently master the cardinal points of his

analysis, without being convinced that this hypothesis is nothing but a delusion and a snare, and that the quicker it is thrown aside and abandoned the better it will be for geological science" (*American Journal of Science*, vol. xxiii. p. 287).

I take this opportunity of pointing out a mistake in my book. At page 156 the number 1127 ought to be 1734; and consequently the number 0·996 ought to be 0·965. The argument will still hold. O. FISHER

Harlton, Cambridge, November 9

P.S.—Since forwarding the above I have observed a note at p. 912 of Dr. Geikie's "Text Book of Geology," in which he says that I have "endeavoured" to show that the secular contraction of a solid globe through mere cooling will not account for the phenomena. The word "endeavoured," does not express the attitude of my mind upon the question. Forty-two years ago the contraction theory occurred to myself independently. I remember that in my youthful joy at what I thought thought a discovery, I forthwith vaulted over a gate! In 1868 I read my paper on "The Elevation of Mountains by lateral Pressure," fully believing that I was elucidating the cause which had produced them in the contraction through secular cooling. In 1873 I began my paper on "The Inequalities of the earth's Surface viewed in connection with the Secular Cooling," while still under the same impression. I first of all estimated the actual elevations, and, this done, I calculated the amount of those which would be formed upon Sir William Thomson's view of the mode of solidification. To my excessive surprise, the result showed the utter inadequacy of the contraction hypothesis. I thought I must have made some error in the calculations, but could find none. I still, however, adhered to the original idea of contraction, and suggested, towards the end of that paper, a fluid condition of the interior at some *former* period, thinking that sufficient contraction might be perhaps obtained by that means; for I had not yet dared to question Sir Wm. Thomson's dictum of the *present* complete solidity of the earth. It was not until about a year ago, when I wrote the chapter in my book about the "Amount of Compression," that I perceived that even the condition of a liquid substratum would not give the necessary degree of contraction to produce the compression. I have thus been driven from the contraction hypothesis step by step, and have by no means been endeavouring to support a preconceived opinion against it.—O. F.

Shadows after Sunset

HAPPENING by chance to look into "Loomis's Meteorology," after reading M. Dechevren's account of the blue, white, and red bands visible before sunrise and after sunset at Zikawei, I noticed under the above heading the following account of shadow-bands, which not only appear to be very similar to those observed by Dechevrens, but are explained in identically the same way ("Loomis's Meteorology," p. 107): "A similar phenomenon [to the water-bands described in the preceding paragraph] is frequently noticed about fifteen minutes after sunset, when the shadows of clouds near the horizon are projected upon the western sky in the form of radiant beams diverging from the sun. These beams are parallel lines of indefinite length, but from the effect of perspective they seem to diverge from the sun, and if they could be traced entirely across the sky, they would for the same reason converge to a point directly opposite to the sun. Such cases are sometimes, though not very frequently noticed. Similar shadows are sometimes seen in the morning before sunrise, and form a conspicuous feature of the morning twilight. This effect is sometimes noticed in nearly every part of the world. It must have attracted the attention of the ancient Greeks, and is thought to explain that poetic expression "the rosy-fingered dawn."

M. Dechevrens appears to think the phenomenon does not occur in Europe or temperate latitudes generally, but from what Loomis says, one would infer that he may be mistaken in this, and that to a modified extent it may be visible in Europe and America. Perhaps some of your readers who are in the habit of observing the face of the sky will be able to verify this supposition. For my own part I have not remarked it in England, but have occasionally witnessed it in Bengal during the rains, very markedly. The explanation offered by M. Dechevrens seems the only reasonable one under the circumstances, but he hardly seems to lay sufficient stress upon the fact that when the sun is below the horizon his rays can only illuminate a shallow stratum of partially condensed vapour in the upper atmosphere. Any obstruction of his rays will consequently shut off the *whole* of the reflected light from this stratum, and cause the blue sky to appear through the shadow, all the more cerulean by contact with the whitish or rosy colour of the adjacent portions which still bask in the solar rays. E. DOUGLAS ARCHIBALD

An Abnormal Fruit of Opuntia Ficus-Indica

THE accompanying figure represents a fruit of *Opuntia Ficus-Indica*, which is wholly inclosed in one of the well-known flat branches of this plant; normally the fruits appear as exserted obovate bodies on the margin, or on either side, of the branches. The figure is exactly half natural size; the fruit is therefore full grown. There is no interruption in the ascending curves of spinous tubercles, only they are somewhat smaller on the fruit, which has also a less wrinkled skin than the remainder of the branch. It is of rather uncommon occurrence, nobody having seen here anything alike in the extensive *tunales* or Indian fig-plantations of our neighbourhood; nor have I been able to find any mention of such a case in the books at my disposal. It is evidently an instance of non-development of peduncle, a special case of suppression of axile organs (Masters, "Teratology," p. 393). But I think it throws also some light on the nature of what generally is taken to be the pericarp of the Opuntia fruit, which, after all, seems to be a slightly modified branch, bearing the ovary of the flower in a cavity on its

Abnormal Fruit of *Opuntia Ficus-Indica* from Carácas.

upper end. A similar view is held forth by Dr. Noll in a paper published in the *Annual Report* of the Senkenbergische Gesellschaft (Frankfurt, 1872, pp. 118-121, with two plates), where he describes and figures two abnormal fruits of *Opuntia coccinellifera* from the Canary Islands, with branches growing from the exterior part of the fruits. Their apparent pericarp is therefore an axile organ of a certain order, say of the order n, whilst the additional branch is of the next order, $n+1$. The case which forms the object of the present note is quite the reverse of those mentioned by Dr. Noll, as the branch of order n, or the exterior part of the normal fruit, is not developed independently, being represented by its parent-branch of order, $n-1$.

If this view be correct, there can no longer be any reason for speaking of an *exserted ovary* in Opuntia (Hooker and Bentham, "Genera plantarum," I., 851), as this organ is wholly sunk in the interior of a branch, just as it happens in other Cactæ with an *ovarium immersum*. A. ERNST

Carácas, October 4

The Comet

THANKS to the entire absence of twilight, and to a beautifully clear sky, I obtained a splendid view of the comet on November 14, 15h. 45m. The tail had a length of 30°, and was divided into two portions at the extreme end, the northern extremity curving very sharply upwards, and separated from the southern branch by a semi-circular space. The general form of the tail being very similar to the Greek character γ. The southern side still remained brighter than the northern. The nucleus was much more elongated than when I observed it on November 8. The two concentrations of light which were very noticeable on that date, were not now so conspicuous, being smaller and much closer together, so much so, that had the definition been otherwise than perfect the division between them could not have been seen. As showing the necessity of observing this interesting object in the absence of twilight I may mention that by 17h. 45m. G.M.T., the apparent length of the tail was reduced to 20°.

B. J. HOPKINS

79, Marlborough Road, Dalston, E., November 20

Soda Flames in Coal Fires

IF a coal-fire be looked into with some attention after a fresh supply of coals has nearly ceased to give out its gases, there will be seen here and there in the hottest parts, and coming out of them through crannies and round dark corners, a pale translucent yellow flame, which one soon gets to recognise easily. What does it consist of? If looked at through a prism, without any slit screen, this flame is at once seen to be monochromatic. Neither its shape nor brilliancy (in which it is deficient) are at all altered or impaired; and it is especially interesting on this account, as there is something uncanny in the appearance of this pale flame defying the power of the prism, as it flickers and plays about the brilliant spectrum representing the red-hot coals.

Coals vary much in their possession of the source of this flame. In some it seems scarcely present at all, while in others it is abundant, being recognisable even in the large surface-flames. The coal in which I have seen it best, is a close hard coal, with a slaty cleavage and rectangular fracture, known, I am told, as "Anchor Brights" (?) The yellow flame appears frequently even in the largest surface ones, when the gaseous products first disengaged have disappeared. Some of them seem, then, to consist entirely of this, giving little or no continuous spectrum. But it is in the body of the fire that it is most fascinating, imparting a reality to the otherwise confused forms, which is more than pretty. I am strongly reminded by this appearance, when, for instance, a black mass is seen to stand out with a clear outline against the pale yellow background of light, of the picture which was mentally present in the days before the solar eclipse of 1868—the first upon which the prism was brought to bear. I have fortunately found a copy of some "Instructions" issued on the occasion of distributing the "hand-spectroscopes" provided by the Royal Society for the study of that eclipse; in which this prognostication is indicated with quite as much precision as the known facts at that time warranted. That it was not fully understood was the only reason why the moon was *not* seen, as it might have been seen, on that memorable occasion, sharply outlined upon the coronal light, just as I now see the coal. This was long before the time when the same arrangement on a larger scale—a prism in front of the object-glass of a telescope—obtained such success in other hands. However that may be, the coal-fire experiment is a very pretty one, and might be made very instructive too as a drawing-room illustration—the ordinary prismatic pendants of a chandelier being quite equal to the occasion, if a direct-vision combination is not immediately available.

J. HERSCHEL.

30, Sackville Street, W.

P.S.—As the monochromatic light—of sodium, of course—is plentiful in the large flames, it will be well seen as a *line*, straight or curved, if the light of the fire on a cylindrical or curved metallic or other reflecting surface be looked at, especially if dark coloured; such as an ebonite ruler, for instance. Of course a direct-vision pocket spectroscope is better than the pendant of a chandelier; but the lenses must be taken off, as well as the slit-screen.

Complementary Colours—A Mock Sunset

INSTANCES of two phenomena recently noticed in NATURE have chanced to come under my observation, and in each case impressed me much with their beauty and distinctness; the first, an effect of contrast of colour on the surface of clear water. Standing looking up stream on a bridge over the Ary, where it flows through meadows close to Inverary Castle, and admiring the transparent brown hue so often seen in the peat-stained waters of Scotch streams, my attention was attracted by a series of wavelets forming a ridge, somewhat spiral in appearance, across the stream, along the top of a low weir over which the water falls. Every single wave presented on its further surface (that seen foreshortened by the spectator) a nearly level space of pure full-toned amethyst colour, while its advancing front showed with crystalline transparency the deep "cairn-gorm" or burnt sienna tint proper to the water. The regular alternation of these patches of rich and brilliantly-contrasted colours, together with their permanency and apparent independence of anything peculiar in the state of the atmosphere, produced a striking and very beautiful effect.

The phenomenon of a mock sunset in the east I witnessed in great perfection on the Lake of Lucerne, when the whole eastern sky was traversed by broad rose-coloured bands converging from the north, south, and zenith towards a point opposite the sun.

I. H.

A Lunar Halo

LAST evening, about 7.15 p.m., a lunar halo of a peculiar character was seen here. It was at some distance from the moon, and instead of being, as usual, concentric with this body, was of an oval, or, more strictly speaking, a horse-shoe shape, the lower part of the halo not being complete. The moon, too, was not in the approximate centre of the horse-shoe. Supposing its distance from the vertex to be represented by the quantity 1, $2\frac{1}{2}$ would represent its distance to the lower part of the halo. Some heavy mist-clouds lay under the moon, which thinned out and became more transparent upwards, and refraction from the dense parts of these may have been the cause of the curious distortion of the circle in this case.

J. RAND CAPRON

Guildown, November 21

A Correction

PERMIT me to correct an error which appears in your report of "The Additions to the Zoological Society's Gardens" (NATURE, vol. xxvi. p. 232). Your reporter states that one of the parrots presented by me is a "New Zealand parakeet (*Cyanorhamphus novæ-zealandiæ*"). The bird I sent is *Cyanosaisseti*, Verr., from hence (New Caledonia), and, according to Dr. Sclater's published catalogue, has never been in the Gardens. It differs—as I have already pointed out—from *C. novæ-zealandiæ* in size, extent of markings, but especially in the shape of the tail feathers (*Cf. Ibis*, vol. 1879, pp. 109 110). It is one of a small group of parrakeets that is found in New Zealand, Chatham Island, Norfolk Island, and here, closely resembling each other, but at once separable when seen together. Neither this, nor *Nymphicus uvæensis*, Layard, which is a new species just described by me, has ever been seen in Europe before, that I can learn.

E. L. LAYARD

British Consulate, Noumea, September 7

[The Secretary of the Zoological Society informs us that Mr. Layard is quite right in his remark, but that the bird has been long since correctly named, and will be shortly figured in the Zoological Society's *Proceedings* under its proper name.—ED.]

Thomson's Mouse-Mill Dynamo

ALLOW me to make a slight but important correction on your description, in last week's NATURE, of Sir William Thomson's *mouse-mill* dynamo. In your description it is said that "at one end of the hollow drum these copper bars [the mouse-mill bars] are united to each other in pairs, each to the one opposite it." This is not so. At one end of the hollow drum the ends of the copper bars are *all united together*, "metallically connected by soldering or otherwise." The effect is electrically the same as that of the arrangement described in your article; but, in the construction of the machine, the uniting of all the bars together at one end, instead of joining them in pairs, is so much more simple and easy that the correction seems of importance.

J. T. BOTTOMLEY

The University, Glasgow, November 18

"Weather Forecasts"

I HAVE recently designed and patented "An improved floating vessel for automatically compressing air by the action of the waves of the sea, and also for the generation of electricity by the agency of this compressed air." This vessel is capable of being moored in 1000 fathoms, and can be connected with the shore by means of an insulated electric cable. Such a vessel moored in the mid-Atlantic in the usual track of the cyclones which approach these islands from the west, would be of immense advantage to the Meteorological Office in determining the velocity of advance and direction taken by these cyclonic centres. I purpose exhibiting a model and drawings of the vessel at the Wint[illegible] Electric Exhibition, to be held at the Westminster Aquarium next month. CHARLES W. HARDING

King's Lynn, November 14

Age of Dogs

I AM acquainted with a black retriever dog aged thirty-one years, and should like to know whether this age is often attained by dogs. R. CORDINER

Oxford, November 15

Waterspouts on Land

WHEN on a fishing expedition this year, in the mountainous district of Minnigaff, in this country, my attention was drawn to the effects of two waterspouts, which had taken place, one in July last, and the other some six months previously. The effects of both are to be seen in the faces of two mountains a mile apart. One is on a hill-farm called Blac Klaggan, about 100 yards above a mountain-stream, where an excavation, by the force of the spout, had been made to the depth of ten or twelve feet, and about twenty yards wide. Stones—boulder-stones from 10 cwt. to 3 tons, were spread out, in the course of the torrent, down to the "burn," which runs below—one boulder, lying in the bed, being quite 3 tons weight. The other waterspout had struck on *White Laggan*, on a steep mountain side, facing the upper part of Loch Dee. It was higher up on the hill, and had cut to the depth of about 15 feet, and was 10 yards wide, scattering the earth and boulders before it, to a distance of 150 yards below, and spreading out the smaller stones and gravel over a flat moor, in varied tracks, more than 100 yards further. I have not heard of anyone who saw either waterspout, and both are supposed to have taken place at night. All the other parts of both mountains are covered with heather and grass, above, on each side, and below, except in the direct course cut by the torrent from each waterspout. No one remembers any previous case of the sort in the district. Perhaps some of your readers can give other instances of this kind, and some information that may prove interesting and useful. JAMES HOSACK

Ellerslie, Kirkcudbright, N.B., November 13

METEOROLOGY OF THE MALAY ARCHIPELAGO[1]

THE two systems of meteorological observations carried on under the direction of the late Dr. Bergsma present us, in these two serial publications, with what must be classed among the most remarkable contributions made in recent years to observational science, and they are all the more valuable on account of the new and exact information they give as to the different climates of the Malay Archipelago, about which so little was previously known.

The first and longest continued series of observations made at the observatory at Batavia take rank among the very best yet made. They embrace hourly observations for the fifteen years ending with 1880, of atmospheric pressure, temperature, humidity, rain, wind, cloud, &c., which have been published *in extenso*. During the first thirteen years the records consisted wholly of eye-observations, but from the beginning of 1879 the observations were made by photographically and other self-recording instruments. In vol. v., in addition to the hourly observations for 1879 and 1880, there is given a discussion of the fifteen years' observations, which from the excellence of its design and execution, represents the meteorology of Batavia with a fulness and completeness at least equal to what has yet been done for any other place on the globe.

Among the more interesting results, those of the rainfall may be pointed to, particularly the tables showing the mean amounts for the different hours of the day. These reveal two daily maxima and two minima. The larger maximum occurs from 2 to 7 p.m., when 32 per cent. of the whole daily fall takes place, and the larger minimum from 6 to 11 a.m., when only 13 per cent. of the daily amount falls. The smaller maximum is from 10 p.m. to 2 a.m., when 17 per cent. falls, and the smaller minimum during the two hours from 8 to 10 p.m., when 7 per cent falls.

The most remarkable, if not the most important of the results arrived at are perhaps those referring to the influence of the moon on the pressure and temperature of the atmosphere and the rainfall, which establish the fact of a distinct lunar atmospheric tide. Assuming the lunar day to commence with the time of the upper transit of the moon, the following are the phases above or below the mean expressed in millimetres :—

	mm.		
1st max.	+0·057	at lunar hour	1
,, min.	−0·053	at ,,	7
2nd max.	+0·064	at ,,	13
,, min.	−0·060	at ,,	19

The lunar tide has been determined for each of the four quarters, and also at perigee and apogee, and the results show differences of great interest. As regards the rainfall, while the mean amount in 24 hours during the 17 years ending with 1880 was 5·19 mm., at the time of new moon there was a mean excess of 0·94 mm., and at full moon also an excess of 0·19 mm., but on the other hand, at the third octant there was a deficiency of 0·61 mm., and at the fifth octant also a deficiency amounting to 0·55 mm.

The result is that the atmospheric pressure at Batavia has a lunar daily tide quite as distinctly marked as the ordinary diurnal barometer tide, except that its amplitude is much less, the lunar daily tide being as compared with the mean solar daily tide nearly in the proportion of a millimetre to an English inch. The lunar tide has also the important difference in that its phases follow the moon's apparent course much more closely than the diurnal barometric fluctuations follow that of sun. The two maxima occur about the 1st and 13th, and the two minima about the 7th and 19th lunar hours, whereas these four daily phases of the diurnal barometric fluctuation occur with respect to the sun's apparent course from one to six hours later. The influence of the moon's phases on the rainfall is quite decided ; for while the mean daily rainfall is 0·205 inches, it rises at full moon to 0·248 inch, from which time it gradually falls to 0·181 inch at the third octant, rises to 0·212 inch at the fourth octant, then falls to 0·184 inch at the fifth octant, and finally rises gradually to the maximum at the time of new moon. The important conclusion follows that the attractive influence of the moon, and consequently that of the sun, must be taken into account as factors concerned in bringing about oscillations of the barometer. In this connection it is interesting to note that in the higher latitudes in inland situations during winter, or at times and situations where the disturbing influences of temperature and humidity tend towards a minimum, the times of occurrence of the four phases of the daily oscillation of barometer approximate to those of the daily lunar atmospheric tide.

The second series of observations, giving the rainfall for the three years 1879, 1880, and 1881, form an extremely valuable contribution to our knowledge of the climates of

[1] Observations made at the Magnetical and Meteorological Observatory at Batavia, 1866 to 1880. Regenwaarnemingen in Nederlandsch-Indie, 1879-80-81. Door Dr. P. A. Bergsma, Directeur van het Observatorium te Batavia.

the Malay Archipelago. This network of rainfall observation now includes 150 stations scattered over the islands at heights varying from near sea-level up to 6404 feet. The averages of the three years show that the mean annual rainfall over the archipelago varies from about 60 inches in Timor to upwards of 200 inches at some spots among the western slopes of Sumatra. But the determining character of the rainfall, as regards the climates is not the absolute amount that falls annually but rather the manner of its distribution through the months of the year. Over the larger proportion of the islands rain falls copiously every month of the year; but as regards some of the islands, the year is divided into dry and wet seasons as markedly as is seen in the climates of India.

The reason of this difference is readily seen on examining the distribution of atmospheric pressure during the months from Australia to China with the prevailing winds resulting therefrom. During the winter months pressure is high in China and low in the interior of Australia, the mean difference being nearly three-quarters of an inch. Between the two regions the fall is practically uninterrupted, and the Malay Archipelago lying between them is swept by northerly winds. Since these winds have traversed no inconsiderable breadth of ocean, they deposit a copious rainfall particularly on the northern slopes of the higher islands, and consequently the rainfall of these months is large over all the islands without exception, the mean monthly amount in some places exceeding 30 inches. It is to these same winds that the north of Australia owes its rainfall; and it is their strength in any particular year which determines the distance to which the annual rains penetrate southwards into the interior of that continent.

On the other hand, during the summer of the northern hemisphere, atmospheric pressure is high in the interior of Australia, and low in China, the mean difference being aboot half an inch, and between the two regions the fall in the mean pressure is continuous and uninterrupted, and consequently southerly winds prevail over the intervening region. These winds are dry and absolutely rainless over the north of Australia, and over Timor and the other Malay islands, which are separated from Australia but by a comparatively narrow belt of sea. During the three years no rain whatever fell at Timor during July and August, and the fall was small during June, September, and October. As the winds pursue their course to northward, they eagerly lick up moisture from the sea, so that by the time they arrive at Amboyna they have become so saturated with moisture that the monthly rainfall of that place rises at this time of the year to nearly 30 inches. At some distance to the west of Timor rain falls at this season more or less regularly every year, the amount increasing in proportion to the extent of ocean traversed by the south-east winds, which blow towards the islands from the direction of Australia. These marked and vital differences of the climates of the Malay Archipelago, which, as they depend essentially on the geographical distribution of the land and sea of this part of the globe may be regarded as permanent, have played no inconspicuous part in the remarkable distribution of animal and vegetable life which characterises the archipelago.

THE COMET

THE receipt of observations from Australia, made between September 8 and 16, has allowed of the determination of the orbit of the present comet exclusively from positions obtained before the perihelion passage when it made so close an approach to the sun. From a mean of the Melbourne and Windsor N.S.W. observations on September 9, and the Melbourne meridian observations on September 14 and 16, Mr. Hind has deduced the following orbit:—

Perihelion passage, Greenwich M.T., Sept. 17·21897

Longitude of perihelion	275 50 20
Ascending node	345 53 2
Inclination	38 0 17
Log. perihelion dist.	7·8501274

Retrograde.

The longitudes are reckoned from the apparent equinox of September 17, and it should be mentioned that the small corrections have been neglected. On comparing the observed places with those calculated from the elements founded upon observations before perihelion, the following differences remain:—

			$\Delta\alpha.\cos\delta\,(c-o)$	$\Delta\,\delta$
			"	"
Tebbutt	Sept.	8	− 25	− 3
Tebbutt and Melbourne	,,	9	0	0
Melbne. merid.	,,	14	+ 21	+ 7
,,	,,	15	+ 5	+ 5
,,	,,	16	+ 1	0
A. Common ...	,,	17	+ 12	− 4

When however we compare with the meridian observations at Dunecht and Coimbra on September 18, or the day after the comet's close approach to the sun, the computed place is found to differ by several minutes of arc from that observed, and at the time when Mr. Gill noted the comet's ingress upon the sun's disc, calculation places it 2′ 30″ within his limb. These differences appear to point to sensible perturbation about the perihelion passage, but a stricter discussion of observations before and after the time when the comet attained that position in its orbit, will be needed before any reliable judgment on this important question can be formed. It may be noted also that a very small change in the time of perihelion passage has a comparatively large effect upon the geocentric positions about that epoch.

Mr. W. F. Denning communicates the following estimates of the length of the tail of this comet made by him at Ashley-down, Bristol; the dates are astronomical:—

Oct. 1	...	10	Oct. 30	...	22	Nov. 8	...	23
,, 11	...	15	Nov. 5	...	23	,, 9	...	22
,, 25	...	19	,, 6	...	23			

To form an idea of the real extent of the tail, assume it first to be situate in the direction of the radius-vector, as is most frequently the case. At 6 a.m. on November 7, by the orbit last published in NATURE, the distance of the comet's nucleus from the earth (expressed in parts of the earth's mean distance from the sun) was 1·4844, and its distance from the sun was 1·4958, the earth's radius-vector being 0·9005. Hence we find the angle at the comet between lines supposed to be drawn to the earth and sun respectively was 38° 49′, from which it appears that an angular extent of 23° would give a real length, as a prolongation of the radius-vector of rather over 196,000,000 miles. But this must be an outside estimate of the linear distance of the extremity of the tail from the nucleus, as there was sensible curvature of the tail, the effect of which may be readily seen by a graphical process upon the above data.

We subjoin the Melbourne meridian observations, to which reference has been made:—

	Melbourne M.T. h. m. s.	Apparent R.A. h. m. s.	Apparent N.P.D. ° ′ ″
Sept. 14	23 10 13·7	... 10 45 53·34	... 89 55 47·1
15	23 22 36·6	... 11 2 14·89	... 89 29 39·2
16	23 39 0·3	... 11 22 37·75	... 88 47 55·2

The observation of September 15 was made with great difficulty, the comet being obscured by cloud.

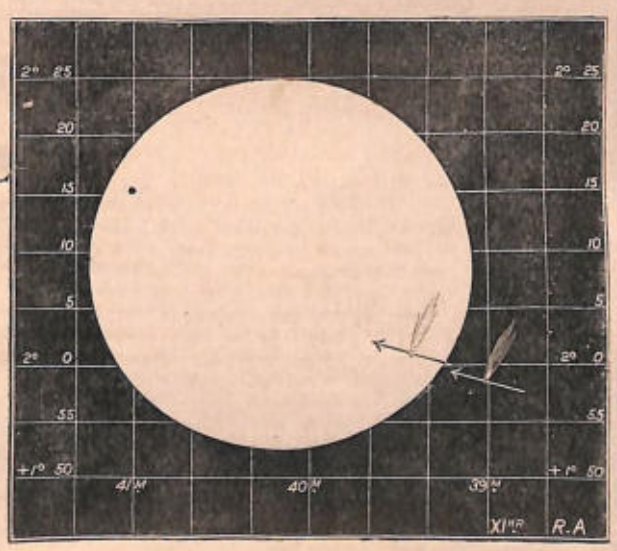
THE following communications speak for themselves :—

Columbia College, New York, November 4

DEAR SIR,—I have received the inclosed communication from Prof. Chandler, of Boston. The letter may interest your readers. J. K. REES

Harvard College Observatory, Cambridge, October 28

DEAR SIR,—Your note of the 26th inst. was duly received. I respond cheerfully to your request, although as I have but a quarter of an hour at my disposal, I trust you will regard my answer as furnishing in a disconnected form the principal points in the results so far reached by me, and will bear in mind that I have not had an opportunity to arrange them in a more formal shape. Of course the most interesting point in connection with this comet, astronomically, is the opportunity afforded to decide the question of the disturbance which a comet will experience in passing through the coronal regions in the close vicinity of the sun. Of all the comets which have passed near enough to be disturbed by this cause, this is the only one which has been observed on both sides of perihelion. Not to mention others, the comets of 1680, 1843, and 1880, all of which present such close resemblance to



Ingress of Gould's Comet upon Sun, September 17, 1882.

the present comet, as to have raised in some quarters the question whether they are not, in fact, returns of the same body, were observed, either insufficiently to decide this question of disturbance in the sun's upper atmosphere, or were observed only on one side of perihelion.

In the case of this comet, however, there will be available a very extensive series of accurate observations at the Cape of Good Hope from September 8 ; almost continuously up to within two hours of perihelion passage, ceasing only with the ingress of the comet upon the sun's disc, the instant of disappearance being accurately observed; an observation unparalleled in astronomical history, and of the greatest value. The comet was also observed at Rio Janeiro on September 11, and probably followed up to perihelion.

I have also received from Dr. Gould a private letter dated September 15, on other astronomical matters, at the end of which he states incidentally that a brilliant comet had been visible there "for more than a week, of which he had two observations, and was awaiting clear weather, in order to observe it in the meridian." Thus in all probability he was the first to descry the comet, as, by a curious coincidence, he was the first to see the one, which so closely resembled it in 1880.

After perihelion of course there exists, and will be accumulated hereafter, an abundant body of data to fix its orbit, after emergence from the coronal regions. Of all the observations before perihelion, we are in possession as yet only of a position on September 8 at the Cape of Good Hope, the time of ingress upon the sun's disc on September 17, and Mr. Common's observations on September 17. The last, Mr. Common's, I have not yet examined ; but from the others I have been led to conclude that little if any disturbance could have been caused by resistance experienced in the sun's atmosphere, so to call it, for the sake of convenience.

The grounds of this conclusion are the following :— Taking all the observations available about a week ago, others have come to hand since, and verify the calculation, although they could not be used in it, which were made since perihelion passage, *i.e.* from September 18 to October 20, I first computed an orbit from normal places, assuming the orbit to be a parabola, with the following results :—

1882.
T = Sept. 17·22013 Greenwich M.T.

π = 55° 22′ 26″·8
ω = 69 28 46·4
Ω = 345 53 40·4
i = 141 55 15·0
} 1882·0
log. q = 7·8915778

The deviation of the middle place ($c-o$) was +18″·8 in longitude and +8″·8 in latitude. It was very plain that the observations could not be satisfied better than this by any parabolic hypothesis. I accordingly computed an elliptical orbit as follows :—

T = Sept. 17·2304 Greenwich M.T.

π = 55° 12′ 41″·2
ω = 69 22 7·2
Ω = 345 50 34·0
i = 141 54 56·2
} 1882·0
log. q = 7·8835636
e = 0·9999700

Notwithstanding the nearness to unity of the value of the eccentricity thus obtained, I believe that the ellipticity of the orbit is real, although the corresponding period is very long, something about 4000 years. Whether this is so or not is not of great importance as regards my present purpose. If now we take the observation of September 8, nine days before perihelion, and compare it with the places which are assigned by these orbits, we find that the difference is only 2½ seconds in right ascension and something over 1′ in declination. Thus the differences (Computation—Observation) are for the

	$c-o$	
	$\Delta\alpha$.	$\Delta\delta$.
Ellipse	−2·5s. ...	+75″
Parabola	+2·5s. ...	+95″

quantities which are certainly not larger than the uncertainty of the calculation, that is, not greater than we ought to expect even if the comet had been subjected to no chance of disturbance.

Again, if we compute the place which would be assigned by the two orbits for the instant of ingress of the comet upon the sun on September 17, as observed at the Cape of Good Hope, and also the place of the sun, we have their relative positions as shown in the inclosed diagram, where the calculated places of the comet are indicated by the sign ♂ for the ellipse and parabola in red and black respectively, and the arrows indicate the direction and amount of the comet's motion in a quarter of an hour, as calculated by the orbits. It is significant that it would be necessary to assume a correction of only five or six minutes in either time of perihelion passage to bring the comet exactly upon

the sun's limb, where observations indicated it should be. As it cannot be considered that from present data we are certain as to the true time of perihelion passage within this amount, it seems that we have no reason to suppose that there has been any effect of retardation experienced. In fact the deviation shown by the ellipse is opposite to that which would have been the result of such retardation.

It should be remarked (as being of interest) that at the instant of entry upon the sun, the comet was about 1,600,000 miles from its surface (the true anomaly being about 90°).

The perihelion passage took place less than two hours after. The whole half circuit of the sun (from $v = -90°$ to $v = +90°$) occupied but 3½ hours. It is certainly an interesting fact to consider, that an object of such limited dimensions and small gravity can pass at such an enormous velocity for hours through the sun's upper atmosphere, and emerge with so slight an effect on its motion as this body has apparently experienced.

An additional argument in support of my conclusion that little or no disturbance was suffered can be drawn from the fact that the comet, after passing this ordeal, is departing with nearly parabolic velocity, as the slight variation of the eccentricity from unity in the above elements proves.

Another interesting point which I would simply indicate, without discussing, is the bearing of the visibility of the comet clear up to the sun's edge. Prof. Pickering has suggested that the light which rendered it visible in this position must have been nearly all from the comet's own incandescence, scarcely any of it from reflection of the sun's light.

I think that the orbits which I have given may be considered as setting at rest completely the idea of identity of the present comet with those of 1668 and 1843. I say nothing of that of 1880, since there, although the hypothesis of its identity has been entertained in some quarters, it cannot for a moment be regarded as tenable. I have elsewhere shown that the deviations between the observations in 1880 and any hypothesis involving an ellipse of less than ten years' period for that comet, are too large to be considered for an instant as probable. The hypothesis of identity with comet 1880, I., may therefore be left to the sensation-mongers.

I inclose a copy of the *Science Observer Circular*, the regular issue of which will be out in a few days. The figures I have here given differ very slightly from those in the printed circular, but you may regard what I give in this letter as the latest. The elliptical orbit will dispose of the systematic deviations in the table (columns $o - c$) completely, and leave only the unavoidable observation errors.

You may make what use you please of this, except to treat it as a formally-prepared paper.

S. C. CHANDLER, Jun.

INFLUENCE OF "ENVIRONMENT" UPON PLANTS

IN the *Indian Forester* for July, 1882, Dr. Brandis, Director of the India Forest Department, has given the following interesting particulars as to the change in the season of flowering of the Australian acacias introduced in the Nilgiris:—

"*Acacia dealbata* was introduced on the Nilgiris before the year 1845. Col. Dun, the owner of many houses in Ootacamund, had planted several trees in his compounds, probably several years before 1845, but the tree was by no means common, and as late as 1855 was sold at the Government gardens, at two annas a plant. A curious fact regarding the flowering of this tree has been observed:—In 1845, and up to about 1850, the trees flowered in October, which corresponded with the Australian flowering time; but about 1860 they were observed to flower in September; in 1870 they flowered in August; in 1878 in July, and here, this year, 1882, they have begun to flower in June, this being the spring month here, corresponding with October in Australia. All the trees do not flower so early, because at various times seeds have been imported from Australia, and the produce of these would of course flower at the same time as the parent trees in Australia, until acclimatised here.

"Having watched the flowering of these trees for nearly forty years, there cannot be any doubt in the matter; and it is a curious fact that it should have taken the trees nearly forty years to regain their habit of flowering in the spring. Commencing in October, our autumn, it has gradually worked its way back to summer, and finally to spring; probably it will remain at this point."

I have tried to see whether any similar change of season could be traced at Kew.

Acacia dealbata can only be grown under glass with us. It forms a small tree in the Temperate House, and is a splendid object when in full flower. This usually takes place in early spring or towards the end of winter, say about February. Sir Joseph Hooker observed that *A. dealbata* and *A. decurrens*, var. *mollis* (which are closely allied species), flowered at the same time in Tasmania. In Aiton's Hortus Kewensis (1813, *A. decurrens*) is said to have been introduced in 1790 by Sir Joseph Banks, and to flower in May-July. The evidence, then, as far as it goes, would seem to indicate that the flowering time had also progressively worked back in England, though under more artificial conditions.

W. T. THISELTON DYER

THE MAGNETIC STORM AND AURORA

THE telegraphic system of this country has, since Friday morning last, been disturbed in a way that far exceeds anything of the kind that has ever happened before. Very powerful electric currents have been swaying backwards and forwards through the crust of the earth, taking all telegraphic circuits in their progress, and entirely stopping communication. Communication has been maintained only where it was possible to loop together two wires, so as to avoid the use of the earth altogether. The electric storm commenced on Thursday, but it reached its climax on Friday morning (November 17) between 10 and 11 a.m. The currents measured over 50 milliampères, which is five times greater than the ordinary working currents. They have repeated themselves at intervals ever since, but have scarcely attained such an intensity as on Friday morning.

Mr. Preece, whose experience in examining earth currents now extends over a period of thirty years, asserts that this storm was the most terrific he has ever observed. It was characterised on Friday by a rapid succession of alternate waves of great strength.

Both the storm and the aurora seem to have extended to America; the Philadelphia correspondent of the *Times* telegraphs under date November 19:—

"The electrical storm which began to derange the telegraph wires on Friday last still continues, though with less intensity. It spread through Canada and the greater part of the United States, as far west as Utah. The electricians say that the disturbance was unlike any heretofore known, acting upon the wires in strong waves, which produced constant changes in the polarity of the current. A magnificent aurora appeared on Friday night and was visible at all points, except where clouds obscured it. Cold weather, with snow, accompanied the storm in many places."

We have received many letters on the auroral phenomenon of Friday last; as introductory to these we give the following communication from Mr. W. H. M. Christie,

the Astronomer Royal, under the title of "Magnetic Storm, Aurora and Sunspot".—

A REMARKABLE magnetic storm, preceded by several days of considerable magnetic disturbance, was observed here on November 17. It commenced suddenly—November 16, 22h. 15m. G.M.T.—with a great decrease in all the magnetic elements, the declination being diminished by more than 1°, the horizontal force by more than 1-100th part, and the vertical force by nearly 1-100th part. From 4h. to 7h., and also from 11h. to 17h., the motions were large and violent, the range exceeding 2° for the declination, and 1-50th part for the horizontal and vertical force. Earth-current disturbances were also recorded, corresponding both in time and magnitude with the magnetic changes.

In the evening, as soon as it was dark, a brilliant aurora was seen, commencing with a bright glow of red light extending from the north and west beyond the zenith, interspersed with pale green phosphorescent light and streamers. At 6h. 4m. a very brilliant streak of greenish light about 20° long appeared in the east-north-east, and, rising slowly, passed nearly along a parallel of declination, a little above the moon, disappearing at 6h. 5m. 59s. in the west, about two minutes after it was first seen. The whole aurora had faded away by about 7h., but it burst out again at 11h. 45m., when an auroral arch, with brilliant streamers reaching nearly to the zenith, was seen from north-north-east to north-west. It faded away about 12h. 10m.

A remarkable sun-spot, visible to the naked eye, was seen on the sun on November 17 and following days, photographs being obtained on November 18, 19, and 20. Its dimensions on November 18, when it was near the central meridian, were: Length 194″, breadth 130″, area of umbra 735, of whole spot 2470 (expressed in millionths of the sun's visible surface), and its position: Heliographic latitude 19° N., longitude 121°. Its spectrum showed C, F, D_3, and the D lines reversed over the principal nucleus, C and F being extremely bright, and D_1, D_2, D_3 doubly reversed. It slightly diminished in size on the two following days. This is the largest spot that has yet been photographed at Greenwich.

Another very active magnetic disturbance commenced on November 19, soon after midnight, and at noon to-day (November 20) it is still in progress, all the elements being greatly disturbed. W. H. M. CHRISTIE

Royal Observatory, Greenwich, November 20

AN extensive aurora occurred last night, though I cannot pretend it was well seen here, both clouds and smoke preventing that. About sunset, and before any aurora had manifested itself, the smoke of the city was simply fearful on every side, rising in enormous volumes, through the calm air from a general bed or bank of it, blue gray below, brown above, that stood ten degrees high on every side in impervious thickness, as seen from the top of the Calton Hill. And no wonder that we neither imprison, nor even fine, those who wilfully thus besmirch the skies and poison the air of the people, when the chief offender was a chimney in the prison establishment itself; a chimney built like an ornamental watch-tower on a medieval Norman castle, but now sending up the most atrociously black column of pitchy coal smoke of all the chimneys around, and in vortex whirls that rose up to and fouled the very zenith sky; leaving in fact no portion whatever of the celestial hemisphere where a pure, unadulterated, and irreproachable optical observation of any astronomical phenomenon could be made, to compare with one through a natural, clear atmosphere of oxygen, nitrogen, and water gases.

About 8 or 9 o'clock aurora began to forcibly manifest itself, chiefly at heights of above 15° or 20°, smoke forbidding direct view lower down. Yet the aurora there must have been exceedingly bright, for the cirro-cumulus clouds above that elevation were often brilliantly illuminated from below, as by a morning dawn. The brightest displays occurred about midnight, and more in the north-east than the usual north-west direction. They seemed all to be of the usual monochrome, citron colour, and mostly took the form of needle-shape jets shooting upwards from a low, but broad circular arc, which they themselves assisted in forming; with this peculiarity too, that while no dark space was seen *below* the arc, as so often occurs, such a space, eminently and distinctly aurorally dark, was formed near the middle of the north-east arc itself, in the shape of a black break in that arch, of about five or six degrees wide, and sharply terminated on either side, while no other part of the sky, whether clear, cloudy, or smoky, could be called more than gray in its degree of darkness.

Auroras of one kind or another have been so frequent here for several weeks past, that, taken in connection with the many large sun-spots, I trust Prof. Simon Newcomb will be now quite satisfied touching the philosophic doubt he expressed a few years ago in his "Popular Astronomy," published during the dark, aurora-less nights of 1876–7. For he, at that time, hesitated to consider the past auroras of, and about, 1870 a consequence of, or anything more than a coincidence with, that maximum period of sun-spots; but showed his kindly feeling for the hypothesis by saying, that if the auroras became numerous again at the next maximum of sun-spots, the connection of the two phenomena would stand on a much surer basis.

Now sun-spots have been of late so large and frequent that I have had not a few letters and communications about them. The last such party was a brace of newspaper reporters, who came together, open-mouthed; for having heard from country correspondents that spots had been discovered by them with the naked eye on the sun, they came to ask me whether it could be true!

Wherefore I could only tell them that it was exactly what should be at this time; and I pointed their attention to a framed and glazed copy of my map of the temperatures, and rise and fall of the sun-spot numbers from 1826 to 1878, its date of publication; but with the sun-spot curve carried forward in outline, and marked with a future maximum for 1882.

C. PIAZZI SMYTH,
Astronomer Royal for Scotland

15, Royal Terrace, Edinburgh, November 18

OTHER correspondents will doubtless communicate to you their observations upon the enormous sunspot now visible, and the magnificent aurora witnessed on Friday night, the 17th inst. My object in writing is to contribute a few notes respecting the grand magnetic storm registered by the Kew magnetographs. The disturbance commenced about 8·30 p.m. on the night of Saturday, the 11th inst. Throughout the whole of Sunday, Monday, and Tuesday the magnet continued slowly oscillating through arcs of about 20′ on either side of its normal position. On Wednesday and Thursday the vibrations were frequent, but very small, partaking rather of the nature of tremors. About 10.30 a.m. on Friday the storm became violent, and from that hour up to 5.30 a.m. of Saturday, the oscillations of the magnet and the changes of force were incessant and frequently enormous, the declination needle ranging at times through almost 2°. Correspondingly large variations were also exhibited by the bifilar and balance magnetometer. The largest deflections were between midnight and 5 a.m. of Saturday. Through that day the movements were somewhat more sluggish, and from 2 a.m. of yesterday up to 1 am. this morning (Monday) the disturbance was but trivial; it has now become again intense, and at the time of writing (noon) it is found that the needles are moving in arcs extending beyond their limits of registration. Observing the large sun-spot yesterday, it was seen that the image projected upon a screen exhibited traces of coloration, yellow and red, in parts of the penumbra; this was noticed both with the photo-heliograph and a Dollond refractor by two observers; probably it will not have escaped the notice of other correspondents. The electrograph does not show any particular disturbance of atmospheric electricity during Friday night's aurora. The tension was much higher and more variable during the dense fog of the succeeding morning. G. M. WHIPPLE

Kew Observatory, November 20

AN aurora was seen here last night. At about 5 o'clock p.m. I was told the "northern lights" were visible, and found that patches of rose-coloured clouds were forming in both the east and west, the larger and brighter portion being in the latter part of the sky. At times these were varied by a white glow, and occasionally there seemed a disposition on the part of the red patches to form into columns or beams. This, however, was never perfected, and no corona actually formed. At a little before 6 o'clock a strange and most unusual phenomenon was

seen. I happened to turn to the south, where the moon (with a very pronounced lumière cendrée on its dark part) was nearly on the meridian, when I saw a spindle-shaped beam of glowing white light, quite unlike an auroral ray, had formed in the east. As I looked this slowly mounted from its position, rose to the zenith, and passed it, gradually crossing apparently above the moon, and then sank into the west, slowly lessening in size and brilliancy as it did so, and fading away as it reached the horizon. The peculiar long spindle shape, slow gliding motion and glowing silver light, and the marked isolation of this cloud from the other portions of the aurora made it a most remarkable object, and I do not recollect in any former aurora to have seen anything similar. About 6 o'clock the aurora gradually died away, to revive again at 9 in the shape of a white semicircle of light in a point north by west, which did not last long. Owing to moonlight, but little could be done with the spectroscope with a wide slit on the most glowing parts of the red patches only the usual green line, with a faint continuous spectrum towards the violet could be made out. At times I thought I caught traces of other lines, but with no certainty at all. The spindle-shaped beam was also examined with the spectroscope, but only gave the green line. Even in the brightest parts of the red glow, the red line could not be made out. The peculiarity of the moving beam of light was its absolute southern position. Its apparent passage across the sky was only a few degrees above the moon, then at a comparatively low altitude. J. RAND CAPRON

Guildown, Guildford, November 18

P.S.—In connection with the aurora of last week, it is interesting to notice the great disturbance of the telegraphic needles which has taken place, as I understand, all over the country. At the local post-office here all the longer lines were much affected during Friday and Saturday, sometimes to an extent interfering with ordinary messages. On Sunday morning my own time signal needle, though connected only with a short (mile and a half) wire, showed continuous disturbance; and this morning I have been watching a needle at the post-office which was working independently of any message or induced current from other wires. The effect upon the needle was not violent, but it gradually drew them over to one side or the other, where they remained a short time, and then steadily returned; and by rotating the disc containing the stop-studs, it was easy to follow the considerable deflection which took place. I saw a message sent during one of these deflections. Of course the needle was violently disturbed for the time, but returned to its deflected position afterwards. From inquiries I made, the deflections, whether to right or left, varied considerably, both as to occasions and length of time during which the needle was drawn aside, and there was no special tendency as to direction of the current. From these observations it would seem we have just now auroræ in active play around us, though from daylight and other circumstances, not always visible as on Friday night. Saturday and last night I saw no actual auroræ, but my assistant thought there was a red glow in the clouded sky of Saturday, and last night there seemed to be a white glow in the east not accounted for by the moonlight.

Since writing the above I learn that the currents have been *very* strong to-day between 1.30 and 2, and working with London intercepted. The needle generally vibrated to and fro, showing a twisted direction of current.—J. R. C.

Guildown, Guildford, November 20

A MAGNIFICENT aurora was visible here on Friday night, 17th inst., which was remarkable not only for its brillancy but for the successive changes in its character as the night advanced. At about 4.45 my attention was arrested by a splendid rosy light as from a cloud over-head, though the sun had withdrawn its light from the hill tops at 4 o'clock. It looked like a broad irregular band of cloud stretching across from west to east, but crossing south of the zenith. A little later bundles of rays of light formed in it, slowly waxing and waning; they appeared in the mass much as crystals forming in a concentrated solution, and without, so far as I could see, any parallelism or harmony of direction. Some of them were visible also in the N.E. away from the general mass. At 5.30 the lights were not so bright and by 7 o'clock nothing could be seen. At 8.30 a splendid display occurred. There was still some red light coming up from the west and stretching towards the zenith, but a low corona was displayed in the northern skies. The crown of the arch was magnetic north. Its lower border was a jagged edge upon the dark space below it, formed by broad and narrow bundles of rays of slighty yellow light all extending radially from the corona very high up over-head. These varied in intensity at different times and seemed to be travelling now east, now west; but the greatest display was at the corona. A band of light similar in character and movement appeared below the corona in the N.N.E., but was not continuous beyond or up to the middle of the arch. Up to this time there had been no rapid flashing of light from the horizon zenithwards. But at 12 o'clock the display was totally changed; waves of light travelling with tremendous velocity upwards from the horizon all round, along certain straight paths momentarily, but repeatedly illumined by them all centreing in a po...t about 10 degrees south of the zenith formed a magnificient spectacle. It was in plan like an umbrella over one's head, but at the point where the "ribs" should meet the "stick" there was an irregular vortex which looked as if it might be made of clouds, but was not, for it was illumined by the flashes in the same way. At 12.30 it was fading away and when the comet was rising at 3.15, I could see nothing more of it in the east and south, the only directions in which I could see.

R. H. TIDDEMAN

H.M. Geological Survey, Kirkby Stephen,
Westmoreland, November 19

AURORAS of varying brilliancy were seen at York on the 12th, 13th, 14th, 15th, 17th, and 18th (Morning of 19th) November, the 16th and evening of 18th being too cloudy for observation; the 17th giving an exhibition of exceptional brilliancy. On the 13th, 14th, and 17th a low arch was visible (5° to 15° altitude), above which a green light was very evenly diffused for 10° to 20°, then shading off in a more or less patchy manner. Streamers were rare and transient, always of the green light. At 10.15 on the 14th two appeared just west of north, broad, short, but very intense, starting from about ½° *below* the arch. At 12 on the 17th similar streamers reached 40° to 50° up, the bases being fog-hidden. Each night the display was observed soon after dusk, and was seen to last, on three occasions, till after midnight. On the 7th, at York, it seems to have begun, suddenly, at 5 precisely; the same hour is also given me from Street, Somerset, by Joseph Clark. Seen by me at Leeds from 5.15 to 6 o'clock, masses of an exquisite rose-crimson spanned the heavens, rising from near Arcturus, having Vega near the centre, and reaching down south, at times a few degrees beyond Atair, and northwards to and even beyond Polaris. Hence the illumination passed on to the east and south-east, changing imperceptibly to green near the horizon, the same colour, as on previous evenings filling the northern sky, the arch centre almost due north-north-west (magnetic north). The light was evenly spread, fading gradually into the green (which was faint) on the north, over Headingley, into a very clear sky, brightly lit by the moon on the south, and over Leeds. There were at this time no streamers, no scintillations. The bright areas expanded and contracted rapidly, but yet imperceptibly. At 5.25 a green arch suddenly shot across south of the crimson areas, very defined 1½° to 2° broad, from west-south-west to east-south-east, passing just *over* the moon. It lasted hardly a minute; the crimson cloud was then bright. Just such a "bar" "shot out" from the south-east at Street, soon after 6, "of yellowish light; it quickly increased in size and brilliancy, and went right across the heavens to the south-west," passing across in less than four minutes. It passed *south* of the moon (*i.e.* apparent altitude really the *same* as that at 5.25, Leeds being nearly 5% 6 diameters of the moon, north of Street). My cousin continued:—"There seemed to be a dark something before the bright bar, which showed the path it would take, also a dark streak where it passed. The postmaster tells me that the telegraph-needle worked very badly this *afternoon*, turning to the right hand constantly." (The wire runs about north and south for two miles of Street at the south end). The following suggestions arise in connection with this series of auroral displays. Except the brilliant crimson cloud of the 17th, the phenomena on the various nights were very similar; *i.e.* the green glare very uniform, streamers rare, and unusually thick; the low arch over a dark, hazy, apparently cloudy space. It is said that clouds always lie near the north horizon during auroras in Great Britain. Is it certain that these in some cases may not be part of the special phenomenon? Certainly, I have always found it *look* cloudy. If such were the case 100 miles or more south of Leeds on the 17th, such "clouds" must have been where, from Leeds, the south to south-west horizon looked specially clear. Again, is the apparent shadow before an advancing ray or bar only an illusion? It certainly is a not unusual

impression. That the bars of bright light seen at Leeds and Street occupied the same relative elevation is striking. If such phenomena are produced at heights of about 50 miles, and supposing the moon's altitude were 25°, the bar seen at Leeds about 5.25 should have passed a little south of the zenith at Birmingham, a few degrees below the Pole Star near Gloucester, and 30° from the north horizon at Street. Again, do we view an actual *object* in auroral displays, and not, as the rainbow, a subjective impression only? If we do, and the display were 50 miles high, the altitude of Atair being, then, about 40°, this southern limit of the red cloud would be about 40° *north* of the zenith at Birmingham, 30° at Gloucester, under 20° at Street. If it was more extended, then either the display must exist at a much greater altitude, or it must be in some way subjective in nature. If it were 100 miles above us, or far higher than is now usually supposed, still the limit of the display would have been 10° south of the zenith at Birmingham, 10° and 35° north of it at Gloucester and Street respectively. For at Leeds, from 5.15 to 6 o'clock, the southern limit reached rarely and only a few degrees below Atair. Finally, since auroras are likely to be frequent at present, could not a regular corps of observers be organised over the United Kingdom, as has been done in the case of meteors? A few data accurately recorded for time and position at two or three localities, would settle definitely the above question, and if auroras are actual objects, the height of the display. The *lower*, well-defined edge of arches, angular height, and point of the compass of streamers, and limits of the coloured clouds might all be determined with comparative ease by star reference.

Bootham, York, November 18 J. EDMUND CLARK

P.S.—November 19. A sixth aurora last night, seen at 5.45 a.m.; the comet as well defined as a month ago, except the nucleus.

LAST evening there was a very fine display of the aurora borealis visible in York. I noticed it first at 5h. 15m. in the west: a large patch of brilliant rose-coloured light sprang from the western horizon, and extended some 30° or 40° towards the zenith, tipped by a fringe of pale yellowish-green light; so bright was the colour, as to be suggestive of an extensive conflagration in the neighbourhood. This bank of coloured light gradually extended northward in the form of an ill-defined arch, when suddenly, about 5.45 p.m., another brilliant bank of rose-coloured light sprang up due east, and was joined by the arch extending from the westerly bank of light. Above this arch were extensive streamers of greenish-yellow light extending past the constellations Taurus, Ursa Major, Cygnus, Lyra, Aquila. A second arch of greenish light subtended the eastern and south-western sky, and stretched from Taurus beyond to the south of Aquila to the horizon. The effect was very splendid, for inside this arch of light the moon was shining brilliantly. I have rarely seen so grand a display in these latitudes, and never where the colour was so brilliant. It gradually faded away, and was very feeble when I last saw it, at 7.15 p.m. I watched the ever-changing scene for about an hour. During the month there have been several large spots on the sun, which I have observed each day that it was possible to make an observation, with a 4¼-inch refractor by Cooke. H. CLIFFORD GILL

Bootham, York, November 18

P.S.—I see in this morning's paper that the telegraphs have been seriously affected by the magnetic storm, not only in England, but on the Continent.

A FINE aurora was visible from here last evening. When my attention was first called to it a few minutes after 5, the whole northern half of the heavens was suffused with a ruddy glow, as though there was a fire in the neighbourhood. Without paying further attention to its general appearance to the eye, I at once proceeded to examine it with a spectroscope, and found a distinct and sometimes quite bright green band. By the aid of a micrometer scale attached to the spectroscope I took about half a dozen readings of the position of the green band, and successively compared its position with that of one of the bands in the spectrum of the flame at the base of a Bunsen burner. My readings were necessarily taken hastily, but they uniformly agreed in being nearly coincident with, but slightly more refrangible than, the band of wave-length 5581, in the flame of the Bunsen burner. The green band was certainly nearer the hydrocarbon band of wave-length 5581, than to the next one in the same group, on the more refrangible side of wave-length 5542, and so agrees well with Ångström's measurement 5567. The ruddy colour varied in intensity and position for about an hour, and soon after six disappeared. I found the green band was easily seen by directing the spectroscope to parts of the sky, on the northern side, even when without it, one would not have noticed any unusual appearance. I also thought I saw indications of blue or indigo bands, but I could not identify any with certainty. Later on in the evening, from about half-past seven till a quarter to nine, when the sky was much clearer and the stars and moon were bright, now and then the aurora was very brilliant; but the light was green except just once towards the last, when at about 60° or 70° from the horizon, the ruddy glow appeared for a few moments. About half-past eight the sky from the horizon to about 30° was suddenly so brightly green, that had I not known of the aurora, I should have imagined the appearance was due to green fire. About this time fine green streamers frequently shot upwards to a great height. Unfortunately during the latter part of the display I had no spectroscope with me to make further observations.

HENRY ROBINSON

University Chemical Laboratory, Cambridge, November 18

MAY I ask space for the record of an observation made during the fine auroral display of Friday evening, which if compared with similar observations made at other stations may serve to determine with considerable accuracy the height above the earth at which the display took place? For the sake of better observation of the aurora I had gone up to the Durdham Downs by which Clifton is bordered to the north, and from which one has an almost uninterrupted horizon in all directions. The sky was every where very clear, even close to the horizon, and the auroral arch was very conspicuous in the north; its summit lying between the stars Delta and Epsilon in the Great Bear. At 3 minutes past six o'clock a brilliant elongated patch of greenish white light appeared suddenly in the east, below Saturn and to the right of it, the centre of the patch being about 8 degrees from Saturn on a line drawn through the planet at an angle of 45° with the horizon. When first seen the patch was about 6 degrees in length and half a degree in width and the ends had a rough splintered appearance. It rapidly increased in length and less rapidly in thickness, till it closely resembled in general appearance the great Nebula in Andromeda as seen with a good telescope, and the length of the conspicuously luminous portion was apparently about as great as the distance between the stars Alpha Pegasi and Delta Andromedae, i.e., about 27 degrees. The breadth at the centre seemed about equal to twice the moon's diameter. I expected it to lengthen out into an arch across the sky like other fainter ones, which were visible at the time between it and the arch to which I have already referred, but instead of doing so the patch began to shift rapidly across the sky end foremost, as if ascending the eastern slope of the arch which I had expected it to form, then after reaching the summit where its length was horizontal, it rapidly descended the western slope and disappeared near the horizon, passing close under the moon at a distance which I estimated immediately afterwards as rather less than three times the moon's diameter, (measuring from the centre of the luminosity to the moon's lower cusp). The duration of the phenomenon was hardly a minute and its brilliance far exceeded that of any other portion of the display. My colleague Mr. Jupp, who observed a portion of the phenomenon from another place estimated the distance from the moon's cusp as four moon's diameters. The width at the centre we agree in estimating at two moon's diameters. It is not, I believe, often that any portion of an auroral display is so easily distinguished from the rest and localized as was this.

A. M. WORTHINGTON

Clifton College, Bristol, November 19

AN auroral display of unusual magnificence, and lasting upwards of four hours, was observed here last evening. At about 5h. the northern quarter of the sky from the horizon to the zenith, was covered with a delicate crimson glow of surpassing beauty, which included evanescent streamers of a deeper tint. These were succeeded by others of a creamy-white colour, which were more persistent, but did not attain so great an altitude. At 6h. 5m., when the display was at its maximum, a remarkable phenomenon was seen—a bright greenish-white band of a lenticular form, about 20° in length and 5° broad (its axis being parallel to the horizon in the south), passed from the south-east to the south-west horizon, attaining an altitude, when due south, of about 20°. It occupied about six seconds in passing from horizon to horizon, and its brightness seemed to be but slightly

affected by the light of the moon, which was shining in the south, and below which it moved. The light of the rosy streamers, when first examined at 5h. 15m. with a small direct-vision spectroscope, gave two very distinct bright lines, one in the red (presumably near C), and the other in the green. There was a faint continuous spectrum towards the more refrangible end, but no traces of other lines. Afterwards, when the display was at its best, only the bright line in the green was observed, but it was much more brilliant than before, and could be traced in every part of the sky except in the south. It was weak in the zenith, but towards the north horizon it stood out with extraordinary distinctness, and was especially strong in the lenticular band seen at 6h. 5m. This line could be easily seen in the northern sky when all signs of the aurora had apparently passed away. At 7h. 45m. the glow assumed the form of a well-defined arch, extending from the north-east to the north-west horizon, and reaching an altitude of about 30°. It remained more or less distinct till 8h. 30m., after which time the light gradually diminished, till at 9h. the sky assumed its usual appearance. During the greater portion of the evening the sky was perfectly cloudless. This display was certainly finer than that seen on October 25, 1870, and though fewer bright lines were observed in its spectrum than on that occasion, the two which were seen were far better defined, and much more brilliant.

Kempston, Bedford, November 18 THOS. GWYN ELGER

ON last Friday afternoon at 5.15 I observed in the north a magnificent auroral display. The moonlight mixed with the fading twilight was of course unfavourable to the brilliancy of such a phenomenon: notwithstanding which the auroral glare—suggestive of rose-coloured clouds, alternately intensifying and fading—was a very remarkable spectacle. A sharp frost supervened. C. ROSE INGLEBY

Valentines, Ilford, November 20

A BRILLIANT auroral display was observed here last night. I first noticed the pale auroral arc at 5h. 30m., the top of the arc at that time being just below Merak and Phecta in Ursa Major. At 5h. 40m. red streamers were seen in the north-west and shortly afterwards in the north-east, and then at intervals pale streamers were observed all along the arc. For about five minutes a double arc was visible, a band of dark sky intervening between the two, which combined to form one broad arc, and remained so to the end of the display. At 6h. there was a very apparent waning of the streamers, and at 6h. 30m. they had entirely disappeared The auroral-arc remained until about 9h. 30m. With a Browning's miniature spectroscope I saw the green line very distinctly, while the red streamers appeared to show a very faint red band. Perhaps it is worthy of notice that the sky, which to the naked eye was dark, showed on examination the characteristic spectrum. C. H. ROMANES

Worthing, November 18

ANOTHER splendid display of aurora was seen here last evening, commencing at 5.10 with a column of rose-coloured light in the north-west, which, rapidly becoming diffused, spread upwards to the zenith, a similar glow being visible in the east. In the northern horizon a double arch of white light extended from beyond Capella to the north-west, from time to time shifting its position and increasing in altitude till the two arches had melted into one, from which rosy streamers went upwards. But lovelier and more wonderful even than this display was a shaft of intense white light, which, just as the chimes of the old church clock were dying away at 6, passed rapidly like a flying arch across the heavens at an altitude of about 30 degrees, and vanished below the southern horizon. After 6.45 the rosy tints had gradually subsided, and at 8 a pale light in the north was all that remained, but I have been told that at 12 and 3 a.m. coloured streamers were again visible. E. BROWN

Further Barton, Cirencester, November 18

THE fine display of the aurora borealis was seen here Friday evening from a little before 6 o'clock. The sky was clear, and the moon, seven days old, was well up. The chief features of the aurora were the two patches of deep pink light, one in the west, in the constellation Hercules, and the other in the east, between Capella and the Pleiades; connecting these two patches was an arc of lighter tint passing between the two Bears. At 6.10 a beam extended from this arc to the left of Cassiopea, towards the zenith; at 6.20 this had disappeared, and another very distinct lay through the body of Ursa Minor, right to the zenith, more over the concentration, as it were, of pink light near Perseus in the east had disappeared, and the light ended at Capella. At 6.40 Capella and β Aurigæ were clear of it. The patch in the west did not disappear, but grew fainter. At 6.50, while watching the display, a magnificent meteor fell slowly from the body of the Little to the tail of the Big Bear, leaving a short red tail there. At 7 the pink tint of the auroral arc had almost disappeared, giving place to one of phosphorescent light, extending from near where Jupiter was rising in the east, through the body of Ursa Major, to below Hercules in the west. This grew fainter, till at 7.30 it was scarcely noticeable. But at a little before 11 p.m. there extended a narrower and brighter line of phosphorescent light, slightly arched from 10° to 15° above the horizon. From this, at 11.20, the streamers began to radiate towards the zenith, alternately forming and disappearing, some stretching to the zenith, some only half way. At 11.45 repeated flashes of light swept up along the streamers, happily likened by one of your correspondents to the flapping of a flag in a breeze. At times a long streamer would appear broken off from the arc of light, and fade away. At 12 the streamers had vanished, leaving only the phosphorescent light near the horizon, though now and then a streamer would form. At 12.30 a pink tint appeared in the north-east, and more streamers formed till 12.45, when the light began gradually to fade away, till at 1 a.m. nothing of the display was to be seen. The day had been overcast, wind north, but towards evening it had cleared; during the night it was freezing; the barometer, at 29·6, was rising; the moon had set at 11 p.m., and the sky, free from clouds, was all that could be desired in which to witness this splendid display of northern lights. FRANK STAPLETON

Oxford, November 19

I BEG to hand you an account of the extraordinary apparition of Friday evening last, November 17, as seen at Clevedon, during a brilliant rose-coloured aurora. The time was about 6.15 p.m. There rose suddenly, through the haze in the east, a beam of light, at an angle of some 60° with the horizon. It crossed the cloudless sky rather below the moon, and sank in the west, occupying about eighty seconds in the transit. The trajectory was much flatter than that of the stars, &c., but was at right angles to the meridian, which was crossed at an approximate altitude of 22°. I estimated the length of the beam at 35°, and the breadth at the middle to be 3°; from whence it tapered gadually to a point at each end. The colour was uniform throughout—a very pale yellowish white, without coruscation or change; and there was no indication of a trail, or of any sort of atmospheric disturbance. The impression conveyed to me was that the beam was stationary in space, and comparatively near, and that we were being carried past it by the rotation of the earth. The major axis lay on the apparent path, but in the earlier and latter parts of the course it was much foreshortened; and as the western horizon was approached, a formation of a similar character, perhaps 7° northward, and running on a parallel track, was visible for several seconds before both were lost in the trees. This second object was also noticed by others whose view westward was less interrupted. I watched the whole evening without seeing any tendency to a repetition of the phenomenon. The sky remained cloudless, with the temperature at the freezing point. There was no wind; and the aurora, which continued off and on until past eleven o'clock, at no time threw out any considerable rays or streamers. The strange visitor caused great commotion among the many who were out of doors looking at the aurora, some of them fearing that the supposed runaway comet was coming into collision with the moon, then half an hour past the meridian, and relieved when it passed below it. I had, however, a much better corroboration of the altitude above given, a careful observer who was with me placing a rod in the direction of the supposed meridian passage. The angle closely agreed with my estimate. We now require to know at what place south of this the beam was seen to cross the moon's disc, for computing the actual distance and position. Many of your readers will not have failed to note that a splendid aurora again coincides with rapid and striking changes in the configuration of a gigantic spot in the sun. With a 3¾-inch achromatic, I was able on the same afternoon to observe those changes from hour to hour, on a scale I never before witnessed.

STEPHEN H. SAXBY

East Clevedon Vicarage, Somerset, November 20

WHILE watching the grand display of aurora on Friday night from our roof, at about 6h. 7m., my wife and I saw a strange gleam of light rising above a bank of cloud on the eastern

horizon, nearly vertically below the Pleiades, like the gleam of another moon rising in a haze. It grew out slowly, as we watched it, into a strong beam of white light slanting towards the south, and we stood in wonderment as it lengthened out making straight towards the moon. Presently its tail was disengaged from the cloud, and it stole through the sky like a long luminous nebulous "cigar-ship" exactly across the moon, and away down into the west, sinking as slowly as it had risen. In the middle of its course it was, as well as I could estimate, about 40° in length and about 5° in width. The ends were, I think, slightly tapering and hazy; the sides pretty well defined. I did not notice if the moon's crescent was at all blurred during the passage; my wife is under the impression that it was. The time occupied from first appearance to final disappearance was about one minute. You will probably receive many accounts of this strange apparition. It will be interesting to know the position relative to the moon in which it was seen by different observers. Was it clear of the earth's atmosphere or not?

Woodbridge, November 19 HUBERT AIRY

YOU will no doubt have abundant accounts of Friday's aurora. I have received the following from a correspondent in North Devon, dated Friday 6.5 p.m. . . . . "As we watched, a brilliant comet (apparently) appeared near Saturn" [which must have been low down, a little N. of E.] "and in a direct line between Saturn and the moon" [at that hour nearly in the meridan and 28° in altitude]. "It was about twice as big as the comet." [Here follows a sketch, which the above 'asides' render it unnecessary to copy.] "It travelled stern foremost towards the moon, and was in sight a full minute. As it disappeared it seemed to leave a black cloud of its own shape which also disappeared in a few seconds (an optical delusion perhaps)." It does not appear to have occurred to the writer that this appearance was itself auroral. J. HERSCHEL

30, Sackville Street, November 18

I AM unable to explain the following occurrence which I observed this evening at 6h. 5m. p.m. It appeared to be a well-defined spindle-shaped body of a cloudy consistency, having a brilliant white colour. It subtended a visual angle of about 20 degrees. I first observed it due east, and immediately noticed that it was moving with very great rapidity, as in less than one minute it had disappeared below the horizon in the south-south-west. There was a rosy aurora visible at the time in the north, which, however, was in no way connected with it. The atmosphere was perfectly clear in that part of the heavens traversed by the phenomenon, though in other parts of the sky there were a few stationary clouds visible. A friend who was with me at the time will corroborate all my statements. As I am utterly at a loss to explain this phenomenon, I would be much obliged for any suggestions or explanations from your readers. A. S. P.

Cambridge, November 17

I THOUGHT that many of the readers of NATURE would be interested in a curious phenomenon which appeared during the beautiful coloured aurora on the evening of the 17th. I was watching it from a position commanding a large view of the sky, when, as I was looking south-east, a long patch of white light appeared about 10° above the horizon. This was commonplace at first, but then it quickly developed into a long, gleaming, and well-defined streak. It looked very like two brilliant comets joined end to end by the tip of the tail. This took about a minute to form, and when complete, it started off in the direction of its length in a curved path which gradually rose above the horizon until it culminated at an elevation of 30° on the magnetic meridian; after which the west end inclined downwards, and it continued its journey in inverse order to the south-west, keeping its symmetry and shape like a rigid body all the way, until it reached a position in the south-west, corresponding to its place when forming, and here it halted and dissolved away. The band of light was about 30° long, and beautifully curved along its path. It took about three-quarters of a minute in its transit, which occurred at 6 p.m. It was an extraordinary sight, and I hope some one else has observed it. During the phenomenon, the aurora in the north-east and north-west (magnetic) was very fine, showing rich red and apple-green streamers; these were very steady all the time. I have made a sketch of the band of light, as nearly as I can remember it. It was very bright, even when under the moon. I think this sketch gives a good idea of it, and I inclose it in case it be wanted. The southern sky was quite *clear* at the time. H. D. TAYLOR

Haworth, York, November 19

ON Friday, November 17, we had a great auroral display at 4.30 before sunset, and continuing till 5.30, the heavens were aglow with auroral light of a rosy tint, changing occasionally into silver grey. A haze overspread the sky until 10 o'clock, from which hour till 2 a.m. Saturday the sky was brilliant with aurora. The streams of light culminated near the zenith, and at midnight the magnetic storm appeared to reach its maximum. The magnetic disturbance must have been great for several hours, as nearly all telegraphic operations had to be suspended.

Newcastle-on-Tyne, November 19 T. P. BARKAS

ABOUT 5.20 p.m. on Friday last I witnessed the most remarkable auroral display I have ever seen, and as it only lasted a few minutes, may have escaped the attention of many. My attention was first attracted by a broad crimson band stretching quite across the sky, and almost coinciding with the Milky Way. Some of the bright stars could be seen through it, but gradually it became opaque at the zenith and appeared to concentrate around an opening, forming a complete corona, out of which the rays seemed to boil over and dart out in every direction, but chiefly northwards. It was a most weird-looking sight, and reminded me of "The Glory," as shown in pictures of Saints. Overhead it rapidly faded away, but bright streamers were visible up till 9 p.m., when a thick fog came on.

W. MAKEIG JONES

Wath-on-Dearne, Rotherham, November 20

IN connection with the recent appearance of the aurora borealis, a remarkably large sun-spot was visible to-day, occupying a position in about the middle of the disc. The spot might be called an aggregation of spots, from its area. Several minor spots were also visible, which were discrete.

Rugby, November 19 GEORGE RAYLEIGH VICARS

THERE was visible here on Friday, the 17th, between 5.30 and 6 p.m., a display of aurora. My attention was called to it by the ruddiness of the sky towards the north, and I continued watching it till near 6 o'clock. The sky was clouded with cumulo stratus, and the stars only visible here and there through the intervals of these clouds. The centre of the ruddiness or glow appeared to be over Auriga, the most brilliant star of which group was just visible. It extended to the east so as to cover Gemini, and about an equal distance west. It shifted and varied very rapidly, maintaining its ruddy colour, and this very rapidity of shift assured me that it was really an aurora. After 6 o'clock p.m. the clouds nearly completely covered the sky, and neither at 7 o'clock nor at 8 o'clock did I see any further sign of the appearance. I could not distinguish any beams whatever. J. P. O'REILLY

Royal College of Science for Ireland, Stephen's Green, Dublin, November 18

P.S.—I was informed that on the evening of Thursday a similar display had been noticed.

AT about 6.5 p.m. on Friday a bright, white, cloud-like object, in shape like a fish-torpedo or a weaver's shuttle, was observed to cross the heavens from east to west. Its length was roughly about 30°, and its breadth about 4°. I noted it first shoot up, like a strong electric ray in a fog, a little south of Aldebaran, and slowly, as it were, slide along at the same N.P.D. across the face of the moon (which was shining brightly at the time), and disappear in the west under Atair. Its surface had a mottled appearance; its colour *white;* its motion was slow, being visible, from horizon to horizon, upwards of 50 seconds; its brightness was strong, and did not seem to fade, even when crossing the moon, and it seemed preceded and followed by a strong black margin; though this I suppose was the effect of contrast and subjective only. The aurora was noted here from 4.30 on Friday till about 5 a.m. on Saturday.

JOHN L. DOBSON

Beaumont College, Old Windsor, November 21

THE CHLOROPHYLL CORPUSCLES OF HYDRA

IN the last number of the *Zeitschrift fur wiss. Zoologie* is an article by Mr. Hamann, assistant in the Zoological Institute of Jena, on the "Origin and Development of the Green Cells in Hydra." I cannot allow

this article to pass in silence, and think that the pages of NATURE, in which already there has appeared a good deal relative to the supposed infection of animal tissues by green unicellular Algæ, offer the most fitting place in which to lodge a protest against the reception of Mr. Hamann's conclusions as reasonable.

In the first place, Mr. Hamann has not made himself acquainted with previous writings on this subject. He briefly states that "R. Lankester disputes" the algal nature of the green corpuscles suggested by Brandt, and the existence of a cell-nucleus in them, and refers the reader to a paper by me on "Symbiosis of Animals with Plants," which has no existence. Mr. Hamann has not read the article to which he refers, which appeared in the *Quart. Journ. Microsc. Sci.* April, 1882, and was entitled "On the Chlorophyll Corpuscles and Amyloid Deposits of Spongilla and Hydra." Mr. Hamann has accordingly failed altogether to take up the points of importance in the discussion. These seem to me to stand somewhat as follows: It had already been urged (1) that the green corpuscles of Hydra multiply by fission; (2) that they possess each one or more cell-nuclei; (3) that they possess a cell-wall comparable to the cellulose wall of a unicellular Alga; (4) that starch is developed within them even after their removal from the living Hydra. It had been inferred (by Semper, and later by Brandt) that consequently these corpuscles must be considered as unicellular Algæ.

To these considerations I had replied in the article above named, by describing carefully the nature of the "fragmentation," or division of the chlorophyll corpuscles of both Hydra and Spongilla. I cited the notorious fact with regard to the chlorophyll corpuscles of plants, namely, that they multiply by fission. I showed further, by description and figures, that *there is not any structure present in the chlorophyll corpuscles of either Hydra or Spongilla which is comparable to a cell-nucleus or to a cell-wall*, and that the ascribing of such parts to the chlorophyll corpuscles of Hydra is *totally erroneous*.

I further insisted that we are not acquainted with any unicellular Algæ at all resembling the chlorophyll corpuscles of Hydra, whilst the chlorophyll corpuscles of plants closely resemble them,—and finally I pointed out that there is as much reason to regard the chlorophyll corpuscles in the leaf of a buttercup as unicellular Algæ as there is so to regard those of *Hydra viridis*.

Mr. Hamann does not in any way deal with these observations, but naïvely remarks, after describing his observation of the already-known multiplication by division of the chlorophyll corpuscles of Hydra, "after these observations the nature of our green corpuscles as Algæ seems to me to be firmly established." This seeming can only arise from the fact that Mr. Hamann is not acquainted with the characteristics either of Algæ or of the chlorophyll corpuscles of plants.

A simple assertion that a nucleus and a cell-wall are present in the chlorophyll corpuscles of Hydra is all that Mr. Hamann gives us on this head; although his paper is illustrated by a plate, no nucleus and no cell-wall are figured by him. Were he able to adduce good evidence of the existence of either of these structures, the view which he has advocated would be materially advanced. But this he is unable to do, because such structures do not exist.

Mr. Hamann offers some observations on the occurrence of chlorophyll-corpuscles in the egg-cell of Hydra which lead him to assume that these corpuscles enter the egg-cell by "wandering" from the endoderm-cells. The figures and statements which he makes do not, in my opinion, tend necessarily to that conclusion.

Lastly, I would point out that the exceedingly variable form of the chlorophyll-corpuscles of Hydra and Spongilla which I have illustrated by figures in my memoir above cited, is not noticed by Mr. Hamann. This variability is quite inconsistent with the view that they are parasitic Algæ. So also is the fact that these corpuscles are represented by colourless corpuscles in the colourless varieties of Spongilla and Hydra which turn green when treated with sulphuric acid.

It should be distinctly borne in mind that it is by no means necessary, supposing that the green corpuscles of Hydra are parasitic Algæ, that a nucleus should be present in them, nor indeed a well defined cell wall. But when the presence of such structures is asserted as evidence that these corpuscles are different in nature from the otherwise closely similar corpuscles formed in the protoplasm of green plants, the question of the actual presence or absence of the nucleus and cell-wall becomes important, and must be definitely decided upon thorough histological evidence.

So far it appears to me, as I have previously maintained, that there is no more and no less evidence for considering the green corpuscles of *Hydra viridis* as parasitic Algæ, than there is for taking a similar view with regard to the green corpuscles in the leaf of an ordinary green plant.

E. RAY LANKESTER

NOTES

WE regret to notice that in Tuesday's papers the death of Prof. Henry Draper of New York is telegraphed. We hope to be able to refer to his work in an early issue.

THE Council of the British Association have nominated Mr. A. G. Vernon Harcourt, M.A., F.R.S., to the office of General Secretary of the Association, in the room of the late Prof. F. M. Balfour.

MARINO PALMIERI, whose death we announced a fortnight ago, must not be confounded with his father, Luigi, the eminent director of the Vesuvius Observatory, who we are glad to be able to say is alive and well.

THE death is announced, on November 11, of Dr. Franz Ritter von Kobell, Professor of Mineralogy and keeper of the mineralogical State collections at Munich, well known through his numerous mineralogical publications. He died at the age of seventy-nine years.

M. JANSSEN has been sent to Oran to observe the transit of Venus from a physical point of view.

WE have received a circular in reference to the visit of the British Association in Montreal, containing the results of the recent meeting in that city, to which we have already referred. It is evident that the Canadians are determined to do all in their power to make the visit of the Association a success. "The city of Montreal, which has a population of about 150,000 souls has," the circular states, "twice entertained the American Association for the Advancement of Science; for the second time in August, 1882, when an attendance of more than 900 members and Associates was registered, and the Association, with its nine sections, found ample accommodation in the buildings of McGill University. The ordinary summer-passage is made in eight or nine days from Liverpool to Quebec, which city is connected with Montreal by two lines of rail, making the journey in six hours, and by river-steamers. From Montreal to Ottawa, the capital of the Dominion, is four hours by rail; from Montreal to Toronto, thirteen hours; and to Niagara Falls, sixteen hours by rail. Montreal is in direct connection with Boston by two lines of rail, by which the journey is made in ten hours. There are also two lines connecting Montreal with New York city in thirteen hours, and one with New Haven in sixteen hours. It is expected that the American Association for the Advancement of Science will hold its meeting in 1884 in New Haven, or some other eastern city of the United States, at such a time

as may permit the attendance of members of the British Association, either before or after their gathering at Montreal. We have assurances that the Government of the Dominion of Canada will make a liberal grant of money to defray the expenses of members of the British Association in crossing the ocean, and that the various railroad and steamboat lines in Canada and in the United States will offer most liberal arrangements to our guests. The Grand Trunk Railway will arrange for an excursion of members of the Association to the Great Lakes and Chicago, while the Canadian Pacific Railroad will give an excursion to the provinces of the North-West, as far as the Rocky Mountains. It is believed that the British Association may count upon a large attendance of local members and associates both from the provinces of the Dominion and the United States. In any case, the Finance Committee are prepared to guarantee that the revenue from this source shall not fall below that ordinarily received by the Association. Members of the British Association in coming to Canada may be assured of a most cordial welcome and generous hospitality, not only from the citizens of Montreal, where every facility will be furnished for their meeting, but from the people throughout the country. It is hoped by the Invitation Committee that these assurances, and the above statement of the advantages and facilities offered them, may secure a large attendance of the members of the British Association at Montreal in 1884."

IN the sitting of the Academy of Sciences of November 20, M. Dumas read an *arrêté* from the Minister of Public Instruction, regulating the competition for the Volta Prize, which will be delivered in 1887. It is expressly decreed that the competition be open to every nation. A report will be made by the Commission *ad hoc*, and published *in extenso* in the *Journal Officiel*.

AT the meeting of the Paris Academy on Monday M. Dumas stated that at the very beginning of its work, the Academical Commission for the destruction of the Phylloxera proposed to arrange for the immediate destruction by fire of each plant proved to be infested. Objections were made to this scheme grounded on the state of French legislation on rural property, and the Academical Commission desisted. M. Dumas states that he has in hand an official report from Switzerland establishing the soundness of the views taken by the Academy on this important question. The cantons of Geneva, Vaud, and Lucerne having resorted to the destroying process, all the vines, of which the value exceeds 40,000,000*l*., had been saved at the expense of a few thousand pounds. A special tax had been imposed on the proprietors of vines for compensation to the owners of the destroyed plants.

A FIRST application has been made of the resolutions of the last Congress of Electricians proposing that regular observations should be made on earth currents during magnetical perturbation. The perturbations of November 17 have been accompanied in France by strong earth currents principally in the south-north direction. We may state, moreover, that others were observed on November 20, exhibiting a very great force.

LARGE electrical disturbances have been observed in Sweden and Norway during last week. On Friday last all telegraphic communication became for a time suspended, and at Stockholm and Jönköping central telegraph stations several instruments were destroyed. In Norway the electric storm was accompanied by thunder, a phenomenon almost unknown at this time of the year.

A LARGE and enthusiastic meeting was held on Saturday evening last, in Trinity College, Prof. Moseley, F.R.S., in the chair, when the following resolution was carried unanimously:—"That it is desirable that a society should be formed for the purpose of bringing together the Undergraduates and Bachelors of Arts of the University, who are engaged in the study of Natural Science, for the friendly discussion of scientific and other topics." The officers and members of the new club were elected, Mr. Bond, B.A., being elected president, and the first meeting will be held in the course of next week.

THE Rev. T. W. Webb writes to the *Times* as follows on the comet:—"As it must be universally admitted that the magnificent comet now receding from our sight is the most interesting, in a popular as well as scientific point of view, of any that have appeared for many years, will you allow me to add the record of a very remarkable phenomenon to the somewhat scanty details respecting its aspect which have as yet been laid before the public? In an extremely valuable letter received by me this morning from a very able and careful observer, Mr. J. T. Stevenson, of Auckland, it is stated that on October 6 and 10 an 'anomalous' tail was feebly but distinctly visible, pointing towards the sun. Your astronomical readers will remember that a similar 'glowing wake' attended the returning course of Newton's great comet in 1680, distinguished, like the present, by its close approach to the surface of the sun, and a few more cases might be cited. It is, however, of such infrequent occurrence, that another instance forms a valuable addition to our stock of information as to these mysterious bodies. I ought to mention that Mr. Stevenson's letter was despatched immediately after his last observation, so that we may hope that, with a climate and position of the comet giving him great advantage over northern astronomers, he may have been able to trace this singular appendage on subsequent occasions."

THE German Society for the Prevention of the Pollution of Rivers, the Soil, and the Atmosphere, held their fifth annual meeting at Brunswick on October 19 and 20 last, under the presidency of Prof. Reclam (Leipzig). The number of papers read was considerable and the attendance very large. Among the speakers were Burgomaster Rittmeyer (Brunswick), Prof. Müller (Berlin), Dr. Blasius (Brunswick), Dr. Engler (Stuttgart), Herr Knauff (Berlin), Dr. Gerson (Hamburg), Dr. Petri (Berlin), and Dr. Beckurts (Brunswick).

WE have received from Mr. J. P. Walker, C.E., Stirling, a communication on the Forth Bridge, but we can hardly venture to insert in our columns the descriptions of Mr. Walker's and other plans for such a bridge. The peculiarities of the plan drawn by Messrs. Fowler (chief engineer) and Baker, and the circumstance that it had been accepted by Commissions of Parliament and of the Board of Trade, gave it great claims on our attention, which can scarcely be recognised as applying to any other proposal.

THE Glasgow *Evening Times* has the credit of being the first daily paper, so far as we know, to introduce into its pages star-maps showing the aspect of the heavens at stated times. On November 11 it started with four such maps, and the series will be continued. There are full instructions as to the meaning and use of the maps, and we have no doubt they will be the means of leading many people to form a practical acquaintance with astronomy.

THE first number of the *American Journal of Forestry* bearing date October last has just reached us. It is edited by Franklin B. Hough, Ph.D., Chief of Forestry Division U.S. Department of Agriculture, and has as contributors an array of well known names connected with forestry matters in America. The journal in size and shape corresponds with the *Journal of Forestry* published in this country, and edited by Mr. F. G. Heath. It is not, however, so tastefully got up, though the printing and the character of the articles are very similar. The contents of the number before us, for instance, are, after the Editorial "Announcement," a paper on "Forestry in Michigan," one on "Larch Wood," one on the "Forestry of the Future," by the Editor, on "Forest Fires," on the "American Forest Congress," and the usual "Miscellany." The forests in America are so

extensive and there is so much connected with them that belongs legitimately to the subject of forestry that we have no doubt the journal will meet with a wide circulation.

THE Annual Report of the Public Gardens and Plantations in Jamaica for the year ending September 30, 1881, has just reached us, and from it we gain some idea of the work that is being carried on in the island under Mr. Morris's care in the dissemination of useful plants. It is satisfactory to find that of late years a considerable amount of attention has been directed to the extended cultivation of economic plants in all our Colonies, a branch of culture that must in the end prove of more lasting value to mankind generally than the growth of any mere horticultural novelty or scientific rarity. Mr. Morris's Report from beginning to end is a record of what can be done by a single establishment in the introduction of new plants and their distribution amongst planters in the several colonies. As an illustration of this Mr. Morris says "there is much activity displayed even by the poorest peasants in obtaining and cultivating new and important plants, and I cannot but hope, that before many years have elapsed this activity will result in the greater prosperity and wealth of the island, and in placing it in the first rank as exporter of fruit and raw materials to the markets of England and America." Regarding Jamaica in particular, Mr. Morris says: "It is evident that Jamaica must depend for its prosperity and success almost entirely on the resources and products of an agricultural character. We have no large stores of timber, we have no minerals, we have no manufacturing industries, and we cannot hope to struggle successfully with other countries in the more advanced arts and sciences. We nevertheless possess a rich and productive soil, a salubrious climate, abundant springs, and a vast extent of uncleared mountain land; and it is mainly on the due utilisation of these valuable natural resources that our prosperity must ultimately depend. Under these circumstances the chief aim of the Department has been directed towards bringing into notice the nature and character of such resources, and to fostering and promoting any well directed efforts for their utilisation. The position and prospects of several new industries, such as Liberian coffee, cacao, tobacco, oranges, mangoes, pine-apples, spices, india-rubbers, fibre-yielding plants, &c., are carefully noticed with this view, and the success which has already attended these comparatively recent efforts would indicate that capital and energy are alone wanting to place the island in an important position as to the source of most tropical productions." Naturally a good deal of attention has been paid to cinchona cultivation, and a large number of plants of the best varieties have been raised, seeds and plants having been distributed to private plantations, and sold in considerable quantities during the year. The cultivation of the jalap plant promises also to become one of considerable importance in Jamaica.

TO give an idea of the dairy-industry in France, M. Hervé Mangon recently stated (at an agricultural gathering) that the milk produced in the country would, if collected, form a stream about 1 metre in width and 33 centimetres in depth (say 3 feet 4 inches and 1 foot 1 inch), flowing night and day all the year, with a mean velocity of a metre per second. Young animals drink a part of this enormous volume of milk, man takes a good part of it, and the rest is transformed into cheese and butter. No branch of agricultural industry has so progressed during the last fifty years as the making of butter. In 1833 France bought abroad 1,200,000 kgr. of butter, and sold to foreigners only 1,100,000 kgr. She now exports 34 to 35 million kgr. of butter annually, and receives in return from abroad (especially from England) a sum of more than 100 million francs. La Manche alone furnishes more than one-third of the total exportation.

A VALUABLE investigation of the origin of metalliferous lodes, by Prof. Sandberger, of Würzburg, has recently been published at Wiesbaden. The various theories are discussed, more especially those of ascension, and of lateral secretion or levigation. Till 1873 the author was a partisan of the former, but he was led to make a chemical study of the gangues and lodes in the Black Forest, and by 1877 he had got so far as to obtain proof, for the greater part of the mining districts in Germany, that the lodes had been formed by levigation of the encasing rock. The second part of the work is elevated to a special study of the environs of Wild Schapbach in the Black Forest, as illustrating the theory of levigation. (An outline of these researches appears in *Archives des Sciences*, October 15.)

AN improved feed-water heater and purifier has been recently described to the Franklin Institute by Mr. George Strong. It is said to effect a saving in coal of 22 per cent., and an increase of evaporation of 1·09 pounds of water per pound of coal. Considering that all substances likely to give trouble by deposition would be precipitated at about 250° F., he obtains this in the heater by action of exhaust steam, aided by a coil of live steam from the boiler. He also uses a filter formed of wood-charcoal, and bone black firmly held between two perforated plates. (Further details will be found in the *Journal* of the Institute for November.)

IT appears from the *Shen-pao*, a Chinese newspaper published at Shanghai, that the Chinese are taking practical steps in the matter of foreign education. A school for the education of Chinese boys in foreign matters has been established in the Pun-yen district of Canton, and it has already fifty scholars. So far the school has been a success, and to meet the requirements of the scholars it is proposed at the next Chinese New Year to solicit subscriptions to enlarge the school premises. The teachers are Chinese well versed in English, and the school bids fair to be followed by many others of a similar kind. A satisfactory circumstance about it is that the institution has been founded by the people themselves with official countenance or assistance, and that Chinese gentlemen competent to teach these schools are now to be found. European teachers and professors are of course absolutely necessary for a time; but their want of knowledge or imperfect knowledge of the language of the country must cause them to be make-shifts at the best.

UNDER the title of "Les Grandes Ascensions Maritimes." M. W. de Fonvielle has published (Paris, Ghio) a *brochure* giving an account of several balloon ascents over the ocean, including some, such as the late Mr. Powell's, which have come to grief by being driven into the sea.

THE Tenth Annual Report of the Lambeth Field Club speaks hopefully of its condition; it seems to be doing good work.

THE public dinner in celebration of the 100th anniversary of the first experiment at Annonay by Joseph Mongolfier was given on Saturday at Paris by the Académie d'Aérostation Météorologique. Three members of the Mongolfier family were present. Several speeches were given, and a general committee was appointed to organise a national celebration on June 5, 1883, the anniversary of the first public experiment at Annonay before the États Généraux du Forez.

THE *Journal Officiel* states that the director of the Compagnie du Cap has given to the Paris Museum of Natural History a diamond weighing 4½ carats, enveloped in its native rock. It is supposed that this generous donation will determine the public authorities to send to the museum a part of the jewels of the French Crown, which are now kept in the Bank. The question of their sale has not yet been settled, in spite of several parliamentary and extra-parliamentary reports.

NEWS from Perugia now states that the earthquake began on October 28 at 6 p.m., and with short interruptions lasted until

October 29 at midnight. A real panic is reigning among the population of Cascia. The extent of the zone of the phenomena cannot yet be ascertained, but it seems that the eruption of Mount Etna is closely connected with it. Several old houses fell at the first shock.

THE additions to the Zoological Society's Gardens during the past week include a Bonnet Monkey (*Macacus radiatus*) from India, presented by Mr. A. S. Gissing; two Common Herons (*Ardea cinerea*), British, presented by Mr. R. H. Rabbetts; a Common Barn Owl (*Strix flammea*), British, presented by Mrs. A. Wright; a Slender-billed Cockatoo (*Licmetis tenuirostris*) from South Australia, deposited; two Red-billed Tree Ducks (*Dendrocygna autumnalis*) from America, a Zenaida Dove (*Zenaida amabilis*) from the West Indies, purchased; a Hairy-rumped Agouti (*Dasyprocta prymnolopha*) from Guiana, received on approval.

BIOLOGICAL NOTES

APPARENT BIRD-TRACKS BY THE SEA-SHORE.—At a recent meeting (October 3) of the Academy of Natural Sciences of Philadelphia, Mr. Thomas Meehan called attention to what appeared to be the tracks of a three-toed bird in the sand near low water-mark, at Atlantic City. These tracks were of a nature that would be readily recognised by observers as bird-tracks; but while thinking of what bird could have caused them, and reflecting on the phenomenon of their being only found on the sand near low water-mark, Mr. Meehan noted on the face of the smooth, receding waves, spots where the water sparkled in the light, and he found this was caused by little riplets as the wavelets passed down over the half-exposed bodies of a small crustacean (*Hippa talpoidea*), and that the water, in passing over the bodies made the trifid marks which had been taken for impressions of bird's feet. These little crustacea take shelter in the sand near low water-mark, and enter head foremost in a perpendicular direction downwards, resting just beneath the surface. The returning wave took some of the surface sand with it, and then the looser portions of the bodies uppermost in the sand were exposed. Often the little creatures would be quite washed out; when recovering themselves, they would rapidly advance in a direction contrary to the retreat of the wave, and would enter the wet sand again as before, their sides being parallel with the shore. Their bodies terminate in a caruncular point which, with the position of the two hind-legs, offer a tridentate obstruction to the sand brought down by the retreating wave, and the water passing round the points made the three toe-like grooves, which resembled a bird's foot from one and a half to two inches long. The crustacea, in their scrambles for protection beneath the sand, managed to keep at fairly regular distances from each other, and hence there was considerable regularity in the tracks, as if they had really been produced by birds. Although the author of these notes presented them as a trifle, yet it will be at once apparent that they are of great interest. Trifid impressions like these, filled with mud and the deposit then to become solid rock, would puzzle, if not altogether mislead, future observers.

AUSTRALIAN FRESHWATER SPONGES.—Up to this date, but one species of freshwater sponge has been described from Australia, *Spongilla capewelli* of Bowerbank; but Mr. W. A. Haswell, at a meeting of the Linnean Society of New South Wales (May 31, 1882) describes two new species from a pond near Brisbane, and one from the River Bell at Wellington. *Spongilla sceptroides* is a green, smooth, encrusting species, with the skeletal spicules very slightly curved, acute at both ends, ornamented with very minute projecting points. The statoblasts are spherical, defended by long, slender, straight, cylindrical spicules, which are armed with numerous acute spinules, chiefly collected around the extremities, forming heads; it is found growing on submerged twigs. *S. botryoides* is a yellowish flat-encrusting species, with curved skeletal spicules, fusiform, acute, with scattered, extremely minute, projecting points. Statoblasts protected by a crust of short, strongly-curved spicules, with heads at each end of numerous short, blunt, or sub-acute spines, somewhat botryoidal-like, the shaft smooth. This species was found with the first: another species found by Mr. E. P. Ramsay in the Bell River, growing on masses attached to submerged timber seems nearly related to *S. Meyeni*, from Bombay. In colour it varies from a grass green to a yellow. It is massive, lobulated, with oscula between the projections. The skeleton spicules are perfectly smooth, and the amphidises are provided with from one to ten acute and prominent spines. Another species from somewhat deep water is indicated by Mr. Haswell.

EARTH-WORMS IN NEW ZEALAND.—The following interesting observations form part of a communication from Mr. A. T. Urquhart, to the editor of the *New Zealand Journal of Science*, and appear in the September number of that periodical. In October, 1875, I dug a trench on some newly-cleared land—a raised beach at Manukau Harbour. The section then showed about 4½ inches of black mould and a horizontal layer, 1 inch thick, of burnt clay, wood-ashes, small stones, and pumice lying on a brownish-green arenaceous clay. The vegetation cleared was the growth of some thirty years. A portion of the land was left undisturbed. Measurements again taken a few days ago gave an average depth of 1¾ inches of turf, 5¾ inches of black mould, and there was no perceptible difference in the layer of ash. An angular block of Trachyte—about twenty-five pounds in weight—placed in May, 1875, had sunk 1 inch, allowing for the turf. As the results of some accurate calculations, as to the number of worms per acre, Mr. Urquhart gives results so considerably higher than Henson's, that he would have hesitated to publish them, were he not in a position to prove them. Henson, it will be remembered by the readers of Darwin on "Vegetable Mould," calculates that there are 53,767 worms per acre in garden mould, and above half that number in corn-fields. Mr. Urquhart's estimates, founded on digging about a quarter of an acre, as well as by a large number of tests on various parts of the fields, some that were under pasture for over sixteen years, gave from four to twenty-six earth-worms per each square foot. The alluvial flats, slopes, and richer portions of the upper lands would average eight to the square foot or say 348,480 per acre. In the uncultivated fern lands worms are scarce. In New Zealand worms not only leave their burrows, but climb up trees in search of food, this chiefly in the night time, though often until a late hour on damp warm mornings.

THE GENESIS OF THE HYPOPHYSIS IN PETROMYZON PLANERI.—Prof. Anton Dohrn, of Naples, writes:—"In his contributions to the history of development of the Petromyzons (*Morphol. Jahrbuch*, vol. vii. p. 158), Mr. W. B. Scott says: 'The organ of smell is one of the most peculiar parts of the whole organisation of the Cyclostoms. . . . . The position of the organ is a symmetrical from the very beginning. It first begins to manifest itself as a shallow depression above the mouth, which we may regard as a common depression for the nasal cavity and the hypophysis. The ectoderm covering the head becomes suddenly thickened at one spot, in order to form the special smell sense epithelia which lie close to the front extremity of the brain. The cells at the bottom of the depression decrease in depth, while the cells that cover the opposite wall of the depression (*i.e.* the continuation of the upper lip) are very low.' Balfour ("Comp. Embryology," vol. ii. p. 358) makes the following criticism upon this statement:—"I have not myself completely followed the development of the pituitary body in Petromyzon, but I have observed a slight diverticulum of the stomodaeum, which I believe gives origin to it. Fuller details are in any case required before we can admit so great a divergence from the normal development as is indicated by Scott's statements." According to researches which I made this summer, the question is solved, but in a way different from either Balfour's or Scott's suggestions. The hypophysis arises rather as an independent depression of the ectoderm between the depressions for the nose and the mouth. Its connection with the nasal depression is only secondary, and is caused by the strong and early development of the upper lip. It has no connection with the mouth depression, because the upper lip develops between the mouth depression and the hypophysis. The particulars of these relations will appear in the next number of the "Studies in the Early Development of Vertebrates" in the *Proceedings* of the Zoological Station at Naples (*Zool. Anzeiger*, November 6, 1882).

FORMIC AND ACETIC ACID IN PLANTS.—Dr. Bergmann sums up the results of his investigations as to the occurrence and import of formic and acetic acids in plants as follows:—1. Formic and acetic acids are met with as constituents of protoplasm throughout the whole of the vegetable kingdom in the most various portions of the plant-organism, and both in chlorophyllaceous and non-chlorophyllaceous forms.

2. Formic and acetic acids are to be regarded as constant products of metastasis in vegetable protoplasm. 3. It is probable that other members also of the unstable group of fatty acids, as for instance, proprionic acid, butyric acid, caproic acid, or even the whole group, are universally distributed in the vegetable kingdom. 4. An increase of the amount of unstable acids takes place in a plant-organism when its assimilation is interfered with by deprivation of light, *i.e.* when put into a state of starvation (inanition). 5. Formic and acetic acids accordingly belong to the constituents of regressive tissue-metamorphosis. It has been premised that the homologous, unstable fatty acids have a similar import in vegetable tissue-metamorphosis. 6. No increase in the amount of unstable acids takes place in a plant-organism, which is withdrawn for a period from the light, under the minimum-temperature required for growth. 7. Accordingly the formation of formic and acetic acids in a plant seems to take place to a certain degree independently of respiration. 8. Acetic and formic acids are mainly to be regarded as decomposition products of the constituents of vegetable protoplasm.

GEOGRAPHICAL NOTES

DR. WISSMANN, of the German African Society was, it is stated, just arrived at Zanzibar, having left Loando in April, 1881, in company with Dr. Pogge. Striking inwards across the numerous streams that take their origin in the great watershed which separates the Congo and Zambesi basins, the travellers were at Mukenge, about 6° S. and 22° E., in November last year. Shortly after they set out for Nyangwe on the Lualaba, whence Wissmann proceeded eastwards to Zanzibar, while Pogge turned back to Mukenge, there to plant a station. The details of this journey will doubtless be full of novelty and interest.

THE German African Society has recently issued a report upon its latest undertakings. There are now four German expeditions in Africa, two proceeding from the east, and two from the west. In the east there is Dr. Stecker, who as the companion of Dr. Rohlfs, paid a visit to King John of Abyssinia, and then continued his journey through the Soudan. His last letter is dated February 15. Dr. Böhrn and Dr. Kayser, who belong to Capt. von Schöler's expedition, report upon a three months' journey to Lake Tanganyika, from which they returned to the station at the end of 1881. From the Gondo Station itself Herr Paul Reichard, who remained there, sends a report; Capt. v. Schöler, after founding a station at Kakama, proceeded to Zanzibar. News has also been received regarding the exploration of the Wala River, to the west of Gondo, as far as its mouth, by Dr. Böhrn and Herr Reichard. On the other hand, Robert Flegel is busily at work. He has taken a minute cartographical survey of the hitherto unknown part of the Niger, between Inuri and Shay. In the spring of 1881 he prepared for a journey to Southern Adanana. He reached Keffi at the beginning of December; thence he intended to proceed by way of Schiber, on the Binne River, through the "heathen lands" to Kantscha and Yola, south of the Binne, then winter there, and thence proceed by water from Meo Kebbi to the Tubori Marsh to Kuka.

AT the beginning of November, Dr. Arthur Krause returned to Germany from his journey to the Chukchi Peninsula and Alaska, which he undertook, partly in company with his brother, Dr. Aurel Krause, and partly alone, at the instance of the Bremen Geographical Society. Dr. Aurel Krause returned to Germany last summer by way of Panama, while his brother remained in Alaska until the autumn. The two brothers have made copious collections of natural history and ethnographical specimens.

THE November number of *Petermann's Mittheilungen* contains an account by Dr. Gerhard Rholfs of the results of his recent journey in Abyssinia. Dr. Ferd. Löwl, of Prag, has a long and able paper on the origin of transverse-valleys; Lieut. Kreitner describes the route from Ansifan through the Gobi desert to Hami; while there are interesting letters from Emin-Bey, Lupton-Bey, and Dr. Junker, mainly referring to the work of the Russian explorer in the Welle region. He has been doing much to clear up the hydrography of the region, and has come to the conclusion that the Welle is really the upper course of the Shari, while the Aruwimi, the great tributary of the Congo, rises further to the east.

A SPECIAL supplement to the *Chamber of Commerce Journal* contains an account by Mr. Colquhoun of his recent journey through Yunnan to Burmah, accompanied by an excellent map. Under the title of "Across Chrysê," Messrs. Sampson Low and Co. will shortly publish a detailed narrative, with many illustrations, of Mr. Colquhoun's journey.

THE ordnance survey of Scotland, a work which has been going on for thirty-seven years, has been completed, and the surveying staff will be withdrawn from Scotland next week. During the last few years nearly a hundred men have been employed in the work.

THE Emperor of Russia has ordered 2200*l.* to be allotted from the Imperial Treasury to the Russian traveller in New Guinea and the Malay Archipelago, M. Miklucho Maklay, in order to enable him to work up the results of his explorations. His Majesty has also ordered M. Maklay to be informed that the cost of the publication of his book of travels will be defrayed by the privy purse.

THE PELAGIC FAUNA OF FRESHWATER LAKES

SEVERAL naturalists have within recent years made the pelagic fauna of freshwater lakes in various regions a subject of study. In the *Archives des Sciences* for September, Prof. Forel gives a list of those researches, with a *résumé* of the results they have yielded.

This fauna has but few species; but the number of individuals of each species is, on the other hand, enormous. The following is an enumeration of the species observed:—

OSTRACODA: *Cypris ovum*. CLADOCERA: *Sida crystallina, Daphnella brachyura, D. pulex, D. magna, D. longispina, D. hyalina, D. cristata, D. galeata, D. quadrangula, D. mucronata, Bosmina longirostris, B. longispina, B. longicornis, Bythotrephes longmanus, Leptodora hyalina*. COPEPODA: *Cyclops coronatus, C. quadricornis, C. serrulatus, C. tenuicornis, C. brevicornis, C. minutus, Heterocope robusta, Diaptomus castor, D. gracilis*.

The author excludes from consideration those animals that enter into the pelagic fauna in an accidental and accessory way, such as fishes (especially *Coregonus*), preying on the entomostraca, and other fishes which prey on those, also infusoria living on pelagic algæ, and animals coming occasionally from the border or the bottom of a lake.

The pelagic fauna is, in its general *traits*, very much the same in all European lakes where it has been examined, from the plains to the Alps, from Scandinavia to Italy. But it is rarely represented in one lake by all animals of the fauna. Pavesi has made a very complete study, in this respect, of the Italian lakes, giving, for each, a complete list of the species found. But an observation by Weissmann has to be remembered here. He found that the different species of Cladocera presented an annual periodicity; they disappear at certain seasons (different for different species), when they are represented only by eggs. Thus the list of pelagic animals of a lake, to be complete, must be based on numerous takes in different seasons.

The common characters of the fauna accord with the mode of life, which involves constant swimming; thus the animals have no organ of fixation, but a well-developed organ of natation. Their density, nearly equal to that of water, enables them to float between two waters without exerting themselves much. Their movements are slow, and they escape enemies rather by their transparence than by agility. This transparence is, indeed, their essential character; they do not generally show a visible point, except that of their eye, which is strongly pigmented with black, brown, or red. The quality of transparence may be interpreted as a case of mimicry.

The food of the fauna is vegetable or animal. Some feed on pelagic algæ, few in species, *Anabæna circinalis, Pleurococcus angulosus, Pl. palustris, Tetraspora virescens, Palmella Ralfsii*, but very abundant in individuals; others pursue and eat the smallest animal species living in the same waters.

The pelagic animals present daily migrations; swimming near the surface at night, and remaining in the depths by day. Fric thought he found, in the Bohemian lakes, each species select a determinate depth; neither Pavesi nor the author have observed such constancy. The different species form groups, or troops, where the net makes rich captures, but these banks of animals of the same species, have not, at least in the large Swiss lakes, a determinate fixed position.

As to the maximum depth at which they are found, Prof. Forel has taken them in Lake Leman as deep as 100 and even 150 metres; at the greatest depths only *Diaptomus*.

The optic nerve of those animals probably suffers from too bright light, and so they descend whenever the light of sun or moon becomes too strong; still, they require some light to seek their prey. In their migrations they traverse a considerable thickness of water. What is the limit of light in freshwater lakes? The author showed in 1877, that the transparence varied with the season; it is much greater in winter than in summer. Under the most favourable conditions, a bright object sinking in the water of Lake Leman disappears at about 16 or 17m. depth. Paper sensitised with chloride of silver gave as light-limit in Lake Leman 45 m. in summer, and 100 m. in winter. Asper, using more sensitive plates (prepared with bromide of silver emulsion), found the *actinic* rays still active in the Lake of Zurich at 90 m. and more. All this, however, does not determine the limit of absolute obscurity for the retina, and especially for the optic nerve of lower animals.

With regard to the origin of this pelagic fauna, Prof. Forel confidently rejects the idea of local differentiation of litttoral species in each lake, producing the pelagic fauna of the lake. The very remarkable character of generality, the almost absolute identity of the pelagic entomostraca in all European lakes point to dissemination and mixture.

How has this dissemination occurred? Active migration from one lake to another is inadmissible, considering obstacles and power of locomotion. On the other hand, a passive migration in the state of winter eggs, attached to the feathers of birds of passage, ducks, grebes, gulls, &c., explains the transport sufficiently. Pavesi has argued against this common origin and mode of dissemination, on account of irregularity in the pelagic population of different Italian lakes, certain species being absent in certain lakes, while they are represented in neighbouring lakes. But this irregularity seems to the author to correspond perfectly with the accidental and fortuitous character of the mode of dissemination referred to. "If this mode of transport be admitted, the differentiation of pelagic species is no longer necessarily localised in the lake in which we find the animals, any more than in the present geological epoch. This fact is very important for explanation of the pelagic fauna of certain lakes the origin of which is comparatively modern; for our Swiss lakes, the glacial epoch forms an absolute limit which prevents our supposing a local differentiation of ancient tertiary species, and their transformation into our present species; the origin of the pelagic faunas of certain Italian lakes of volcanic nature, is still more modern. But since we are no longer limited to a local differentiation of autochthonous species, we find more time and more space for this process of differentiation."

Prof. Forel believes the cause of differentiation of pelagic fauna will be found in a combination of two facts, viz., the daily migrations of entomostraca, and the regular local breezes on large lakes. There are two such breezes in calm weather, one blowing from the land at night, the other from the water by day. Crepuscular animals of the shore region, which come to swim on the surface at night, are carried out into the lake by the surface-current of the land breeze. By day the light sends them down, and thus they escape the surface current of the breeze that would bring them back to the shore. Carried each night further out, they become finally relegated to the pelagic region. Differentiation by natural selection then operates, and after a few generations, there remain only the admirably transparent animals and excellent swimmers we know. This differentiation once effected, the pelagic species is transported by the migratory birds from one country to another, from one lake to another, where it is multiplied, if the conditions are favourable. Thus we may find, even in lakes too small to possess an alternation of breezes, true pelagic Entomostraca that have been differentiated in other larger lakes by the play of such breezes. The differentiation of most pelagic species may thus be easily accounted for.

There are two species, however, the author points out, whose origin is not so explained; these are the most beautiful and interesting of pelagic Entomostraca: *Leptodora hyalina* and *Bythotrephes longimanus*. These two Cladocera have no known parentage in the freshwater species forming either the shore fauna of lakes or the marsh or river fauna. We must, with Pavesi, seek a marine origin for them. *Bythotrephes* probably descended from a common ancestor with Podon, its nearest parent, and the *Leptodora* from a primitive Daphnis.

How did the passage from salt to fresh water take place? Pavesi supposes closure of a fjord and gradual transformation of the lake water in consequence. Prof. Forel further suggests as possible, passive migration and successive transport to lagoons less and less salt; and there may have been other ways. We have not the elements for settling the question. "But the adaptation to fresh water once accomplished, the dissemination of these forms of marine origin has certainly taken place like that of other pelagic fresh-water forms, and those two species have so been transported into lakes which have never had direct communication with the sea."

There are evident analogies, Prof. Forel remarks in closing, between the lacustrian and the marine pelagic fauna; the differences appear chiefly in relative size and proportions. In the sea all is on a large scale; in lakes, on a small; the number of species and of individuals, the size, the extent of the migrations, the area of extension. But, with this exception, the general laws are the same in the two analogous faunas.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

FOUR chairs in the University College, Dundee, have been filled up as follows:—Mr. Steggall, Fielden Lecturer in Mathematics, in Owens College, Manchester, was appointed Professor of Mathematics; Mr. Carnelly, Professor of Chemistry in Firth College, Sheffield, was appointed Professor of Chemistry; Mr. Ewing, Professor of Engineering in the University of Tokio, Japan, was appointed to the Chair of Engineering; and Mr. Thomas Gilray, M.A., Head Master in English at Glasgow Academy, to the Chair of English Literature and Modern History. The salary guaranteed to each professor is 500*l*.

THE University of Zürich will, at the end of the current winter term, celebrate the fiftieth anniversary of its foundation.

SCIENTIFIC SERIALS

The Journal of Anatomy and Physiology, vol. xvii. Part 1, October, 1882, contains:—On the lymphatics of the walls of the larger blood-vessels, and lymphatics, by Drs. George and Elizabeth Hoggan.—On micrococcus poisoning, by Dr. A. Ogston.—On omphalo-mesenteric remains in mammals, by Dr. W. Allen.—On the action of saline cathartics, by Dr. M. Hay.—On a hitherto undescribed fracture of the Astragalus, by Dr. F. J. Shepherd.—On a secondary astragalus in the human foot, by Prof. W. Turner.—Note on the rectus abdominalis et sternalis muscle, by Dr. G. E. Dobson.—On a case of ectopia vesicæ, &c., in a newly-born infant, by Dr. F. Ogston.—On nickel and cobalt; their physiological action on the animal organism. Part i., Toxicology, by Dr. T. P. A. Stuart.—A kerato-thyro-hyoid-muscle as a variation in human anatomy, by S. G. Shattock.—On Cesalpino and Harvey, by Prof. Humphry.

The Proceedings of the Linnean Society of New South Wales, vol. vii. part 1 (Sydney, 1882), contains: Wm. A. Haswell, on the structure of the paired fins of Ceratodus (plate 1).—Notes on the anatomy of *Ædirhinus insolitus* and *Turacæna crassirostris*.—Wm. Macleay, on Port Jackson Pleuronectidæ, with descriptions of new species; on the fishes of Palmer River; on an Alpine species of Galaxias.—E. P. Ramsay, the zoology of the Solomons, Part IV.; on a new species of Mus from Ugi Island; contributions to Australasian oology (plates 3-5); on the zoology of Lord Howes Island; on *Apogon guntheri* of Castelnau; on some Fijian bird's eggs.—Alex. Morton, notes of a cruise to the Solomons.—Prof. F. W. Hutton, note on *Fossarina petterdi*; list of New Zealand freshwater shells.—Rev. Dr. Wools, the plants of New South Wales, No. 8.—Rev. J. E. T. Woods, botanical notes on Queensland; on a new species of Stomopneustes, and a new variety of *Hipponoe variegata*; on fossil plants of Queensland.—J. Brazier, fluviatile shells of New South Wales; a list of Cypræidæ of the Victorian coast.—Wm. Mitten, on some Polynesian mosses.—Rev. C. Kalchbrenner, new Australian fungi.—Dr. J. C. Cox, on the edible oysters of Australia.

Journal and Proceedings of the Royal Society of New South Wales, vol. 15, 1882, contains: On the climate of Mackay, by H. L. Roth.—Notes of a journey on the Darling, by W. E. Abbott.—The astronomy of the Australian aborigines, by Rev. P. MacPherson.—On the spectrum of the recent comet; on

new double-stars; on the transit of Mercury, November 8, 1881, by H. C. Russell.—On the inorganic constituents from epiphytic ferns, by W. A. Dixon.—A census of the genera of plants native to Australia, by Baron Ferd. von Mueller.—On water storage and canalisation for the colony, by F. B. Gipps.

Rivista Scientifico-Industriale e Journale del Naturalista, September 15.—Luni-solar influence on earthquakes, by F. L. Bombicci.—On the transformation of electricity into voltaic currents, and the application of these currents, by G. Govò.—Doderlein's ichthyological manual of the Mediterranean, by E. Riggio.

Archives des Sciences Physiques et Naturelles, September 15.—On the rotatory polarisation of quartz (third part), by MM. Soret and Sarasin.—The pelagic fauna of freshwater lakes, by F. A. Forel.—Researches on the quantity of carbonic acid contained in the atmospheric air, by E. Risler.—The air thermometer arranged with a view to a determination of high temperatures in practice, by H. Schneebeli.—Remarks on M. Louis Lossier's work, entitled "Electrolytic Calculations," by C. E. Guillaume.—Geometric proof of the theorem of Wheatstone's bridge, by the same.—Emile Plantamour.

Bulletin de l'Academie Imperiale des Sciences de St. Petersbourg, Part xxviii., No. 2.—New researches on artificial double stars, by O. Struve.—Topographical observations of Jupiter, by J. Kalazzi.—On the oxidation of isodibutylene by hypermanganate of potash, by A. Boutlerov.—Observations of the planets Jupiter, Saturn, and Neptune in their oppositions in 1881, by A. Sowitsch.—Determination of the mass of Jupiter by means of observations of the reciprocal distances and the directions of his satellites, by O. Backland.—Action of zinc-methyl on chloral, by B. Rizza.—De Marci Antonini Commentariis, by A. Nauck.—Hydrological researches (continued), by C. Schmidt.

Zeitschrift für wissenschaftliche Zoologie, Bd. 37, Heft. 2, September 27, 1882, contains: Contributions to the anatomy of *Ankylostoma duodenale* (Dubini) = *Dochmius duodenalis* (Leuckart), by Wm. Schulthess (plates 11 and 12).—On the ontogeny of *Reniera filigrana* (O. Schmidt), by Wm. Marshall (plates 13 and 14).—Contribution to a knowledge of the structure and functions of the heart in osseous fishes, by Kasem-Beck and J. Dogiel, of Kasan (plates 15 and 16).—Contribution to a knowledge of the cestoid worms, by Dr. Z. von Roboz (plates 17 and 18).—Comparative embryological studies of Elias Metschnikoff, No. 3, on the gastrula of some Metazoa (*Echinus milistubereulatus*, *Lineus lacteus*, *Phoronis hippocrepina*, *Polygordius flavocapitatus*, *Ascidia mentula*, and *Discoporella radiata* (plates 19 and 20).

Morphologisches Jahrbuch eine Zeitschrift für Anatomie und Entwickelungsgeschichte, bd. viii. heft 2, 1882, contains:—Contribution to the Angiology of the Amphibia, by Dr. J. E. V. Boas (with plates 6 to 8).—On the nasal cavities and the lachrymo-nasal canals in the amniotic vertebrata, by Dr. G. Born (with plates 9 and 10).—New foundations for a knowledge of cells, by Dr. A. Rauber (with plates 11-14).—Observations on the development of the crown of tentacles in Hydra, by H. Jung.

SOCIETIES AND ACADEMIES

LONDON

Linnean Society, November 2.—Sir J. Lubbock, Bart., in the chair.—Prof. J. C. Ewart, G. Fry, and Lord Walsingham were elected Fellows of the Society.—Mr. A. P. W. Thomas drew attention to a series of specimens under the microscope, and diagrams illustrative of the life history of the Liver Fluke (*Fasciola hepatica*). His experiments show that the embryos of the Fluke, as free Cercariæ, burrow into and develop within the body of *Limneus truncatulus*, and thereafter pass with the herbage into the stomach, and ultimately liver of the sheep. Salt added to the sheep's diet is found to act as a prophylactic.—Mr. W. T. Thiselton Dyer exhibited specimens and made remarks on the plant producing *Cassia lignea*, and on the native implements used in the collection and preparation of the Cassia bark in Southern China.—Mr. C. T. Druery showed two proliferous forms of *Athyrium filix fœmina*, a family hitherto remarkable for its unproliferous nature. Both examples appeared simultaneously; not the least significant feature being their extreme precocity, since bulbil-bearing ferns are proliferous-usually only on their mature fronds.—Mr. F. Crisp exhibited preparations in illustration of the views of Drs. Loew and Bokorny on the difference between dead and living protoplasm, viz. the power of the living organism to reduce silver salts in a very dilute alkaline solution.—Prof. E. Ray Lankester exhibited and made remarks on a series of marine organisms dredged by him, last summer, in the fjords of Norway. Of these may be mentioned a branch of *Paragorgia arborea*, three feet across, specimens of the same in spirit, as also of *Lophelia prolifera*, *Amphiheria ramea*, *Stylaster norvegicus*, *Primnoa lepadifera*, and *Paramuricia ramosa*, both dried, and also with the polyps preserved in spirit. The collection also included some very large new forms of Foraminifera specimens of *Rhizocrinus Lofotensis*, of the aberrant mollusca *Neomenia* and *Chætoderma*, and of *Rhabdopleura Normani*, besides a large series of sponges and Asteroidea.—Mr. T. Christy exhibited a living specimen of the Japanese peppermint plant, which yields the Menthol of commerce, this being the first plant grown in this country. Mr. Holmes mentioned that although this mint did not differ in botanical characters from *Mentha arvensis*, it had a strong peppermint odour and flavour, which were not found in the specimens growing either in Europe or India. He therefore proposed that the plant should be named *M. arvensis*, var. *piperanrus* by way of distinction.—Mr. J. G. Baker showed a specimen of *Lycopodium complanatum* collected in Skye by Prof. Lawson.—Sir J. Lubbock then read his tenth communication on the habits of ants, bees, and wasps, a notice of which appeared in our last issue, p. 46.—A paper was read on medicinal plants of North-West Queensland, by W. E. Armit. Among these is a species of *Aristolochia* and a Croton; also *Grewia polygama*, a specific for dysentery; *Careya arborescens*, used for poultices; *Erythræa australis*, and *Andropogon citriodora*, tonics in febrile complaints; and *Euphorbia pilulifera* and *Datura australis*, valuable in cases of asthma.—A remarkable malformation of the leaves of *Beyeria opaca*, var. *linearis*, from Yorkes Peninsula, South Australia, was described by Mr. Otto Tepper.—Dr. F. Day exhibited specimens in illustration of a paper read by him, on variation in form and hybridism in *Salmo fontanalis*.—Mr. H. N. Ridley afterwards read some teratological notes on a Carex, a Grass, and an Equisetum

Zoological Society, November 14.—Prof. W. H. Flower, F.R.S., president, in the chair.—A letter was read from Mr. E. L. Layard respecting a specimen of *Schænicola platyura* received by the British Museum from the late Mr. Cuming.—Prof. F. Jeffrey Bell exhibited some examples of *Lymnæus truncatulus*, lately discovered to be the chief host of the larvæ of the sheep-fluke.—Prof. Flower exhibited and made remarks upon the skull of a young chimpanzee from Lado, in the Soudan, sent to him by Dr. Emin Bey, which exhibited the deformity called "Acrocephaly," associated with the premature closure of the fronto-parietal suture.—Mr. H. E. Dresser exhibited and made remarks on specimens of *Melittophagus bochmi*, Reichenow, and *Merops dresseri*, Shelley, which he showed to be identical.—A communication was read from Mr. W. A. Forbes containing some supplementary notes on the anatomy of the Chinese Water Deer (*Hydropites inermis*).—A communication was read from the Rev. L. Baron, containing notes on the habits of the Aye-Aye of Madagascar in its native state.—Mr. G. E. Dobson read a paper on the natural position of the family Dipodidæ, which he maintained to be with Hystricine, and not, as generally supposed, with the Murine Rodents, and to be most nearly allied to the Chinchillidæ.—Prof. F. Jeffrey Bell read a paper on the genus *Psolus*, relating its literary history, and giving an enumeration of the described species. Attention was directed to the extensive distribution of *P. fabricii*, and to the variations during growth. After the description of other known forms, two new species (*P. peronii* and *P. ambulata*) were described; for the latter a new sub-genus was suggested, and the genus itself was divided into three sub-generic groups.—A second paper from Prof Bell contained an account of a Crinoid from the Straits of Magellan, obtained by Dr. Coppinger during the voyage of H.M.S. *Alert*, which was referred to a new variety of *Antedon eschrichti* of the Arctic seas.—Mr. W. H. Neale read some notes on the natural history of Franz-Josef Land, as observed in 1881–82, during the stay of the *Eira* expedition in that land.—Dr. Gwyn Jeffreys read the fifth part of his list of the Mollusca procured during the expeditions of H.M.S. *Lightning* and

Porcupine. This part, which embraced the species from the Solenoconchia to the Calyptræidæ, comprised sixty-nine species, of which twenty two were now for the first time described or figured. The geographical, hydrographical, and geological range of all these species was given, as in his former papers; and the author especially noticed the points of agreement between the deep-water Mollusca from the American and European expeditions.

Physical Society, November 11.—Prof. Clifton, president, in the chair.—Prof. Rowland, of Baltimore, exhibited a number of his new concave gratings for giving a diffraction spectrum. He explained the theory of their action. Gratings can be ruled on any surface if the lines are at a proper distance apart and of the proper form. The best surface, however, is a cylindrical or spherical one. The gratings are solid slabs of polished speculum metal ruled with lines equidistant by a special machine of Prof. Rowland's invention. An account of this machine will be published shortly. The number of lines per inch varied in the specimens shown from 5000 to 42,000, but higher numbers can be engraved by the cutting diamond. One great advantage of their use is that the relative wave-lengths can be measured by the micrometer with great accuracy. The author has designed an ingenious mechanical arrangement for keeping the photographic plates in focus. In this way photographs of great distinctness can be obtained. Prof. Rowland exhibited some 10 inches long, which showed the E-line doubled, and the large B groups very clearly. Lines are divided by this method which have never been divided before; and the work of photographing takes a mere fraction of the time formerly required. A photographic plate sensitive throughout its length is got by means of a mixture of eocene, iodised collodion, and bromised collodes. Prof. Rowland and Capt. Abney, R.E., are at present engaged in preparing a new map of the whole spectrum with a focus of 18 feet. In reply to Mr. Hilgar, F.R.A.S., he stated that if the metal is the true speculum metal used by Lord Rosse, it would stand the effects of climate he thought; but if too much copper were put in it might not. In reply to Mr. Warren de la Rue he said that 42,000 was the largest number of lines he had yet required to engrave on the metal.—Prof. Guthrie read a letter from Capt. Abney, pointing out Prof. Rowland's plates gave clearer spectra than any others; they were free from "ghosts" caused by periodicity in the ruling; and the speculum metal had no particular absorption.—Prof. Dewar, F.R.S., observed that Professor Liveing and he had been engaged for three years past in preparing a map of the ultra-violet spectrum, which would soon be published. He considered the concave gratings to make a new departure in the subject, and they would have greatly facilitated the preparation of his map.—Mr. W. R. Browne then read a paper on the conservation of energy and central forces. He showed that the doctrine of the conservation of energy necessarily involved central forces and could not be proved unless on the assumption of a system of central forces. This involved the hypothesis of Boscovich that matter consists of a collection of centres of force, and the author criticised the objections of Clerk Maxwell, Tait, and others to Boscovich's theory. The paper will appear in the *Transactions* of the Society.—Prof. S. P. Thompson read some historical notes on physics, in which he showed that the voltaic arc between carbon points was produced by a Mr. Etienne Gaspar Robertson (whose name indicates a Scotch origin) at Paris in 1802. This reference is found in the *Journal de Paris* for that year. Laboratory note-books at the Royal Institution, however, are said to show that Davy experimented with the arc quite as early. The experiment usually attributed to Franklin of exhausting air from a vessel of water "off the boil" and causing it to boil afresh, is found in Boyle's "New Experiments touching the Spring of the air. Prof. Thompson also exhibited an early Reis's telephone, made by Philip Reis in 1861 at Frankfort, and designed to transmit speech. It was modelled on the human ear, one form of transmitter being a rudely-carved wooden ear, with a tympan, having a platinum wire behind, hard pressed against a platinum-tipped adjustible spring. Prof. Thompson showed by various proofs that words were actually sent by that and similar apparatus.

Meteorological Society, November 15.—Mr. J. K. Laughton, F.R.A.S., president, in the chair.—Eleven new Fellows were elected, viz. Rev. J. Brunskill, F. B. Buckland, C. F. Casella, W. H. M. Christie, F.R.S., A. Cresswell, R. S. Culley, C. Morris, O. L. O'Connor, H. Parker, F.Z.S., A. Rowntree, and D. R. Sharpe.—The papers read were: On certain types of British weather, by the Hon. Ralph Abercromby, F.M.S. The author shows that there is a tendency of the weather all over the Temperate Zone to occur in spells associated with certain types of pressure distribution. In Great Britain there are at least four persistent types—the southerly, the westerly, the northerly, and the easterly. In spite of much fluctuation, one or other of these types will often continue for weeks together, and tend to recur at the same date every year. The value of the recognition of type groups is shown in the following ways:—(1) They explain many phenomena of weather and many popular prognostics; (2) in some cases they enable forecasts to be issued with greater certainty and for a longer time ahead; (3) we can by their means correct statistical results by giving the real test of identity of recurrent weather which no single item such as heat, cold, rain, &c., can do; (4) they enable us to treat such geological questions as the influence of changing distribution of land and sea on climate in a more satisfactory manner than any other method.—On the use of kites for meteorological observation, by Prof. E. Douglas Archibald, M.A., F.R.S. In this paper the author advocates the use of kites for meteorological observation, and describes the mode in which they may be best flown so as not to be mere toys, but scientific instruments, capable of ascending to great heights, remaining steady in currents of varying velocity, and of being manipulated with ease and rapidity by the observer.—The meteorology of Mozufferpore, Tirhoot, 1881, by Charles N. Pearson, F.M.S.

Institution of Civil Engineers, November 14.—The president, Sir W. G. Armstrong, C.B., F.R.S., in the chair.—The paper read was on "Recent Hydraulic Experiments," by Major Allan Cunningham, R.E., Honorary Fellow of King's College, London.

BERLIN

Physical Society, October 3.—Prof. Rœber in the chair.—Dr. Kœnig had already reported in a previous session on the Leukoscope, designed and constructed by Prof. Helmholtz, and communicated now the results of his further experiments with this instrument. It consists essentially of a calc-spar-rhomboid, a plate of quartz, and a Nicol's prism. A luminous pencil entering the calc-spar is split up into two rays polarised at right angles which traverse the quartz-plate and the Nicol. When spectroscopically analysed, these rays show two spectra of absorption-bands, in the spectrum of the one pencil at points where in the spectrum of the other pencil the intensity is undiminished, and *vice versâ*, so that the two spectra superposed would give a continuous spectrum. The number of bands increases with the thickness of the quartz, and they are shifted by rotating the Nicol. The *modus operandi* then is to put in a quartz plate of such a thickness, and to rotate the Nicol so much that in each of the spectra the colours that are not blotted produce together white light. When different sources of light are examined with the leukoscope, the different amounts of rotation of the Nicol are required for effecting a conformity of the two images, the relative quantity of certain rays being different in every different light, the prevailing tint belonging therefore to the one, and not to the other spectrum. Further experiments having proved that the plate of quartz could remain unaltered, the rotation angles of the Nicol were a gauge of the quality of colours of the light examined. Dr. Kœnig has tried in this way a series of sources of light, and found the angles wanted for homogeneity of the white images to be as follows:—With stearin candles = 71°·20; with gaslight = 71°·5; with electric arc light = 79°; with magnesium light = 86°; with solar light = 90°·5; with burning phosphorus and Drummond lime-light the angles were between gas and electric-arc light. The succession of the sources of light thus stated coincides strikingly with the results of spectro-photometric measurements of Prof. Pickering. The fact that the magnesium light is more like the solar light than the electric arc light quite corresponds with the known fact that of the aniline dyes, scarcely distinguishable by gas-light, the greatest part can be perceived by electric light, but not all, viz. the so-called bronze hues; whereas by the magnesium light they are all as well distinguished as by solar light. Furthermore Dr. Kœnig has made many measurements with the leukoscope on different electric incandescent lights; with Swan's lamp and Edison's lamp he gave the results of his experiments in tables in which the strength of the current, the intensity of light, and the angles of the leukoscope were indicated. From these numbers it follows that luminosity augments at first at a much greater rate with increasing strength of current than the latter; by doubling the strength of the current

the illuminating power was increased about sixty-fold. The angles of the leukoscope became likewise greater with the rising intensity of the light in such a manner that a curve traced with the light intensities as abscissæ and the angles as ordinates is concave to the abscissæ and approaches assymptotically a maximum near 78°, an angle approximately equal to the angle (79°) of the glowing carbons of the electric arc light. The measurements with a Siemens' incandescent lamp gave also numbers which could be represented by a similar curve.

PARIS

Academy of Sciences, November 13.—M. Jamin in the chair.—The following papers were read:—Results of experiments made with electric candles at the Exhibition of Electricity, by M. Allard and others. The systems examined, those of Jablochkoff, Jamin, and Debrun, now produce nearly the same economical results.—On the reproduction of osmides of iridium, by M. Debray. Osmium and iridium may crystallise together in all proportions, without the form of their combination being altered. They are then isomorphous. And natural osmides may be true isomorphous mixtures, belonging to the cubic system, notwithstanding the hexagonal appearance of certain varieties (but this view is given with reserve, natural osmides being of complex composition).—Report to the Bureau des Longitudes on the approaching eclipse of May 6, 1883, by M. Janssen.—Note on the telluric lines and the spectrum of aqueous vapour, by M. Janssen. He recalls his own method, based on study of the spectrum of water vapour in a tube; he is now working at it. The *telluric lines* (so called by him) are historically quite different from the *bands of Brewster;* (an expression of M. Cornu's seemed to affirm their equivalence.)—On the currents produced by nitrates in igneous fusion, in contact with red hot carbon, by M. Brard. Owing to the tendency of fused nitrates to spread in heated bodies, a current may be had if a short carbon rod with one end put in the nitrate has only the other end incandescent; also if fused nitrate in a metal capsule is placed on burning carbon (the nitrate soaks through, so that the outer surface of the capsule becomes quite moist); indeed, such a capsule merely hung over a centre of combustion gives a current (from the nitrate bath to the outer surface of the capsule). The effect is improved by putting plumbago, or lampblack, on the outside, and covering all with metallic foil. Nitrates kept in fusion have great fixity.—Chemical studies on the white beet of Silesia (continued), by M. Leplay.—Observations made during the total eclipse of the sun of May 17, 1882, by M. Tacchini. He gives a *résumé* of his memoir, which will shortly appear.—On Abelian differential equations in the case of reduction of the number of periods, by M. Picard.—On a theorem of M. Tisserand, by M. Stieltjes.—Extension of the problem of Riemann to hypergeometric functions of two variables, by M. Goursat.—On the development of functions in series of other functions, by M. Hugoniot.—On the exactness of measurements made with the mercury thermometer, by M. Crafts. The pressure (of the air) has little influence. Permanent elevation of the fixed points, produced at a high temperature, preserves the thermometer against the influence of heat, in this respect, at lower temperatures.—Conclusions of hydrodynamic experiments in imitation of phenomena of electricity and magnetism; reply to a note of M. Ledieu, by M. Decharme. The theory of waves seems to him to be "the secret of nature," and he places the results of his experiments against the unverified ideas of M. Ledieu.—Electric deformations of quartz, by MM. Jacques and Curie. With delicate apparatus, they observed and measured such deformation when a charge was given to two pieces of tin at the opposite ends of the electric axis. The dilatations measured agreed satisfactorily with those calculated from the electricity liberated.—On the electrification of air, by M. Mascart. In the Amphitheatre of the College of France he electrified the air by discharging a Leyden jar with a flame, during ten seconds; another flame, 8 m. off, communicated with an electrometer in an adjoining hall. The maximum deflection in the latter was reached in about a quarter of an hour; then there was slow diminution, but after two hours 1-20th of the maximum still remained. The electrified gas probably rises and is diffused like smoke. To study the lower atmospheric layers, the potential should be determined in a large inclosure formed of metallic netting, connected with the ground.—On atmospheric nitrification, by MM. Muntz and Aubin. A constant absence of nitrates in meteoric waters was observed at the top of the Pic du Midi (nearly 3000 m.). A comparison of thunderstorms shows the summit to be generally above them. Atmospheric nitrification is probably produced in the lower regions of the air.—On the decomposition of phosphates at a high temperature by sulphate of potash, by M. Grandeau.—Point of solidification of various mixtures of naphthaline and stearic acid, by M. Courtonne.—On œnocyanine, by M. Maumené.—On the cause of liberation of oxygen from oxygenated water by fibrine; influence of hydrocyanic acid exhausting the activity of fibrine, by M. Béchamp. He shows that the fibrine loses somewhat; and that it no longer decomposes oxygenated water nor fluidifies starch, nor gives bacteria.—On the signification of the polar cells of insects, by M. Balbiani.—On the vaso-dilator reflex of the ear, by MM. Dastre and Morat.—Phenomena of death from cold in Mammalia, by MM. Richet and Rondeau. The respiratory and cardiac functions may be suspended for half an hour, without death certainly ensuing. (Rabbits, shaved (*rasés*), were inclosed in flexible tin tubes, through which flowed salt water cooled to −7° C.).—Analogies and differences between curare and strychnine, as regards their physiological action, by M. Couty.—On the causes of migration of sardines, by M. Launette. Each migration is normally under the two conditions of food and temperature combined.—Contribution to the geological history of the iron of Pallas, by M. Meunier.

VIENNA

Imperial Academy of Sciences, October 12.—V. Oppolzer, finding the reduction to infinitesimal arcs of vibration at pendulum-observations.—H. Kreuter, computation of the trajectory of the comet 1771.—V. Barth and T. Schreder, on the behaviour of benzoic acid if dissolved in caustic potash.—N. Herz, the theory of computations of the trajectory of a comet.

October 19.—R. v. Lendenfeld, on a new self-registrating thermometer.—V. Oppolzer, on an eclipse of the sun mentioned by Archilochos.—W. Demel, on the Dopyrlerite of Ausser (Styria).—W. Gintl and F. Reinitzer, on the constituents of the leaves of *Fraxinus excelsior*, L.

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THURSDAY, NOVEMBER 30, 1882

THE INDIAN SURVEY

General Report on the Operations of the Survey of India during 1880-81. 61 pp. Report, 93 pp. Appendix, and 22 Plates. (Calcutta, 1882.)

THIS Report for 1880-81 (the fourth since the various branches of the Indian Survey were amalgamated) shows as usual a good amount of useful work done in the year, and contains also many points of general interest. There were in all twenty-nine field-parties and six large head-quarters' offices. The whole out-turn of work cannot be shortly stated, and the total cost is not given; but it appears that there were 22,765 square miles surveyed topographically, 6141 square miles in great detail, besides much minor and special work, also that eleven Revenue Branch parties surveyed 11,326 square miles at a cost of about 81,000*l.*

The principal triangulation of India proper as designed by Col. Everest, *has now been finished.* The result is shown on a skeleton map, which is itself a wonderful sight. There is a continuous "chain" of triangles right round India proper, connected across by *many* meridional and east to west "chains," the longest being from Mussoorie to Cape Comorin (say 1600 miles north to south), and from Chittagong to Kurrachee (say 1800 miles east to west). Outside India proper there are five important extensions, viz. (1) to Kandahar and Khelat; (2) over Káshmír; (3) up the Indus beyond Leh; (4) up the Brâhmaputra to Sudya; and (5) a coast "chain" from Chittagong to Tenasserim. This great work, now finished, is one of which India may well be proud.

Certain important changes of procedure are being introduced in the general survey work, viz.: (1) All the topographical work is being brought to a uniform system; (2) Fieldbooks are gradually giving way to direct plotting of detail in the field with advantage in speed of work and economy; (3) Special riverain surveys will in future be made; (4) Local agency is being tried for detail work; this last measure is expected to effect great economy in the survey of Burma, for which at present a staff of 2500 men is taken from Calcutta and back again each season.

Great difficulties often beset the parties in the wilder parts of the country. Many parts are extremely unhealthy, and the parties often suffer severely from fever, &c. In a few parts the roughness of the country, in others climatic conditions, render travelling exceptionally difficult, *e.g.* travelling in the hot wind across the "Rann" (great salt desert) of Katch is dangerous to both man and beast. In a few parts even in India proper, *e.g.* among the wild Bhíls, the surveyors are looked on with suspicion and sometimes attacked. The greatest praise is due to men who carry out their field-work through such difficulties as these.

In general a survey party now accompanies every military expedition; thus some extension of geographical and trigonometrical work was done in 1881 by parties sent with the Mahsúd Wazírí expedition and with the troops at Kandahár. A curious difficulty has arisen in that the modern use of the heliostat in military signalling almost precludes its use for survey stations along with an army.

Self-registering tide-gauges with 5 feet barrels have been set up at fourteen places, and have worked well as a whole. Tide registrations (mostly from older instruments) for twenty-three years in all have been analysed by the harmonic analysis at enormous labour. The discussion shows (for the first time) the existence of a "lunar fortnightly tide" as had been expected from the tidal theory. Tide-tables for 1882 were published for fifteen ports.

The tidal stations of Madras and Bombay have been connected by "levelling" right across the peninsula with the curious result that the mean sea-level at Madras *appears* to be 3 feet above that of Bombay. The cause of this is still a subject of inquiry. It is really a very curious question. Thus, it is said that "there can be no sensible differences of level," *i.e.* as determined by *levelling*, "because the causes by which they would be produced must equally affect the spirit-levels of the instruments and the water-levels of the ocean," so that had the "levels been carried, without error, along the coast line from Bombay . . . to Madras, they must have shown identity of sea-level, &c." On the other hand it is also said that "the Western Ghâts are a source of attraction, which, if not counteracted, must raise the sea-level at Bombay no less than 31 feet above the mean sea-level at Madras." The difference (which should be zero?) is attributed to *observation-error*, and chiefly to the effect of the oblique sunlight illuminating the two ends of the instrument-bubble unequally: thus it is said that an error of only 1·2 seconds in levelment (a very minute quantity) at even one-fourth of the instrumental stations would produce the total error in question.

An interesting improvement has been introduced in the engraving branch, viz. in steel-facing the copper-plates, and is said to be very successful. Apparently engraving on copper is still largely used (as also in the British Ordnance Survey), but it would seem that this tedious and costly process must give way to some of the rapid and cheap photographic processes. The Indian Survey is also utilising the latter very largely, with the wonderful result that "at present publication may, and frequently does, follow the survey in a few days." There is a curious instance of the possible saving in departmental manufacture, in that about 334*l.* has been saved by making up collodion in the office instead of purchasing it.

Of underground temperatures it is noted that at Dehra the maxima occurred at the three depths, 6·4, 12·8, 25·6 feet, about September 20, October 15, and November 15 respectively (the maximum in the air being probably in June?).

An extraordinary outburst of solar spots, covering 630 million square miles, was observed to take place on July 25, 1881, within a period of thirty-seven minutes; it is rare that so grand an outburst is so closely located in time.

The Indian Survey was well represented at the Venice Geographical Exhibition. The whole collection sent seems to have excited great interest, especially the tidal instruments which were connected with the Main Canal so as to be shown in actual work. This exhibition brought to light a striking difference in recent practice of construction of instruments in England and on the Continent in that recent improvements in graduating circles are so

great as to lead to the general adoption (by continental makers) of small circles with powerful reading micrometers in place of large circles with verniers.

A very simple process of making relief maps in Germany is described, viz. by cutting out contour strips from a contoured map, and pasting each on to cardboard cut to same outline. Altogether the Report is a very interesting one.

ALLAN CUNNINGHAM

GREEN'S "GEOLOGY"

Geology. By A. H. Green. Part I. Physical Geology. Third and Enlarged Edition. (London: Rivingtons, 1882.)

STUDENTS of Geology will welcome this third and much enlarged edition of Prof. Green's excellent text-book, though they may at first sight regret the exchange of the old convenient manual form of the book for that of the present handsome and well-printed octavo. One of the first features that strikes the reader in this new issue of the work is the large augmentations made to the lithological sections. In fact this part of the treatise may be said to have been re-cast and almost wholly re-written. The author devotes 150 closely printed pages to crystallography and the description of minerals. It may be open to question whether the full details which he gives to the crystallographic characters of minerals are not rather out of place in a geological treatise. They are not ample enough for the mineralogical student, and the geologist who takes up the subject must necessarily study text-books of mineralogy, where they are given at much greater length. Prof. Green, however, has put them so clearly and succinctly that this portion of his book cannot fail to be of use.

Some changes have been made in the arrangement of rocks. The non-crystalline or derivative rocks now come first—a grouping which no doubt has its advantages in teaching, particularly in elementary classes, but which is not that usually employed in petrographical works After briefly describing the lithological character of the non-crystalline rocks, the author, following his original plan, proceeds to discuss the mode of formation of these rocks, dealing first with denuding agents and their work, and then considering the manner in which the denuded material is aggregated into rock-masses. In these sections he brings his subject abreast of the onward march of the science. Another change in the original treatment of his subject occurs in the author's chapter on the "confusedly crystalline rocks." He has not been so happy in his choice of a title for them as he has been in his description of their general characters. After giving an account of the lithological features he proceeds to discuss their modes of origin, dealing first with volcanoes recent and extinct, then with earthquakes (though one wonders what these have to do with a description of crystalline rocks), next with plutonic rocks which, however, are rather inadequately discussed. The chapter on metamorphic rocks has been carefully revised, and may be commended to the student as an admirable summary of what is at present known on this subject. The chapter upon the way in which rocks came into their present positions was one of the best in the first edition of the book. Its excellence has now been increased by a thorough revision. For practical insight into the structure of the earth's crust it is unsurpassed in any treatise known to us.

Prof. Green more than makes up for the curious omission in the first edition of any mention of mineral veins. We doubt, however, the advantage of inserting minute descriptions of metallic ores in a general geological text-book. The author would do well in his next edition to give references to the Continental works on mining, particularly to some of the numerous treatises which have been published in Germany. Chapter XIII. retains its place as a valuable account of how the present surface of the ground has been produced. The last two chapters discuss the former fluidity and present condition of the earth's interior, the cause of upheaval, contortion, and metamorphism, and the origin of the changes of climate which have taken place during geological time. These parts of the book are exceedingly well done. The author has held the balance fairly between contending disputants, and sums up the evidence with conspicuous and judicial impartiality. Altogether, he may be congratulated on the appearance of this edition of his text-book, which sustains and extends his reputation as an exponent of his favourite science.

OUR BOOK SHELF

A History of British Birds. By the late William Yarrell. Fourth Edition, Revised to the end of the Wryneck, by Alfred Newton, M.A., F.R.S., continued by Howard Saunders, F.L.S., F.Z.S. Part XV. (London: John Van Voorst, November, 1882.)

THE fifteenth part of the new edition of what the British ornithologist fondly calls his "Yarrell" contains the final contribution of Prof. Newton to this work, and the first pages of the portion which Mr. Howard Saunders, his successor in the editorship, has undertaken. Few of the subscribers, we believe, will be much pleased with the change of authorship of their favourite work of reference. No living writer, it may be confidently asserted, is so competent to prepare a new edition of "Yarrell's British Birds" as Prof. Newton, and the conscientious care with which he has laboured upon the two volumes now completed must be patent to all who consult them. At the same time it should not be forgotten that time is an element in all human matters not even excepting books on British birds. When, therefore it is considered that nearly eleven years have elapsed since Prof. Newton commenced his new edition, and that only the first half of the work is now completed, it is obvious that the Professor has not acted unwisely in surrendering the second half to an editor who is able to devote more time to the undertaking.

Mr. Howard Saunders, it is generally understood, intends to issue the two final volumes of the new edition in two years, and if his health and strength permit, will doubtless accomplish his task within the allotted period. In this his large practical knowledge of the bird-life of Southern Europe, as well as his well-known familiarity with modern ornithological literature, are likely to be of the greatest assistance.

Mr. Saunders commences his second volume with the pigeons, and gives us an excellent account of the four British species, as also of the American passenger pigeon, which can only be looked upon as one of our rarest stragglers from the New World. When, however, he says that all true pigeons lay two eggs he must have forgotten that the crowned pigeons, and the numerous forms of fruit-pigeons are, so far as is known, content to lay but one. There is therefore no good reason for calling the

Columbæ "Bipositores," as one of our systematists has proposed to do! After the pigeons Mr. Saunders places the sand-grouse as an intermediate order between the Columbæ and Gallinæ. This is certainly a better plan than that adopted by some of the more ardent reformers of the ornithic system—of uniting the sand-grouse in the same group with the pigeons, and thus spoiling the symmetry of the order Columbæ. In this and in other particulars the new Editor of "Yarrell's Birds" show a judicious spirit, which cannot fail to make the results of his labours generally acceptable.

Episodes in the Life of an Indian Chaplain. By a Retired Chaplain. (London: Sampson Low, Marston, Searle, and Rivington, 1882.)

THIS interesting narrative of the adventures and vicissitudes of a devoted and single-minded Indian Chaplain, appears to be addressed to two classes of readers. A considerable portion must be considered more or less theological, and hence not applicable to the columns of NATURE; but running throughout the unambitious work is a considerable residue of facts and observations relating to zoology, which are never tiresome and sometimes original. In the days of his boyhood our author's leisure time was given to his "different collections of natural history and antiquities," and after many years' official duties he seems to have once more resumed his early tastes, on his appointment to the curatorship of the museum and secretaryship of the public gardens belonging to the Maharajah of Travancore. It is whilst employing his leisure in this vocation that the reader experiences more of the naturalist and less of the chaplain, but both phases are so kindly and modestly described, as to disarm criticism and at the same time promote an amiable impression of the writer.

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 ensure the appearance even of communications containing interesting and novel facts.*]

Sir George Airy on the Forth Bridge

SIR GEORGE AIRY'S letter (*vide* NATURE, vol. xxvi. p. 598) criticising Messrs. Fowler and Baker's design for the Forth Bridge is so important, that I think it but right, as I am not without experience on the subject, to make some remarks on the subject of it. Sir George Airy states:—

1. "That the proposed construction is, as applied to railway bridges, entirely novel." This is not quite exact. There are a number of cantilever bridges in America; and I have, myself, used practically similar principles of construction and erection, on a large scale, with entire success, and find them so satisfactory that, for a very long span, I would not think of using any other.

2. "The magnitude of its parts is enormous." Undoubtedly they are—and all the more credit to the men who had the nerve to design them.

3. "There has been no succession of instances of the construction with rising degrees of magnitude which might furnish experimental knowledge of some of the risks of construction." If this reason were sound, the same objection would have prevented the construction of the Conway, Britannia, and Saltash bridges, and *Great Eastern* steamer, but so far from the statement being correct, the engineering profession has gained ample experience in the erection of the St. Louis, Kentucky River, Douro and Minnehaha bridges to give assurance that the Forth Bridge can be made a perfect success.

4. "The safety of the bridge depends entirely on a system of end thrusts upon very long rods." This is a very singular statement. What would become of the safety of the bridge in case there was no answering and complementary tension system equally exposed to danger from a "system of end pulls upon very long rods" does not appear from Sir George's letter; nor does he seem to remember that the tests of the last few years show conclusively, that iron exposed to compression within its buckling limit is compacted in texture and strengthened by such use while, if subjected to continuous tension beyond two-thirds of its elastic limit, it is attenuated and weakened.

5. "No reference is made to theory applied to the buckling of rods under end thrusts." None was necessary. Mr. Baker has designed struts, or columns—not rods. These members in the Forth Bridge are presumed to have such a proportion of diameter to length that the question of buckling does not come into consideration. In America, columns of many shapes—in full-sized sections—have been tested in lengths of from 10 to 70 diameters, and the value of these shapes, in pounds of resistance per square inch of section for each $\frac{\text{length}}{\text{diameter}}$ is definitely known.

These results are now the common property of all English-speaking engineers. Sir George Airy's remarks on long struts are the more extraordinary, as there is in England, in the upper chord of the Saltash Bridge, an example of a long strut without lateral support which is greater in its ratio of length to diameter than any member that I know of in the Forth design. Moreover, it is 455 feet long, near enough to the length of St. Paul's Cathedral for him to contemplate in connection with that edifice, in presenting a picture to the people of London.

6. "The liability to ruinous disturbance by the lateral power of the wind acting with the leverage of the long brackets appears to be alarmingly great." This liability to destruction by wind is common to all large spans; but the danger is greater in the case of a suspension bridge than in any other (I speak with some knowledge on this point, having made the effects of tornadoes a special study for a number of years past, and having visited most of the bridge wrecks which have occurred in the States, from this cause, since 1858). So far as destruction by wind can be guarded against in the Forth design, it has apparently been done; and the bridge will be vastly stronger in this regard than many other bridges in England which can be easily named, and about the strength of which there is supposed to be no question.

To conclude:—The opinion of those American engineers with whom I have conversed on the subject, and whose experience in building long-span bridges makes that opinion valuable, is uniformly to the effect that the design of Messrs. Fowler and Baker is well digested, perfectly practicable as to execution, and thoroughly permanent in character when finished.

I may also add that three years since, when called on to design a railway bridge for the crossing of the Great Colorado cañon, which was to be 900 feet span and 750 feet above the river, I investigated the relative merits and cost of the various systems—arch-suspension and cantilever with mid-span. Working drawings were made of each, and the result was, that the cantilever was adopted as being equally strong and stable—less liable to be affected by wind and thermal changes, and decidedly more economical in first cost and easier of erection than either of the others. I am, therefore, not surprised that the engineers of the Forth Bridge should have reached the same conclusion.

CHARLES SHALER SMITH

St. Louis, Mo., November 11

The Aurora

I HAD not the good fortune to see the very unusual phenomena which took place during the aurora of Nov. 17. It was, however, well seen by four of the students of this College, Messrs. Sykes, Wildeblood, Thornhill and Wackrill. Although you are doubtless inundated with letters on the subject, I send a short account of the observation, as such an opportunity of determining the height of an auroral light very rarely occurs. The commencement of the movement of the "Whitehead-torpedo-shaped" streak of light does not appear to have been noticed by them; it passed however just below the moon, one observer thinks that its upper edge just grazed the lower edge of the moon. The light when close to the horizon bore due south-west, a position which has since been verified by bearings taken by a prismatic compass. The spot where the observers stood is, by the new ordnance map in lat. 51° 25′ 57″ N., and long. 0° 34′ 5″ W.

HERBERT MCLEOD

Royal Indian Engineering College, Cooper's Hill, Nov. 24

AT Ilford, Essex, on the 17th instant, at 6h. 4m. p.m., by a watch which was within 2m. of G. M. T., I witnessed, during

the auroral display, the extremely singular phenomenon which has been described by several of your correspondents. It looked exactly like a white cloud, about 20° long and 2° wide, tapered somewhat from the middle to each end; but it was more luminous than a cloud could well have been at that time. When first seen, its nearest end may have been 30° east of the moon. Its length was nearly parallel to the horizon, and continued so till lost sight of about as much to the west of the moon; and its passage over an area of some 80° occupied probably less than a minute. It passed very near to the moon, but I cannot say whether over it or not. CHARLES J. TAYLOR

Toppesfield Rectory, Halstead, Essex, Nov. 25

FOLLOWING up my last week's letter concerning the electric meteoroid, if one may so term it, of the 17th inst., I have sifted all the testimony within my knowledge, assigning a numerical weight to each report from internal evidence of its probable value, and correcting for latitude where the altitude of the moon was made the standard of comparison. With data so precarious, and triangles so ill-conditioned, the results can of course only be regarded as a very rough approximation to the truth; for what they are worth, however, they are as follows:—1. That the course of the meteoroid was about S. 70° W. Probably it was 71° 45′, the complement of the magnetic declination. 2. That there was a proper motion of a little more than a mile a minute. 3. That the path was vertically over a line upon the earth's surface, whose least distance from Greenwich was 72 miles. 4. That the actual elevation was 44 miles. On this reckoning the body would seem to have crossed in the zenith in North Belgium, the Boulogne district, Cherbourg, and the north coasts of Brittany. STEPHEN H. SAXBY

East Clevedon Vicarage, Somerset, November 28

MY observation at Ramsbury, near Hungerford, was to the effect that while watching the northern aurora, my attention was called, at ten minutes past six, to this monster meteor, then slowly approaching in a direct line to the moon, which was shining most brilliantly. It seemed to pass exactly over the disc, and reappeared on the side, much reduced in size, as if going away from us; and at a distance of about 6° from the moon, scarcely seemed to measure more than 5° in length, it being then about 6h. 8m., which corresponds with the position over Sidmouth at that time. It was very definite in form, like a torpedo. I estimated its length at 15°, and 3° in breadth. I hope to have a hand-made photograph of its appearance ready for publication, by the Autotype Company, in a few days, and on the same sheet is a hand-delineation of the great comet to the same scale. ALFRED BATSON

The Rookery, Ramsbury

Lavoisier, Priestley, and the Discovery of Oxygen

In the last number of this journal my friend Mr. Tomlinson has criticised my observations on the respective claims of Lavoisier and Priestley to the discovery of oxygen. Without examining, or attempting to refute one of my arguments, and without the citation of any warrant, or authority, he has stated his opinions with an asseveration worthy of a 15th century Professor of Dogmatic Theology. His letter consists of *five* general statements, and *nine* dogmatic assertions. I have endeavoured to show that of the former, *two* are self-evident truths, or at least universally-admitted conclusions, while the remaining *three* are misstatements; and that of the latter *five* are completely erroneous, while *three* are open to question, and *one* is correct.

1. The universally admitted conclusions are:—(*a*) that "chemistry has no nationality," and that "discoverers are mutually dependent." Nothing that I have said can possibly be construed into the expression of a shadow of doubt concerning the truth of either of these statements.

2. The three misstatements are that (*a*) I have "thought it necessary to revive the old oxygen quarrel," (*b*) that I have "taken an unpatriotic part against Priestley," and (*c*) "endorsed the complacent statement of Wurtz, that chemistry is a French science founded by Lavoisier." If it be reviving a quarrel and acting an unpatriotic part against a man, to show that by the light of evidence hitherto overlooked one of the greatest scientific men of the last century has been unfairly accused of dishonesty, I am quite willing to be considered unpatriotic and a quarrel-monger. As to endorsing the statement of M. Wurtz, all I say is that he did not say it "without reason." Many people regard the assertion as quite unreasonable. I confess I do not, but at the same time I do not mean to say that I fully accept it.

[As to my "forgetting, perhaps, that the title 'La Chimie Française' was invented by Fourcroy, and objected to by Lavoisier," I may say that I do not see that this bears the least upon the question. Lavoisier's own words are "Cette théorie n'est donc pas, comme je l'entends dire la théorie des chimistes français, elle est *la mienne*, et c'est une propriété que je réclame auprès de mes contemporains et de la postérité." (*Œuvres de Lavoisier*, tome 2. 1862, p. 104.) Dr. Thomas Thomson (*Hist. of Chem.* p. 101, vol. ii.) says, "Lavoisier's objection, then, to the phrase *La Chimie Française*, is not without reason, the term *Lavoisierian Chemistry* should undoubtedly be substituted for it." But this does not affect the question whether or no chemistry is a French science as M. Wurtz puts it, for surely Lavoisier was a Frenchman of the French. I say nothing, however, as to the justification of the remark that chemistry *is* a French science.]

3. "That the compound is always equal to the sum of its elements was known long before Lavoisier" remarks Mr. Tomlinson. I have nowhere asserted that it was not, but the statement is new to me, and I should like to have references.

4. . . . "So early as 1630 Rey gave the true explanation of the increase of the weight of metals by calcination." Any one who will take the trouble to read through Rey's essay "*sur la recherche de la cause pour laquelle l'estain et le plomb augmentent de poids quand on les calcine*," cannot fail to observe how very vague his ideas on the subject were. He indeed attributed the increase of weight to thickened air (*l'air espessi*), but the following, as I have elsewhere stated, seems to have been his mode of reasoning:—Air possesses weight; it may be produced by heating water, which during distillation separates into a heavier and a lighter part; hence as air approximates to a liquid nature, it may be supposed to be separated into a heavier and a lighter part by the action of heat; now the heavier part (the "dregs") of air is more nearly allied to a liquid than air, for it has assumed a "viscid grossness," and this part attaches itself to calces during the process of calcination, and causes such of them as possess much ash to be heavier than before calcination. If we calcine a vegetable or animal substance there is no gain of weight, because the assimilated thickened air weighs less than the volatile matter expelled by heat; but in the case of a metal the assimilated air weighs more than the volatile matter expelled, hence there is a gain of weight. Thus he imagined that all calces, from a vegetable ash to a metallic calx, attract this thickened air. It can scarcely be said that a man with these extremely crude notions "gave the true explanation of the increase of weight of metals by calcination."

5 and 6. "Lavoisier's note of 1772 was, as he admitted, based upon Priestley's earlier experiments, begun in 1744." I can nowhere find in Lavoisier's writings any admission of the kind alluded to. (Will Mr. Tomlinson give references?). On the other hand, I do find a note by Lavoisier at the end of Chap. VI. *De la calcination des metaux*, published in the *Opuscules Physiques et Chimiques* (1774), (*Œuvres*, Vol. I., p. 621), in which he says, "Je n'avais point connaissance des experiences de M. Priestley, lorsque je me suis occupé de celles rapportées dans ce chapitre. Il a observé, comme moi et avant moi, . . . &c., &c." This would seem to sufficiently disprove the former statement.

Mr. Tomlinson speaks of Priestley's "earlier experiments begun in 1744." Now Priestley was born in 1733, and although no doubt a clever fellow he certainly did not begin to experiment at *eleven* years of age! His first paper on gases was published thirty-nine years later, viz. in 1772.

7. That "the acceptance of Lavoisier's doctrine was mainly due to the capital discovery of the composition of water by Cavendish in 1784," I utterly deny; and if desirable will show cause why. Nevertheless, as it has been so asserted, we may, for the present at least, regard it as an open question.

8. Mr. Tomlinson calls Black, Priestley, and Cavendish, "the founders of pneumatic chemistry." Surely John Mayor and Stephen Hales have a better right to the title.

9. "Priestley discovered oxygen in 1774." This, no doubt, is true in a sense because everybody says so. If it means that he got a gas from red oxide of mercury it is true. But let us not forget:—(*a*) that he discovered it by a random experiment, "by

accident" as he confesses; (*b*) that he regarded it as air containing nitrous particles; (*c*) that he remained in complete ignorance of its nature till March, 1775, before which time Lavoisier was well acquainted with its principal properties, and had recognised many of its functions.

10. "Cavendish discovered hydrogen in 1784." On the contrary, he described it in his "Experiments on Fictitious Air," published in 1766.

11. "Davy abjured Lavoisier's *principe oxygène*, and by his numerous discoveries gave the chemical edifice so rude a shake that it had to be taken down and rebuilt." From our point of view, *in spite of* the numerous discoveries of Davy, the edifice erected by Lavoisier, and which is still standing, had not to be taken down and rebuilt, except in one small part. The theory of acidification was a small part of Lavoisier's labours, and it was Berthollet who called chlorine *oxymuriatic acid*, and who thought that he had proved it to be a compound of muriatic acid and oxygen.

12. Mr. Tomlinson after asserting that "chemistry has no nationality," and "that discoverers are mutually dependent," goes on to say with strange inconsistency that chemistry "had no proper existence for us until Dalton discovered its laws." Surely this is almost as if he slightly altered the "complacent statement of Wurz," and said, "Chemistry is an English science; it was founded by Dalton of immortal memory." We do not think that many will differ from us when we say that chemistry was a science long before the time of Dalton.

Thus we have endeavoured to show that of the nine dogmatic assertions given above (numbered 4-12):—*one*, viz. 9, is correct; *three*, viz. 7, 8, and 11, are open to grave question; while *five*, viz. 4, 5, 6, 10, 12, are altogether erroneous.

There is no possible excuse for us to remain any longer in ignorance of the mighty works done by Lavoisier. The fine quarto volumes, 1862-1868, published by the French government, are a fitting monument to the genius of the man. The petty jealousies which disfigure the history of science during the end of the last, and commencement of the present century, ought to find no place in our minds. The Republic of Science is large enough for every man to receive his due.

G. F. RODWELL

The Comet

IT would scarcely perhaps be civil to take no notice of Mr. Backhouse's letter in NATURE, vol. xxvii. p. 52, the object of which seems to be principally to discredit my account of the disappearance of the comet in a moonlit sky. Still less, however, would it be reasonable to take offence at it—albeit, Mr. Backhouse is wrong. Indeed, a little more reflection might have shown him that ample time having elapsed without any correction from me appearing in your columns, the presumption must have been strong that I had nothing to correct. I have in fact seen the comet frequently since—as well as many times before—and am moreover really experienced enough not to have made quite so gross a blunder; or at least to have found it out, if I did make it, when so many subsequent opportunities permitted. Besides that, I have fortunately the following testimony in corroboration. One of my sisters wrote, "What you did not see of the comet agrees exactly with F.'s experience. She looked out at Court-Lodge: splendid night; many, even small, stars, though moon shining bright; but the comet *wasn't to be seen*, though she and Miss B. scanned the whole fine expanse of east and southeast sky." Another wrote about the same time that though visible two days later, it was so pale that she did not wake a nephew who wished to see it. My drawing of the 23rd October has two stars above the nucleus, with one of which it made the base of an isosceles triangle, the other being at the vertex. These two stars were plainly visible all the morning of the 30th, but not so high above the roof across the way, but what the motion of the comet since I last saw it (23rd) *may* have lowered it enough to conceal the nucleus. In fact, either I am wholly right as to the disappearance, nucleus and all, under moonlight, or at least the nucleus must have been concealed. There is no other alternative. As to the great sweep of tail—let us be reasonable in our guesses as to the fallibilty of others however improbable their evidence. May not something for instance be ascribed to the London atmosphere as likely to increase the amount of moonlight reflected? It was for this that I wished the observation made public, viz. as a real phenomenon having a real cause; all the more interesting that it was so surprising—nay, as it seems, so incredible. My only regret is that I have been now tempted into so long a reply.

Before I leave the comet, may I presume to express my surprise that the question as to this comet's return is still *sub judice*. It is said that three well observed places are enough to determine the elements of a comet's orbit. But this one has surely furnished more nearly a score since its perihelion, to say nothing of those before—which no doubt belong to a previous orbit. It is not without fear that I may be misunderstood, that I ask of those who are skilled in such things for an explanation, knowing that of all men they are most deeply interested in the early solution of such a question. It may be said that the observations at and about the time of perihelion have scarcely yet reached this country; but is not the fact that the comet was at one time, which I imagine is known with some certainty, *behind the sun's disc*, equivalent to an observation of its place sufficiently exact to rank with others in calculating the orbit? I do not presume to say that it is so. I merely formulate a question which, in its general bearing, must surely be agitating the minds of many besides myself, after all we have read about the possible past history and future fate of this remarkable comet. It has now been under observation during two months, in which time it must have traversed nearly one quarter of its entire orbit, if an elliptical one of moderate extension. Its present path in space must be so nearly straight that continued observation can hardly be expected to furnish improved data until, if ever, departure from that shall settle the question decisively in favour of an elliptical path. But is it for this that we must wait? I can hardly think so, for surely no comet has ever yet been *seen* in the neigbourhood of aphelion.

J. HERSCHEL

30, Sackville Street, November 18

An Urgent Need in Anthropology

BOTH zoology and geology possess a yearly "record" of the work achieved in their respective domains, but anthropology still remains without that aid to its proper advancement. All workers are of course cognisant of the current bibliography given in the German anthropological publications, and the supplemental information on the same subject contributed by Dr. O. Mason in the *American Naturalist*, and are not unappreciative of the same; but these lists are but partial, and necessarily incomplete, as must be evident when the peculiar nature and wide scope of the study of man is taken into consideration.

Compared with anthropology, the record of zoological work is simple in the extreme. Zoology possesses its accredited organs and regular channels of publication, and with trifling exceptions, its yearly work can be gleaned from these sources. But what is anthropology? It may be described as the very Talmud of humanity with its "Mishnah" of ethnological facts, and its "Gemara" of anthropological conclusions. Scattered up and down the bye-ways of literature, here and there recorded by the traveller, illustrated by the historian or accentuated by the essayist, hidden in blue-books, and awaiting extraction from medical reports, existing in the papers of the missionary and the publications of the statisticians are the unaccumulated and unrecorded facts and observations which form the foundation on which to rear a complete science of man. Our own savages afford as excellent illustrations of the comparative in civilisation as do the primitive peoples of the jungle or the swamp, and hence a large fund of information is still to be supplied and tabulated from our city alleys, prisons, and lunatic asylums. To the question, Is such a record needed? must be added, How is such a record possible?

It seems at once clearly impossible that such a work could be either intrusted to the care of one man, or to the men of one nationality. No individual can be expected to have perused the whole current literature of his country, and could such a phenomenon be discovered, it is still more unlikely that he would combine in himself those qualities which are necessary to detect the varied data that make for anthropology. An alternative course, however, is present, which is possible, and not too exhaustive as regards time and labour. In each country where anthropology is cultivated as a science, a few of its votaries could form an association for the purpose of abstracting from *its* literature such facts, arguments, and observations as appertain to the study of man, and these might, in a condensed and tabulated form, appear as a regular yearly contribution in the pages of the different publications of the varied ethnological and anthropological societies which now embrace so many nationalities. It is perhaps not presumptuous to say that these papers would not be the least valuable in the volumes in which they appeared. It seems work that anthropological societies might

justly undertake, and we might then expect to hear less of the little interest felt in the science by the general public. When we have an "applied anthropology" to our daily life, and a system of anthropology taught in our public schools, we shall wonder how it was that the science so long remained in the esoteric stage. However, paradoxical as it may seem for the writer to admit, no science has been illustrated by so many excellent handbooks and compendiums as anthropology. From the time of Prichard to the works of Lubbock, Peschel, and Tylor, there have always been competent workers and writers, and the last-named works represent the very essence of our knowledge on the subject. In the face of this there is still a vast and unrecognised mass of material waiting extraction from the total annual literature of each country.

One other work requires compilation, and refers to the past. How frequently a traveller or missionary, anxious to write fully on the people he has visited, and wishing at the same time to have his views enlarged by the opinions of others, inquires for the list of authors and authorities who have written on the same subject. With very few exceptions such a desideratum is unprocurable, and yet if we would at present understand the social position of any tribe, however degraded or improved, the records of their earliest visitors must be compared with the narratives of their latest describers. This again can only be the work of a specialist, who, having carefully searched for and studied the literature relating to some particular tribe or race, would voluntarily present his "bibliography" to students at large, and for that purpose endeavour to have the same published by his local or some other anthropological society. These lists, if once begun, would slowly accumulate, and would not only confer lasting fame on their compilers, but also, by their publication in the *Transactions* of the societies devoted to the study of man, make the contents of those works more valuable by their presence, and at the same time promote the absence of some memoirs which a further knowledge of the subject would render somewhat unnecessary.

It is, however, only in the hope of further suggestions from other workers, that I have ventured to obtrude these remarks in the columns of NATURE.

W. L. DISTANT

A Modification of the Gold-leaf Electroscope and a Mode of Regulating its Charge

THOSE who experimentalise with the usual form of gold-leaf electroscope must know well that the instrument requires a vast amount of preparation and drying before it is ready for use, and also that in wet weather it keeps its charge but a little while. At the same time the electroscope when in good order is a beautifully sensitive instrument and of great value in demonstration. I have made a slight addition to the present form of instrument, which makes it useful in all states of the weather. A flat spiral is cut out of sheet ebonite with a fret saw, about 8 mm. wide, and 4 mm. thick; the diameter of the spiral is the same as the internal diameter of the glass shade; the spiral is cemented to the shade just below the line at which its dome begins; the centre of the spiral carries the brass rod to which the gold leaves are attached; the rod comes up through the top of the shade without touching it; thus a very long insulator is placed between the charged leaves and the surface of the shade; on a damp day the leaves are powerfully divergent two to three hours after being charged. If instead of the spiral a little tube of ebonite takes the place of the usual varnish glass tube, the charge will be kept a fairly long while.

If the same angle of divergence of the gold leaves be required in two similar electroscopes, charged, say, with electricity of opposite sign, this can be effected by fully charging each instrument, and then bringing a lighted candle about ten centimetres above the brass disc or knob of each; by lowering or raising the candle, the charge can be drawn off as slowly as you please. It is well known that a flame has been used ATTACHED to an electrometer in testing atmospheric electricity. Volta used a flame connected to an exploring rod, and in Sir W. Thomson's electrometer a slow-burning match is used; but it will be noticed that in the experiment I have described for regulating the charge, the flame is only held near the disc or knob, but is NOT allowed TO TOUCH IT. I also find, and it is very remarkable, that electroscopes can be fully charged by placing them about a metre from a charged jar, if a taper be now placed on the top of the jar, by means of an insulator the leaves instantly diverge and the electroscopes remain charged.

FREDERICK JOHN SMITH

Taunton, November 18

Palæolithic Gravels

THE subject of the preservation of human remains in drift beds has been so fully discussed by every author who has written on the antiquity of man, that it would be mere waste of space to reprint what has been so many times printed before. No doubt the day will one day arrive when we shall have plenty of examples of the osseous framework of palæolithic man; at present but few of his bones have been found for study. Human bones are extremely liable to decay, but no doubt some of our palæolithic precursors are preserved somewhere; they will be lighted on some day.

In 1878 I had an opportunity of removing the stones from several cairns at Cynwil Gaio, in Carmarthenshire; the kist-vaens or stone graves were then exposed. On carefully removing the covering stones from each kist, the place in which the human body was originally deposited was laid bare. The soft, smooth bed of fine clay (brought from a distance) was there on which the body was placed at the time of burial, but not in a single instance was there a trace of a bone, a tooth, or any relic whatever of the body; it had entirely vanished. Now if we can find nothing in a grave that is only a very few thousands of years old, what can we expect from one that is tens or possibly hundreds of thousands?

When Prof. T. McK. Hughes lectured on the Antiquity of Man before the Victoria Institute he said (reprint p. 8): "I will not waste time to discuss whether the objects we refer to man, now found in numbers in post-glacial river-gravels, are really of human work." The Professor was quite right, for any one who can see any art in the Parthenon, or any human work in Raphael's Cartoons, ought to see art in palæolithic implements; and, of its class, uncommonly good art too. But none are so blind as those who won't see, and many persons have not strength of mind or courage enough to accept the teachings of their own reason.

WORTHINGTON G. SMITH

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Ancient Monuments

WHILST in North Wales last autumn, I visited the famous Kist-Vaen, on Tynycoed Farm, Capel Garmon, not far from Bettws-y-coed. This is a sort of double subterranean cromlech, the single cap-stone now remaining being on a level with the ground. On two of the large upright supporting stones, two blockheads had painted their names in green oil-paint from top to bottom of the stones. The trouble of taking the green paint and brushes to this place must have been considerable, and I hope now that General Pitt-Rivers is appointed Inspector of Ancient Monuments, he will find these parties out, and make them take a pailful of turpentine, and rub out the offensive inscriptions.

I also visited the two circles of stones, termed on the Ordnance Map Maenan-hirion, by Penmaenmawr, and looked out for the two outlying stones stated to be on the north-east side of the larger circle. I could not see them; there is a large naturally-imbedded boulder on the east-south-east side, but the intermediate one has been removed. Whilst I was at the smaller circle, I noticed that one of the stones had recently been pulled out of its setting, and was lying beside the hole.

The great camp on Penmaenmawr was plentifully bestrewn with sandwich papers and empty bottles, but the immense walls and hut circles of our forefathers defy the efforts of excursionists to a great extent. I, however, saw several of these terrible persons on the top, taking off the stones from the ancient walls and throwing them down below.

I noticed several other stones in the neighbourhood of the circles that had recently been thrown over.

In some of the more romantic and rocky situations in Wales—places visited by "cheap trips" (as near Bettws)—the rocks and even highly-esteemed antiquities—as the elaborately carved road-side cross at Carew, Pembrokeshire—are plastered over with printed bills about auctions, tea-meetings, sermons, and quack medicine.

WORTHINGTON G. SMITH

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Shadows after Sunset

IN reference to Mr. Douglas Archibald's letter, I may say that in 1873 I made three drawings of the "Sheaf rays" at the Isle of Wight. In these they are marked as "con-

verging in the east," but the point is apparently below the visible horizon. Shortly after I had, however, the opportunity of seeing the true convergence, as we were crossing the Peasemarsh, a large common near here. It was after rain, and there appeared a very bright spot in the east opposite the true sun, which to the best of my recollection was setting and not set, for I momentarily took the appearance to be some form of reflection of the sun itself. The rays were quite strong in the east and west, and though fainter could be distinctly traced across the sky. I believe that there were no clouds and that the ray intervals were equidistant, though I will not be certain on this point. I notice that one of my drawings also shows this peculiarity, though I confesss my impression has been hitherto that these rays were due to the interference of clouds. J. RAND CAPRON

Guildown, Guildford, Nov. 24

On the Isomerism of Albuminous Bodies

AMONG organic compounds there are large number of bodies hoving the same composition, but different constitution. They are called isomerides. The number of these isomerides increases in proportion as the number of atoms which they contain increases.

Prof. Cayley has already calculated the possible number of isomerides of hydrocarbons. From his result it can be easily seen that the increase of isomerides in proportion to the complexity of the composition is an exceedingly rapid one.

Now the number of atoms which the so-called albuminous bodies contain are very large. The number of isomerides which they can give therefore must be exceedingly large, in fact almost innumerable.

Prof. Schorlemmer, in his "Rise and Development of Organic Chemistry," says: "The enigma of life can only be solved by the synthesis of albuminous compounds." If then these albuminous bodies are really the basis of life, the different species of living beings must come from innumerable sources, for albuminous bodies have innumerable isomerides. According to this theory, we can say that the different species of living beings, whether animals or plants, were developed out of the chemical compounds having the same composition, but different constitution, but cannot assert, as some do, that they were developed out of the same source, or a few sources

Tokio, Japan, October 12 SHIGETAKÉ SAGIURA

An Extraordinary Lunar Halo

ON Monday evening, November 20, an unusual halo surrounded the moon from 6.15 to 6.25. The moon was not quite full, and the halo to some extent assumed the form of the moon. The halo consisted of a succession of concentric rings. The ring next the moon was equal to four diameters of the moon, and had a soft yellow-white radiance, almost equalling the moon in brilliancy; it was surrounded by a succession of prismatic rings, red commencement, and proceeding outward orange, yellow, green, blue, indigo, and violet. At 6.15 the chromatic rings were pretty sharply defined, with the exception of the outer one, which was faint and evanescent. Outside of the ring was a corona-like envelope. This aspect continued about five minutes, and during the next five minutes rapidly changed; the edges of the rings became irregular, radii shot from the rings towards the moon, and at 6.25 the phenomenon disappeared.

Newcastle-on-Tyne, November 24 J. P. BARKAS

Meteor

A BRIGHT meteor was seen here about 4.30 p.m. in the east. It did not explode, but dissipated itself with scintillations. It reached a very low level before it disappeared.

Oxford, November 27 W. L. HARNETT

Flame in Coal Fire

THE flame referred to by Major Herschel (NATURE, vol. xxvii. p. 78) is simply that of carbon monoxide, which may be observed in most coal fires, after the hydrocarbons are consumed, burning with a pale blue flame. Any yellow tint is of course due to sodium present in the coal. The production of carbon monoxide depends more upon the arrangement of, than the quality of, the coal. Major Herschel will find the reason of its presence give in any text-book on chemistry.

I cannot understand what advantage is obtained by removing the slit of the spectroscope, especially if one wishes to show that a flame is mono-chromatic. When burnt at ordinary pressure, carbon-monoxide has no definite spectrum. SM.

Rugby, November 24

Waterspouts on Land

I AM of opinion that the phenomena referred to by Mr. Hossack are not the effect of waterspouts, but are rather to be attributed to landslips. I may mention a case which may throw some light on the matter. About 1872 (I cannot give the exact date) a landslip occurred on the banks of the Tay, about seven miles north of Dunkeld, close to Guay Station on the Highland Railway, and on the east side of that line. I lived close by at the time, and shortly afterwards saw the effects. Local opinion attributed it to the following causes:—Along the top of the gravelly slope planted with oak and other trees, ran a brook. Immediately above the place where the landslip occurred, the banks of the brook had been burrowed by rabbits. When the sudden flood occurred which caused the landslip, the water of the brook entered these holes, undermined the gravelly slope or terraced beach, and precipitated it across the highway into the field below, devastating fully an acre of it. The trees, turf, &c., were deposited in the field much as they grew upon the slope. I was surprised that they had not been overturned, but it would appear that they had slid down. The effects are still quite visible to passengers on the railway. Had they been photographed at the time, they would have formed a capital illustration for a geological text-book.

Guildhall Offices, Carlisle JOHN GEDDES MCINTOSH

NOTES FROM THE LETTERS OF CAPTAIN DAWSON, R.A., IN COMMAND OF THE BRITISH CIRCUMPOLAR EXPEDITION

MAY 21. *On board the s.s. "Nova Scotian."*—A grey sky, a grey foam-flecked sea, floating ice-floes, fog and rain, with a thermometer a few degrees above freezing—such are the features of the Gulf of St. Lawrence this morning, and a cheerful welcome to the New World. Our course has been a long way to the south of Newfoundland on account of the ice, consequently our passage has been a long one. Yesterday was quite lovely, several icebergs were in sight eight or ten miles off, looking like peaks of snow mountains at a distance; now we are in the midst of ice fields delaying us a good deal, as at times it is difficult to find a passage.

May 22. *Quebec.*—We sighted land last night, and saw such a lovely sunset as we went up the St. Lawrence. We have been steaming up the river eighteen hours, but we cannot yet see the land on both sides. We have just passed the *Peruvian*, which left Liverpool a fortnight before us, but she got among the ice and broke her screw, and has been twenty-seven days on the voyage. Another of the Allan line steamers ran into an iceberg. So we feel lucky in getting across without mishap. At the end of the week I start for Winnipeg—2,500 miles by rail—a long journey of five days and four nights.

I find Quebec quite wintry after England; indeed, the snow is still lying in sheltered places where it has drifted, and no trees are in leaf.

June 3. *On Lake Huron.*—On reaching Toronto we went back again into summer—everything was green and spring-like, and the air was quite soft and balmy.

We left Toronto for Sarnia, where we embarked for Duluth, on the west end of Lake Superior—thence it is about twenty-four hours' journey to Winnipeg. Toronto was looking very well. There are groves of horse-chestnut trees in the principal streets, which have a very good effect. At Toronto I was introduced to the Canadian Premier, who took a great interest in my expedition. I also dined with the chief of the observatory there, and they gave me some wine at dinner which was made from their own vines in the suburbs. To Sarnia is about six hours—a most fertile country. The weather, however, is very rainy at present—this is the wet time of the year.

Every train and steamer is full of young Englishmen on their way out to Winnipeg, where they expect to make their fortunes, and no doubt it is a great place to make money just now.

We were two days running up Lake Huron, for the most part out of sight of land, and the land we did see was flat and ugly, till in the evening of the second day we reached the river joining the two lakes (Lake Huron and Lake Superior), and anchored at Sault St. Marie for the night. The river runs between rocky pine-covered shores, and in the evening we had one of those sunsets one only seems to see in this country—a blood-red sky overhead, orange at the horizon, with the pine woods rising black against it, and the broad reaches of the river winding away westward, all a blaze of golden light—just the subject for Turner.

The next morning we went through a lock into Lake Superior, and twenty-six hours' run took us to Thunder Bay, a barren looking place. Hard by is Thunder Cape, a bold headland 1,300 feet high. The water of Lake Superior never rises more than two or three degrees above freezing-point, and in old days it would certainly have been thought an enchanted lake, so strange are the effects of the mirage. At one moment you see a long line of cliffs, a minute later they have turned into a reef of rocks hardly above the water, or a little table-topped mountain on the horizon suddenly splits into two sharp peaks, and anon takes the shape of an hour-glass.

June 8. *Winnipeg.*—When we awoke this morning we were on the prairies—just like the sea, only grass instead of water—a green plain losing itself in the far horizon. The journey along the Northern Pacific Railway, from Duluth, by the side of the rapid river St. Louis was lovely.

Winnipeg is a flourishing place with 20,000 inhabitants, where a few years ago there was nothing but a few huts. It stands on the Red River of the north—a fine river about the size of the Rhine. All the people here are Cree Indians, who speak their language and don't understand English, but they are dressed in European dress, so they look more like gipsies than anything else.

June 27. *Fort Carlton.*—We arrived here yesterday, such lovely country, like an English park, with wild roses and other flowers growing in great profusion. The river rather reminds me of the Thames at Richmond. The Saskatchewan is a magnificent stream, far larger than the Red River, flowing between pine forests. The weather is simply perfect, except that the sun is rather hot in the middle of the day. The fare is rather rough. No milk or fresh bread—chiefly fish, biscuit, and salt meat. It was slow work getting up the rapids. A boat with a crew of Indians takes out a hawser a mile long, which is made fast to a tree above the rapids, then the other end is brought down to the steamer, and fastened to the capstan, and we slowly drag ourselves up. The steamer is propelled by an enormous paddle wheel at her stern, and at the bow is a great arrangement of spars for lifting her off sandbanks, should she run aground; and though she carried 150 tons of cargo she only drew three feet of water.

On the 23rd we reached the Forks of the Saskatchewan, where the river divides; we took the northern branch and warped up the rapids to the settlement of "Prince Albert," where the country looks quite like England. Land is to be had here for 2 dollars or 8*s.* an acre, and it seems wonderfully fertile—the soil looks so rich. It is certainly the place I should recommend any enterprising emigrant to come to if he only has a little capital to start with—300*l.* would be plenty. The soil wants no clearing; you have only to build a house and plough and sow your land. The climate is one of the finest in the world. I was talking to a retired officer of the 50th who has been here seven years, who says he has never had an hour's illness, and feels as though he were growing younger every year.

Fort Carlton is the *beau idéal* of a Hudson's Bay fort, with a stockade twenty feet high and towers at the corners. But the days when the Blackfeet made their raids are over, and the Cree or Ojibbeway Indians, whose "lodges" one sees all around, are very pacific. A great many speak a little French, but no English.

July 14. *Ile à la Crosse.*—We left Carlton on the 30th, *i.e.* my own party and two missionaries. I had a train of ten Red River carts drawn by horses and oxen. I drove in a light American waggon. The scenery was at first like English country, only without hedges. There was plenty of deep grass and vetches, which afforded splendid fodder for the animals. There were quantities of snipe, duck, and prairie chicken. The land was gay with wild flowers; orange-lilies were most conspicuous, and lots of wild strawberries. The mosquitoes were the only drawback, at times forcing us to wear veils and gloves, and to eat our meals in the smoke of our camp fires. After three days we reached a hill, from whence we saw the great sub-arctic forest stretching away like a sea to the north. It extends nearly to the Arctic Circle, and from the Atlantic to the Pacific.

On the 9th we reached Green Lake, but it blew so hard that we did not start till the 11th. Our conveyance was a Hudson's Bay Company's inland boat; our crew was of Crees and Chipewyans. The latter speak a language like the ancient Mexicans, quite unlike any other I have heard; it is like the noise of a person choking. It takes years to learn even a smattering of it. We drifted down the stream all night, our boats being lashed together, and we slept as best we could in the bottom of them.

Ile à la Crosse is on an island in the middle of a lake, and is comparatively free from mosquitoes. I had a splendid boat's crew—seven oars and a steersman; we pulled nearly fifty miles the first day. We rested on Sunday, and the day after crossed Buffalo Lake most fortunately—a fair wind sprang up just in time to take us across, as it cannot be crossed against the wind. Then we began to ascend the Rivière la Loche, which took us all the next day, there being two portages or places where the contents of the boats and sometimes the boats themselves have to be taken overland. Thence we entered Methy Lake, about thirty miles long at the north, and a narrow creek took us to the beginning of Portage la Loche, or the Long Portage, which is a road some twelve or fourteen miles long, leading to the Clear Water River which flows into the Athabasca and ultimately into the Mackenzie, so we are on the Arctic Slope at last.

July 22. *Portage la Loche.*—I rode over last night in company with the Hudson's Bay Company's officer in charge of the post. The road leads through pine woods, and passes a pretty lake, and ultimately descends a hill of about 400 feet into this valley. I am writing this in my tent, pitched on the bank of the Clear Water River, which flows past about three yards off. Across the river are wooded hills 600 feet high; to the left the river disappears among the pine woods in a dark ravine; to the right it winds away in the distance among blue hills. It is all so green and pretty that it is difficult to believe that in a few months all will be ice and snow. All the last week the heat has been intense, the thermometer over 86° in the shade all day. This morning we saw a bear prowling about opposite. We are now among the Chipewyan Indians; they are very different from the Crees; in appearance they remind me a little of drawings of the Esquimaux, with round greasy faces. About here they are mostly Roman Catholics, as there is a large mission at Ile à la Crosse.

The best description of this country in general is by saying that it is like Switzerland without mountains, but with big rivers and lakes. The plants are much the same, and the climate is much the same. The trees are very fine, and, as elsewhere, strawberries, raspberries, cranberries, black and red currants, and gooseberries grow wild.

There is a fine view down the valley from the top of the hill; it was mentioned by Sir J. Frankland, who has been through all this country.

July 24.—The Athabasca boats arrived last night, so we are off this morning.

ON THE GRADUATION OF GALVANOMETERS FOR THE MEASUREMENT OF CURRENTS AND POTENTIALS IN ABSOLUTE MEASURE[1]

II.

IN the preceding investigation nothing has been said as to the units in which the quantities m and H are measured. It will be convenient, before proceeding further, to consider shortly the measurement of magnetic and electrical quantities in absolute units, and particularly the centimetre, gramme, second (c.g.s.) system now generally adopted.

According to what is called the electro-magnetic system, all magnetic and electrical quantities are measured by units which are derived from a magnetic pole chosen as the pole of unit strength. This pole might be defined in many ways; but in order to avoid the fluctuations to which most arbitrary standards would be subject, and to give a convenient system in which work done in the displacements of magnets or conductors, relatively to magnets or to conductors carrying currents, may be estimated without the introduction of arbitrary and inconvenient numerical factors, it is connected by definition with the absolute unit of force. It is defined as *that pole which, if placed at unit distance from an equal and similar pole, would be repelled with unit force.* The poles referred to in this definition are purely ideal, for we cannot separate one pole of a magnet from the opposite pole of the same magnet: but we can by proper arrangements obtain an approximate realisation of the definition. Suppose we have two long, thin, straight, steel bars, which are uniformly and longitudinally magnetised; their poles may be taken as at their extremities; in fact, the distribution of magnetism in them is such that the magnetic effect of either bar, at all points external to its own substance, would be perfectly represented by a certain quantity of one kind of imaginary magnetic matter placed at one extremity of the bar, and an equal quantity of the opposite kind of matter placed at the other extremity. We may imagine, then, these two bars placed with their lengths in one line, and their blue poles turned towards one another, and at unit distance apart. If their lengths be very great compared with this unit distance, say 100 or 1000 times as great, their red poles will have no effect on the blue poles comparable with the repulsive action of these on one another. But there will be an inductive action between the two blue poles which will tend to diminish their mutual repulsive force, and this we cannot in practice get rid of. The magnitude of this inductive effect is, however, less for hard steel than for soft steel, and we may therefore imagine the steel of our magnets so hard that the action of one on the other does not appreciably affect the distribution of magnetism in either. If, then, the two blue poles repel one another with a unit of force, each according to the definition has unit strength.

The magnitude of unit pole is by the above definition made to depend on unit force. Now unit force is defined, according to the system of measurement of forces founded on Newton's Second Law of Motion, the most convenient system, as that force which, acting for unit of time on unit of mass, will give to that mass unit of velocity. Our unit pole is thus based on the three fundamental units of length, mass, and time. According to the recommendations of the B.A. Committee, and the resolutions of the Paris Congress, it has been resolved to adopt generally the three fundamental units already in very extended use for the expression of dynamical, electrical, and magnetic quantities, namely, the centimetre as unit of length, the gramme as unit of mass, and the second as unit of time. With these units, therefore, the unit force is that force which, acting for one second on a gramme of matter, generates a velocity of one centimetre per second. This unit of force has been called a *dyne*. The unit magnetic pole, therefore, in the c.g.s. system of units is that pole which, placed at a distance of 1 centimetre from an equal and similar pole, is repelled with a force of 1 dyne. Each of the poles of the long thin magnets of our example above is therefore a pole of strength equal to one c.g.s. unit, if the mutual force between the poles is 1 dyne.

The magnetic moment m of anyone of the deflecting magnets is equal to the strength of either pole multiplied into the distance between them, which for magnets of such great length in comparison with their thickness is nearly enough the actual length of the magnet. Therefore either pole has a strength of $\frac{m}{2l}$ units. If r and l are measured in centimetres, and W in grammes, the strengths of the magnetic poles deduced from equation (4) or (6) will be in c.g.s. units.

A magnetic field is the space surrounding a magnet or a system of magnets, or a system of conductors carrying currents, at any point of which, if a magnetic pole were placed, it would be acted on by force. From the definition of unit magnetic pole we get at once the definition of magnetic field of unit intensity. *Unit magnetic field is that field in which unit magnetic pole is acted on by unit force*, and in the c.g.s. system, therefore, it is that field in which unit magnetic pole is acted on by a force of one dyne. In the theory of the determination of H, given above, the horizontal force on either pole of the needle due to the horizontal component of the earth's field is taken as $\frac{m'}{2l'}.H$, and again the horizontal force on either pole of the deflecting magnet as $\frac{m}{2l}.H$. H is, therefore, the strength in units of magnetic field intensity of the horizontal component of the earth's field. By formula (5) or (7), when r and l are taken in centimetres, and W in grammes, H is given in dynes; that is, it is the number of dynes with which a unit red pole would be pulled towards the north, and a unit blue pole towards the south if acted on only by the earth's magnetic field. We can now go on to the measurement of currents.

According to the theory of electro-magnetic action given by Ampère, every element of a conductor in which a current is flowing acts upon a magnetic pole with a force which varies inversely as the square of the length of the line joining the centre of the element with the pole, and directly as the strength of the current and as the length of the projection of the element on a plane at right angles to that line. The direction of this force is at right angles to a plane drawn through the pole and the element, and acts towards one side or the other of that plane, according as the current in the element is in one or the opposite direction, and according as the magnetism of the pole is red or blue. From this it is easy to obtain a definition of unit current in the electro-magnetic system. It is that current which, flowing in a wire of unit length bent into an arc of a circle of unit radius, acts on a unit magnetic pole placed at the centre of the circle with unit force. Thus the current of unit strength in the complete circle of unit radius would act on a unit pole at the centre with 2π units of force, in the c.g.s. system with 2π dynes. This force acts towards one side or the other of the plane of the circle, according to the nature of the pole and the direction of the current. If the current, considered as flowing from the copper plate to the zinc plate of a Daniell's cell, were made to circulate round the face of a watch in the direction opposite to that in which the hands move, a red pole placed at

[1] Continued from p. 35.

the centre would be moved out through the face of the watch, and a blue pole in the opposite direction; and the opposite would be the case if the current were reversed. This is easily remembered by those familiar with the representation of couples in dynamics, by observing that when the direction of the current is the same as that in which a positive couple tends to turn a body, the direction in which a red pole is urged is that in which the axis of the couple is drawn. Or, the direction of the force may be found at any time, by remembering that the earth may be imagined to be a magnet turned into position by the action of a current flowing round the magnetic equator in the direction of the sun's apparent motion.

From the definition of a magnetic field we see that unit current may also be defined as that current which, flowing in a wire of unit length bent into an arc of a circle of unit radius, produces at the centre of the circle a magnetic field of unit intensity. The direction of the resultant magnetic force at that point is by Ampère's law at right angles to the plane of the circle, and the side towards which it acts in any particular case may be found as stated above.

If we take then the simple case of a single wire bent round into a circle and fixed in the magnetic meridian, with a magnet, whose dimensions are very small in comparison with the radius of the wire, hung by a torsionless fibre so as to rest horizontally with its centre at the centre of the circle, we may suppose that each pole of the magnet is at the same distance from all the elements of the wire. A current flowing in the wire acts, by Ampère's theory, with a force on one pole of the needle towards one side of the plane of the circle, and on the other pole with an equal force toward the other side of that plane. The needle is thus acted on by a couple tending to turn it round, and it is deflected from its position of equilibrium until this couple is balanced by the return couple due to H. Let us suppose the strength of each pole of the needle to be m units, r the radius of the circle, and C the strength of the current in it. Then by Ampère's law we have for the whole force without regard to sign, exerted on either pole of the needle by the current, the value $Cm\frac{2\pi r}{r^2}$ or $Cm\frac{2\pi}{r}$. If l be the length of the needle the couple is $Cm\frac{2\pi}{r}l$, before any deflection has taken place. After the needle has been deflected through the angle θ the arm l of the couple has become $l\cos\theta$, and therefore the couple $Cm\frac{2\pi}{r}l\cos\theta$; and the return couple due to H is $mHl\sin\theta$. Hence we have equilibrium when

$$Cm\frac{2\pi}{r}l\cos\theta = mHl\sin\theta$$

and therefore

$$C = \frac{Hr}{2\pi}\tan\theta \quad . \quad . \quad . \quad . \quad . \quad (8)$$

if θ be the observed angle at which the needle rests in equilibrium when deflected as described from the magnetic meridian. If instead of a single circular turn of wire we had N turns occupying an annular space of mean radius r, and of dimensions of cross-section small compared with r we should have

$$C = \frac{Hr}{2\pi N}\tan\theta \quad . \quad . \quad . \quad . \quad . \quad (9)$$

In practice the turns of wire of the tangent galvanometer may not be all contained within such an annular space. It is necessary then to allow for the dimensions of the space occupied by the wire. For a coil made of wire of small section we may suppose that the actual current flowing across a unit of area is everywhere the same. Hence if C be the current strength in each turn, and n the number of turns in unit area, we have for the current crossing the area A of an element E the value $2\pi nCA$. Taking a section of the coil through the centre, let BC be a radius drawn from the centre C in the plane cutting the coil into two equal and similar coils, and taking $CD(=x)$ and $DE(=y)$ at right angles to one another, we have $A = dxdy$ and $CE^2 = x^2+y^2$. Hence the force exerted on a unit magnetic pole at the centre C by the ring supposed at right angles to the plane of the paper, of which this element is the section, will be $\frac{2\pi nCy\,dx\,dy}{x^2+y^2}$ in the direction at right angles to CE and in the plane of the paper. If we call the component of this force at right angles to BC, dF, we have

$$dF = \frac{2\pi nCy^2\,dx\,dy}{(x^2+y^2)^{\frac{3}{2}}}.$$

Hence for the whole force at right angles to BC we have

$$F = 2\pi nC\int_{-b}^{b}\int_{r-c}^{r+c}\frac{y^2\,dx\,dy}{(x^2+y^2)^{\frac{3}{2}}},$$

where r is the mean radius of the coil, $2b$ its breadth, and $2c$ its depth in the plane of the circle.

Integrating, and putting N for the whole number of turns $4nbc$, we get

$$F = \pi NC\frac{1}{c}\log\frac{r+c+\sqrt{(r+c)^2+b^2}}{r-c+\sqrt{(r-c)^2+b^2}} \quad . \quad (10)$$

If θ be the angle at which the deflecting couple is equilibrated by the return couple due to H, we have as before the equation

$$F = H\tan\theta.$$

Hence, substituting the above value for F and solving for C, we have finally

$$C = \frac{H\tan\theta}{\pi N\frac{1}{c}\log\frac{r+c+\sqrt{(r+c)^2+b^2}}{r-c+\sqrt{(r-c)^2+b^2}}} \quad . \quad (11)$$

When the value of r is great in comparison with b and c this reduces to the equation

$$C = \frac{Hr\tan\theta}{2\pi N} \quad . \quad . \quad . \quad . \quad . \quad (12)$$

which we found before by assuming all the turns to be contained in a small annular space of radius r. In practice, in galvanometers used as standards for absolute measurements, generally neither b nor c is so great as $\frac{1}{10}$ of r, and in these cases the difference between the values given by equations (11) and (12) is well within the limits of errors of observation, and the correction need not be made. The value of C given by (12) is then to be used.

In this investigation the suspension fibre has been supposed torsionless. If a single fibre of unspun silk is used as described below for this purpose, its torsion may for most practical purposes be safely neglected. The error produced by it may however be easily determined and allowed for by turning the needle, supposed initially in the magnetic meridian, once or more times completely round, and noting its deviation from the magnetic meridian in its new position of equilibrium. The amount of this deviation, if any, may be easily observed by means of the attached index and divided circle, or reflected beam of light and scale, used as described below, to measure the deflections of the needle. From the result of this experiment the effect of torsion for any deflection may be calculated in the following manner.

Let a be the angular deflection, in radian[1] measure, of the magnet from the magnetic meridian produced by turning the magnet once round, then the angle through which the thread has been twisted is $2\pi - a$. The couple produced by this torsion has for moment $Hlm\sin a$.

[1] A *radian* is the angle subtended at the centre of a circle by an arc equal in length to the radius. It has generally been called in books on trigonometry hitherto by the ambiguous name *unit angle in circular measure*.

Hence, by Coulomb's law of the proportionality of the force of torsion to the twist given, we have for the couple corresponding to a deflection θ the value

$$\frac{\theta}{2\pi - a} H m l \sin a.$$

If then under the action of a current in the coil the deflection of the needle is θ, the equation of equilibrium is

$$C m \frac{2\pi}{r} l \cos \theta = m H l \left(\sin \theta + \frac{\theta}{2\pi - a} \sin a\right)$$

and therefore instead of (9) we have

$$C = \left(1 + \frac{\theta}{2\pi - a} \frac{\sin a}{\sin \theta}\right) \frac{Hr}{2\pi N} \tan \theta . \quad (13)$$

If a be an angle of say 1°, and θ be 45°, $\frac{\theta}{2\pi - a}$ is very nearly $\frac{1}{8}$ and $\frac{\sin a}{\sin \theta}$ is $\frac{1}{57{\cdot}3} \times \frac{1}{{\cdot}707}$ or $\frac{1}{40{\cdot}5}$. Hence

$$C = \left(1 + \frac{1}{324}\right) \frac{Hr}{2\pi N}$$

The error therefore is somewhat less than $\frac{1}{3}$ per cent.

The accuracy of the measurements of currents, made according to the method of which I have just given the theory, of course altogether depends on the careful adjustment of the standard galvanometer, and the care and skill of the observer. The standard galvanometer should be of such a form that the values of its indications can be easily calculated from the dimensions and number of turns of wire in the coil. Such a galvanometer can be made by any one who can turn or can get turned a wooden, or, preferably, brass ring with a rectangular groove round its outer edge to receive the wire. It is indeed to be preferred that the experimenter should at least perform the winding of the coil and the adjustments of the needle, &c., himself, to make sure that errors in counting the number of turns or in determining the length of the wire, or in placing the needle at the centre of the coil, are not made. The breadth and depth of this groove ought to be small in comparison with its radius, and each should not be greater than $\frac{1}{16}$ of the mean radius of the coil, which should be at least 15 cms. The size of the wire with which the coil is to be wound must be conditioned of course by the purposes to which the instrument is to be applied, but it should be good well insulated copper wire of high conductivity, and not so thin as to run any risk of being injured by the strongest currents likely to be sent through the instrument. For the exact graduation of current as well as potential galvanometers directly by means of the standard instrument, it is convenient sometimes to have two coils—one of comparatively high, the other of low resistance. The latter may very conveniently be a simple hoop of say 15 cms. radius, made of copper strip 1 cm. broad and 1 mm. thick. To form electrodes to which wires can be attached the ends of the strip are brought out side by side in the plane of the ring with a piece of thin vulcanite or paper between for insulator. Insulated wires are soldered to the ends of the circle thus arranged, and are twisted together for a sufficient distance to prevent any direct effect on the needle from being produced by a current flowing in them. In constructing a coil the operator should first subject the wire to a considerable stretching force, and then carefully measure its electrical resistance and its length. He should then wind it on a moderately large bobbin, and again measure its resistance. If the second measurement differs materially from the first the wire is faulty and should be carefully examined. If no evident fault can be found on the removal of which the discrepance disappears, the wire must be laid aside and another substituted. When the two measurements are found to agree the wire may then be wound on the coil. For this purpose the ring may either be turned slowly round in a lathe or on a spindle so as to draw off the wire from the bobbin, also mounted so as to be free to turn round. The wire must be laid on evenly in layers in the groove, and the winding ended with the completion of a layer. Great care must be taken to count accurately the number of turns laid on. The resistance should now be again tested, and if it agrees nearly with the former measurements the coil may be relied on. The ring carrying the coil thus made should now be fixed to a convenient stand in such a manner that if necessary it can be easily removed. The stand should be fitted with levelling screws so that the plane of the coil may be made accurately vertical. A shallow horizontal box with a glass cover and mirror bottom should be carried by the stand at the level of its centre. Within this the needle and attached index are to be suspended. The needle should be a single small magnet about a centimetre long, hung by a single fibre of unspun silk about 10 cms. long from the top of a tube fixed to the cover of the shallow box, so that the centre of the needle when the coil is vertical is exactly at the centre of the

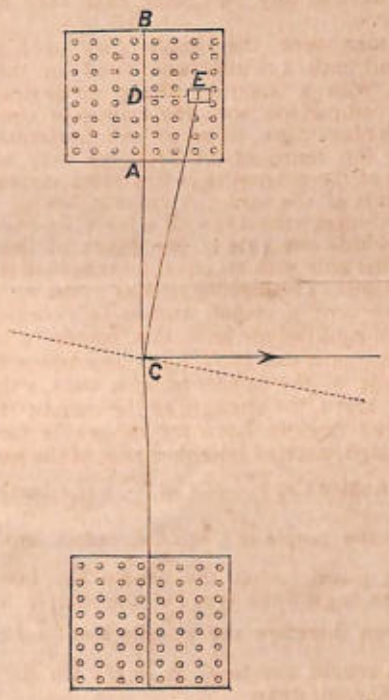


FIG. 3.

coil. To allow of the exact adjustment of the height of the needle, the fibre should be attached to the lower end of a small screw spindle, made so as to be raised or lowered, without being turned round, by a nut working round it above the cap of the tube. The needle should carry a thin glass index, about 6 inches long, made by drawing out a bit of thin glass tube at the blowpipe. In order that the zero position of the index may not be under the coil, the index should be fixed horizontally with its length at right angles to the needle, so as to project to an equal distance in both sides of it. To test that this adjustment is accurately made, draw a couple of lines accurately at right angles to one another on a sheet of paper. Then suspend a long thin straight magnet over the paper, and bring one of the lines into accurate parallelism with it. Remove then the magnet and put in its place the little needle and attached index If the index is parallel to the other line the adjustment has been carefully made. The needle may then be suspended in position and the box within which it hangs closed to prevent disturbance from currents of air.

A circular scale graduated to degrees, with its centre just below the centre of the coil and its plane horizontal, is placed with its zero point on a line drawn on the mirror bottom of the box at right angles to the plane of the coil, so that when the needle and coil are in the magnetic meridian the index may point to zero. The accuracy of the adjustment of the zero point is to be tested by finding whether the same current produces equal deflections on the two sides of zero. To test whether the centre of this divided circle is accurately under the centre of the needle supposed at the centre of the coil, draw from the point immediately under the centre of the needle two radial lines on the mirror bottom, one on each side of the zero point and 45° from it, and turn the needle round without giving it any motion of translation. If the index lies along these two radial lines when its point is at the corresponding division on the circle the adjustment is correct.

When taking readings the observer places his eye so as to see the index just cover its image in the mirror bottom of the box, and reads off the number of degrees and fraction of a degree, indicated on the scale by the position of the index. Error from parallax is thus avoided.

A mirror with attached magnets may be used, as in the magnetometer, instead of the needle and index. When this arrangement is employed the coil is in the magnetic meridian, when equal deflections of the spot of light on the scale on the two sides of zero are observed. These scales, as has been already remarked, should always be carefully glued to a wooden, piece instead of being, as they frequently are, fixed with drawing pins.[1]

ANDREW GRAY

(To be continued.)

PROFESSOR HENRY DRAPER, M.D.

THE late Professor Henry Draper, whose death we announced last week, was born in Virginia in 1837, but three years later removed to New York, at the time when his father, Prof. J. W. Draper, was appointed to the Chair of Chemistry in New York University. At this University Dr. Draper was educated, graduating in Medicine in 1858, after which he travelled abroad. In 1860 he was elected to a professorship in his own University, which he retained till his death the other day. In 1866 he was elected Professor of Physiology in the Medical Department of the University and managing officer of the institution, a position he resigned in 1873.

Dr. Draper's scientific work began with a series of experiments in 1857 on the function of the spleen, carried out by the aid of microscopic photography, an art then in its infancy. On his return from Europe, stimulated by a visit paid to Lord Rosse's 6-foot reflector, he began the construction of a 15½-inch reflecting telescope, and with this, when completed, he took photographs of the moon. A full account of the methods of grinding and polishing reflecting mirrors and the system of testing them was printed in 1864 in the Smithsonian "Contributions to Science."

Dr. Henry Draper subsequently constructed an equatorial reflecting telescope of 28 inches aperture, making both the mounting and the silvered glass speculum himself. The object for which this instrument was intended, and which it succeeded in accomplishing in 1872, was photographing the spectra of the stars, a work which has been carried on with such success by Dr. Huggins in this country. Since the invention of the gelatino-bromide dry process the difficulties of this research have much decreased; all the more credit is therefore due to Draper and the other pioneers in this branch of inquiry; he had taken more than a hundred spectra of various stars.

In 1872 Dr. Draper produced a photograph of the diffraction spectrum of great excellence. It comprised the region from below G, wave length 4350, to O, wave length 3440, on one plate.

In 1874 Draper was appointed by the United States Transit of Venus Commission, Superintendent of its Photographic Department, and his duties in this connection were so satisfactorily performed, that in the fall of that year the United States Government caused a special gold medal to be struck in his honour at the Mint in Philadelphia, bearing the inscription, "Decori Decus Addit Avito." This was the first time that such a public recognition had ever been accorded to a scientific man in the United States by the Government.

In 1877 Dr. Draper printed his paper on the "Discovery of Oxygen in the Sun and a New Theory of the Solar Spectrum." This research has given rise to as much interest as any in recent times; whatever the future verdict may be upon it, it was the result of several years' work and most costly and elaborate apparatus. In 1877 Dr. Draper went to the Rocky Mountains, and made experiments on the transparency and steadiness of the atmosphere at elevations up to 11,000 feet. In the succeeding summer he took a party into the same region to observe the total eclipse of the sun, and was fortunate enough to photograph the diffraction spectrum of the solar corona, which on this occasion was shown to be continuous.

During the last autumn and winter he took photographs of the nebula in Orion. These were the first he ever made, and required an exposure in the telescope up to 140 minutes, even when the most sensitive of Eastman's gelatine plates were used.

Dr. Draper's work has been done mainly at his observatory at Hastings-on-Hudson, and at his laboratory in New York. In the former he had three large telescopes.

Dr. Draper's genial nature won him many friends and many English men of science well know the hospitable home at Dobb's Ferry. These and many more will sympathise with Mrs. Draper in the loss which not only she but science has sustained in the death of so earnest a seeker after truth.

THE COMET

WE have received the following communications on this subject:—

The latest information indicates that the September comet was first seen on the 3rd of that month at Auckland.

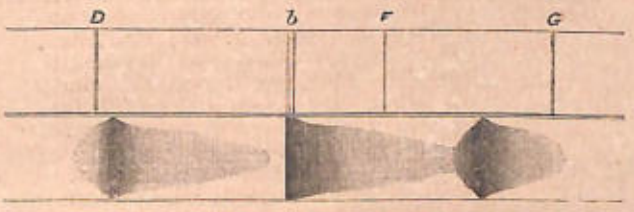
The sketch, No. 1, represents the appearance of the spectrum of this comet on October 15 and 16, and subsequent mornings. The spectroscope used was one of Browning's direct-vision, with five prisms. It was attached to the comet-seeker, which has a 4-inch object-glass, the focal length of the instrument making a distinct general view of the spectrum easy. As the spectroscope was not furnished with any means of comparing spectra, the positions of the bands, as shown in the sketch, were obtained by adjusting the viewing telescope so that each band was, in succession, just in the edge of the field, clamping the telescope, and then viewing the spectrum of a candle. This operation was repeated several times on October 16, and subsequently on the 25th. The position of the band in the orange-yellow was referred directly to the sodium line in the candle-flame. The band in the middle of the green was much the brightest, and on the least refrangible side was sharply defined; but, in the other direction, gradually diminished in brightness. When the slit of the spectroscope was gradually closed, the light was gradually diminished, but no separate line made its appearance, as the well-defined edge of the band would have led one to expect.

The other two bands were of about equal brightness; both of them fading rapidly on the more refrangible side, but much more slowly in the other direction.

[1] ERRATUM.—In the preceding part of this article, p. 30, col. 1, line 24 from top, for *2r* read *r*.

It will be remembered that the first spectroscopic observations, by M. Thollon, at Nice, reported the spectrum of the nucleus as continuous, very brilliant, and much extended toward the violet. The head gave the sodium lines very brilliant, clearly double, and appearing displaced toward the red. This report was confirmed on the same day by a similar one from Mr. Lohse, with the additional remark, that he saw *many bright lines*, the sodium being the brightest, and all apparently displaced toward the red.

October 15. This state of things had entirely changed. The change had probably been gradual, and was dependent upon the distance of the comet from the sun.



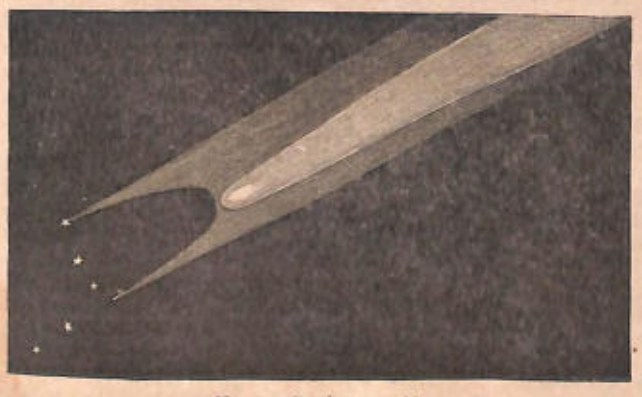
No. 1.—Spectrum of Cruls's Comet, October 15 and 16.

The first observation made on September 18, when the comet was near the sun, gave a continuous spectrum, which was due to the strong reflected light, while the bright lines were due to the vapours developed by the intense heat of the sun.

On October 15 the spectrum resembled the spectra of the comets of 1868; of the sodium line there was no trace, although the spectrum contained light of about the same refrangibility. The tail of the comet gave a faint but apparently continuous spectrum brightest in the green.

A somewhat similar change was observed, I believe, in the spectrum of the Comet Wells as it approached the sun, except that its nucleus gave always a continuous spectrum, to which was added the sodium line as the comet neared the sun. If we are soon to witness a return of the September comet, it is desirable that many observers should be prepared to watch the changes as the comet approaches the sun.

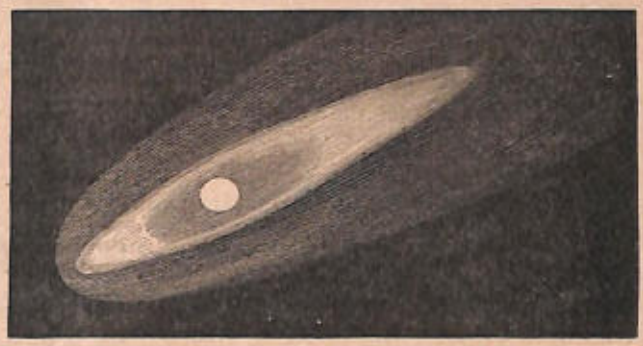
Sketch No. 2 represents the comet as it appeared in the comet-seeker on the morning of October 10, which



No. 2.—October 10, 1882.

was particularly clear. This outer envelope I first noticed on the morning of the 8th, when I traced it far beyond the head of the comet in the direction of the sun, but only on the east side. On the 10th it appeared as represented in the sketch. The outer edges were perfectly sharp and parallel to the axis of the comet, thus forming a cylinder whose diameter was about four times the diameter the tail measured several degrees from the head. When I again looked for this envelope on the 25th, it could be traced only on the east side, but retained the same relation to the tail. The greatest length to which this attained was about four degrees beyond the head.

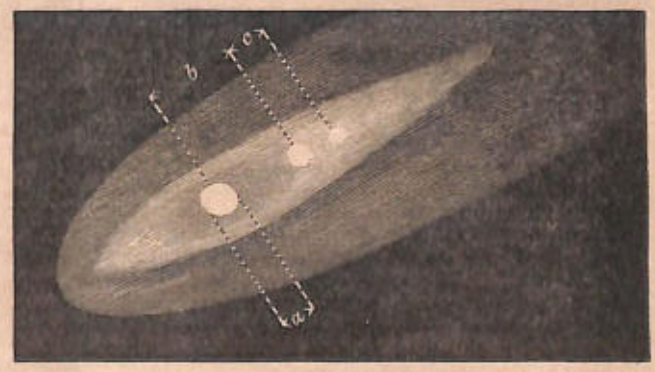
Sketch No. 3 represents the head of the comet as it appeared on October 25 in the 26-inch equatorial. Owing to the low altitude of the comet, this instrument had not been used before. The head appeared more elongated than at any time before but instead of the uncertain, delusive appearance which it presented in the 10-inch equatorial, the image brought out the peculiarities of each portion of the head, and left little doubt that there was, at that time, an essential difference between the central portion or nucleus proper, and the other two portions. The central part was circular, of considerable apparent



No. 3.—Nucleus of Comet, October 25, as seen in 26-inch Equatorial.

diameter, and of quite uniform brightness throughout. The other two portions were irregular in shape, much less bright than the nucleus, and their brightest parts were also irregular in shape. Both were apparently separated from the nucleus, though on its side they were joined to each other. The portion extending in the direction of the tail was the longest and brightest.

The next opportunity to examine the comet was on November 3, when it had decidedly changed in appearance, as represented in No. 4. The nucleus remained as when last seen, as did also the portion of the coma nearest the sun. The other portion showed a circular



No. 4.—Nucleus of Comet, Nov. 6, 1882, as seen in 26-inch Equatorial.

condensation almost as distinct as the original nucleus, and about two-thirds its size; still further in the direction of the tail was another condensation, smaller and less distinct than the second. On November 6 these condensations were still more pronounced, and shone with a much stronger light than the coma in which they were enveloped.

The following micrometric measurements were made on the 3rd and 6th, using the 26 in. equatorial:—

Distance a = 0".66
" b = 1·70 } November 3.
" c = 0·84
Distance a = 0·74
" b = 1·66 } November 6.
" c = 1·03

Assuming 0·1705 and 0·1714 to be log. Δ on those days respectively, the distance a would be about 4000 miles, the distance b about 10000 miles, and the distance c about 5500 miles.

It would not be surprising, judging from the history of this comet, if another condensation developed in the portion of the coma nearest the sun, thus forming four nucleuses.

W. T. SAMPSON,
Commander U.S.N.

Naval Observatory, Washington, November 11

Since my first communication, with sketch of the comet, on October 21, which appeared in NATURE, vol. xxvi. p. 622, I have had good views on 21 out of 31 days. The fine weather and clear atmosphere of this place give exceptional facilities for the continued and frequent observations which are needed to obtain a knowledge of so anomalous and surprising an object. Some windows of my villa command an extensive sky and sea view (including at times the mountains of Corsica, 120 miles distant), and from my bedroom—sometimes even from my bed—I have been able to watch the comet with ease for from a quarter of an hour to an hour, on each of those twenty-one days; using only a good field binocular in occasional aid of a strong natural sight. I have more powerful telescopes, but for this object they give no help; and I am not astronomer enough to avail myself of other instruments.

The comet was seen in all its brightness on October 20, 21, 23, and 24, with its nucleus like a star of first magnitude, but elongated and nebulous—its tail beginning with slender stem, slightly curved, with downward convexity, and gradually expanding to its extremity, the diameter of which was about five times that of the head. The lower, slightly convex margin, was brighter, and more defined; but a strong nebulous light pervaded the length and breadth of the tail, shaded along the upper margin in gradually diminishing haze. The tail ended in an elongated crescent, the lower or eastern horn of which was longer than the other. Both horns were prolonged in faint lines, hardly perceptible, a few degrees further (as noticed by your correspondent, Mr. Larden). No such prolongation could be seen from the hollow of the crescent, which terminated by a narrow fringe of diminishing light, beyond which was an oval patch of shade, *obviously darker than any other portion of the visible sky*. This appeared to me nothing else than a *shadow* projected by the comet on the space beyond the end of its tail. I cannot admit the correctness of Major Herschel's *suspicions*, "that this impression was produced by contrast only" (NATURE, vol. xxvii. p. 4). The still greater contrast between the brightness of the lower margin and the adjoining sky produced no such shade there *at that time*: later I shall allude to such a shade appearing there also. The ultra-caudal patch was obviously darker than any other spot of the sky: so it appeared to me, and my experience in landscape painting has given me some skill in appreciating lights and shades. I am quite aware of the difficulty of physically explaining the existence of light and shadow in the vacuity of space, but this is a question of pure observation, to which I invite further attention. Two of your correspondents, Mr. Larden of Cheltenham, and Mr. Cecil of Bournemouth, describe "a black rift in the sky," and "a strong apparent shadow" behind the comet—seemingly in confirmation of my observation.

When the comet was next seen, after an interval of bad weather, on the 29th it had lost in dimensions, but still more in brightness, and its form was changed. The upper margin from the head upwards had expanded and become more feathery; so had the end of the tail, which had lost its crescentic form; the shadow beyond had quite disappeared, and was replaced by an ill-defined luminosity, losing itself in the darkness of the sky. The lower margin of the tail had lost less of its brightness and definition; and now if there was a shadow anywhere, it was along this edge, down even to the head of the comet; but the shade was much less marked than had been that beyond the tail, and I might have ascribed it to contrast but that it was not present when this margin was brighter and the contrast greater. This shadow is noticed by Mr. Cecil in NATURE, vol. xxvii. p. 52.

The comet was well seen on October 30 and 31, and November 2, 3, 4, 6, and 7, gradually diminishing in brightness and in the definition of its outline, its light being now further paled by moonlight. So faint was it that I am not surprised at Major Herschel's description of its non-appearance in the London sky of November 5; but I cannot help "suspecting" that this was due not to moonlight only (as the testimony of others proves), but also to the gas-lit haze of the London atmosphere, which from fifty years' experience I know to be, at its clearest, quite sufficient to mask a faded comet, even although the brighter light of stars may still remain visible. On the 8th the comet was seen before moonrise, more distinct, although pale and hazy in outline; lower margin still the brightest, with a slight attendant shade. It was seen every day (except the 13th, 14th, and 15th) until the 22nd, with little other changes than that it was gradually becoming fainter, although still a conspicuous object in the dark sky from 2 to 5.30 a.m. On the 21st I made a careful portrait of it in oils, with its attendant stars, by the side of one that I had painted from the sketch taken October 21, when it was in its glory. The alteration which has taken place in the month is such that it now seems the mere ghost of its former self. The comparison strikes one as showing how much more it has lost in brightness and compactness, than in length and breadth. Is not this in exact conformity with what has been ascertained (see NATURE, vol. xxvii. p. 58) that the comet has been receding more rapidly from the sun than from the earth.

C. J. B. WILLIAMS

Cannes, November 23

THE APPROACHING ECLIPSE OF MAY 6, 1883[1]

THE sixth of May next year will witness, in the distant regions of Oceania, one of the rarest and most important astronomical phenomena of the century, viz. a total eclipse of the sun, which, owing to the respective positions, but rarely realised, of the sun and the moon, will have a duration quite extraordinary.

Now, in the present state of science, when the most important questions as to the constitution of the sun and that of the unexplored spaces near him, and the existence of those hypothetical planets which Le Verrier's analysis indicated within the orbit of Mercury, are still pending, a phenomenon which presents to us, for long minutes, all those regions, with the sun's dazzling brilliancy withdrawn, and renders them accessible to observation, is one of the first order.

We shall presently examine the conditions under which this rare solar occultation will be produced; let us first see what is the state of the questions which have to be considered on this occasion. One of the most important is that regarding the constitution of the space immediately bordering on the envelopes of the sun at present known.

The great Asiatic eclipse of 1868, came wonderfully *à propos*, both by its long duration and by the maturity of the problems that had to be attacked, enabled us in some sort to tear the veil which hid from us the

[1] Report to the Bureau des Longitudes, by a Commission consisting of MM. Fizeau, Admiral Cloué, Lœwy, and Janssen (reporter).

phenomena existing beyond the visible surface of the sun. It was then that was solved the enigma so long pondered over regarding the nature of those roseate protuberances which surround in such a singular way the limb of the eclipsed sun.

Spectral analysis taught us that they were immense appendages belonging to the sun, and formed almost exclusively of incandescent hydrogen gas. Almost immediately, the method suggested by this same eclipse, and which allows of a daily study of those phenomena, revealed the relations of those protuberances to the solar globe. It was perceived that the protuberances are merely jets, expansions of a layer of gas and vapours, 8″ to 12″ in thickness, where the hydrogen preponderates, and which is at a very high temperature, by reason of its contact with the surface of the sun. This low atmosphere is the seat of frequent eruptions of vapours coming from the solar globe, and among which one chiefly observes sodium, magnesium, and calcium. We may even suppose that, in the lowest part of this *chromosphere*, as it has been called, most of the vapours, which in the solar spectrum, produce the dark lines it presents, exist in the state of high incandescence.

The eclipse of 1869, which was visible in America, allowed indeed of the important observation (always confirmed since) of the reversal of the solar spectrum at the extreme border of the disc, that is to say, at the points where the photosphere is immediately in contact with the chromosphere; a phenomenon which does not signify that the photosphere itself may not contain the same vapours and concur in the production of the solar spectral lines.

Thus the discovery of a new solar envelope, the recognised nature of the protuberances, and the knowledge of their relation to the sun; lastly, the conquest of a method for the daily study of those phenomena; such were the fruits of spectrum analysis applied to the study of this long eclipse of 1868.

But a total eclipse presents other manifestations completely unexplained up to the time of which we speak. There is seen, beyond the protuberances and the chromospheric ring, a magnificent aureole, or luminous corona, of soft brightness and silvery tint, which may reach as far as an entire radius of the dark limb of the moon.

The study of this beautiful phenomenon, by methods which had given such magnificent results, was immediately undertaken, and occupied the astronomers during the eclipses of 1869, 1870, and 1871.

But the aureole or corona, though constituting a brilliant phenomenon, has in reality but weak luminous power. Hence the difficulty of obtaining its spectrum with its true characters. Thus the astronomers differed at first as to the real nature of the phenomenon. In 1871, and by the use of an extremely luminous instrument, it was definitively proved that the spectrum of the corona contains the bright lines of hydrogen, and the green line called 1474 of Kirchhoff's maps, an observation which demonstrates that the corona is a real object constituted of luminous gases forming a third envelope round the solar globe.

If indeed the phenomenon of the corona were a simple phenomenon of reflection or of diffraction, the coronal spectrum would merely be a weakened solar spectrum. On the other hand, the characters of the solar spectrum are here quite subordinate, and the spectrum is that of protuberantial gases and of matter still unknown, indicated by the line 1474.[1]

The subsequent eclipses of 1875 and 1878, and that recently observed in Egypt, have yielded confirmation of these results.

But if the constitution of the sun is being thus rapidly unveiled, there still remain great problems to be solved, both as to this last solar envelope, and as to the region near it.

First of all, have the immense appendices which the corona has presented during some eclipses, an objective reality, and are they a dependance of this immense coronal atmosphere, or might they rather be streams of meteorites circulating round the sun (as one of the members of the Bureau has suggested)?

We do not forget the zodiacal light, the relations of which to those dependances of the sun remains to be determined.

But these problems are not the only ones we have now to attack, during the occultations of the solar globe. Do the regions with which we are occupied contain one or several planets, which the illumination of our atmosphere, so bright in the neighbourhood of the sun, may have always concealed from us? Leverrier long studied this question, and his analytical researches led him to suppose their existence.

On the other hand, several observers have alleged that they have observed transits of round and dark bodies in front of the sun; but these observations are far from being certain. The surface of the sun is often the seat of small, very round spots, which appear and disappear in a time often short enough to simulate the passage of round bodies before that star.

The question is of capital importance; hence it at present justly engages the thoughts of all astronomers.

May the analysis of Leverrier enrich the solar world towards its central regions, as it has done with such a magnificent success in the most distant regions?

We have but two means of solving the problem, whose solution is more particularly incumbent on French astronomy; the attentive study of the solar surface, or the examination of the circumsolar region when an eclipse renders their exploration possible to us. This last means seems the most efficacious, but on the condition that the occultation is long enough to allow of a minute exploration of all the regions where the small star may be met with.

This gives a capital importance to the eclipse of May 6 next, one of the longest of the century.

We will now examine the circumstances of this great eclipse, and the means that it would be well to employ for observation of it.

The total eclipse of May 6 next will have a duration of 6 minutes at the point where the phase is maximum (5m. 59s.); a time triple that of ordinary eclipses.

The central line is wholly comprised in the South Pacific Ocean, and we can only hope to observe it in the islands of that ocean.

After an attentive study of the question, it has appeared to us that two islands would do about equally well for observation; those of Flint and Caroline.

Flint Island (lat. 11° 30′ S., and long. 151° 48′ W. of Greenwich) is the nearest to the central line. Calculation gives for the duration of totality in this island 5m. 33s. Caroline Island is 150° 6′ W., and 9° 50′ S.; the duration of the totality there will be 5m. 20s.; that is, only 13 seconds less than in Flint Island.

It will be seen that the astronomical conditions of the phenomenon are extremely favourable in these islands, and it is to these stations we should propose to the Bureau to send an expedition.

This expedition should start from Paris, go to New York, traverse the American Continent by the railway to San Francisco, and there find a steamer (of a French service about to be established), which should carry it to the Marquesas Islands. There a man-of-war of the French station should take it up, and deposit one portion at Caroline Island, the other at Flint Island. This ship

[1] One of us has expressed the idea (Notice du Bureau des Longitudes, 1879) that the coronal atmosphere which is in dependence on the chromosphere and photosphere must present a much more agitated appearance at the epoch of maximum of spots and protuberances, since the jets of hydrogen which then penetrate it are much more numerous and rich. Ulterior observations, and especially those which have been made during the last eclipse at the moment when the solar eruptions were abundant, have confirmed this previsi n.

which, further, should be provided with all that is necessary for the establishment of the stations, the safety and the subsistence of the observers, should not leave those regions before bringing the mission to Tahiti, where our *envoyés* would find means of transport for their return, either by the way they went, or (which would seem preferable), by way of Australia.

THE TRANSIT OF VENUS ON WEDNESDAY, DECEMBER 6

AT the Transit of Venus in 1874 the tables of the planet prepared by Prof. Hill appeared to have a decided advantage over those of Leverrier. The correction to the tabular place deduced from the observations of the transit is in close accordance with that shown by a meridian observation at Washington on the day preceding the phenomenon. Although the entire discordance was not negatived by the tables of Prof. Hill, they went far towards removing it in 1874, and as the coming transit (December 6) will take place in nearly the same point in the planet's orbit, we shall assume in what follows, that the tables of the American astronomer will again be fairly correct. Prof. Newcomb assumes and probably with much reason, that the error of Leverrier's tables will prove to be an increasing one, and is therefore inclined to apply a still larger correction to the place deduced from them. It may be mentioned that the calculations of the transit in the *Nautical Almanac*, the *Connaissance des Temps*, and the *Berliner Astronomisches Jahrbuch*, depend upon Leverrier's tables. For the diameter of the planet we adopt that found by Prof. Auwers from heliometric measures in Egypt during the last transit, combining it with the diameter of the sun, inferred by Leverrier from his discussion of the transits of Mercury.

Direct calculations for Greenwich, Edinburgh, and Dublin give with the elements so obtained the following *Greenwich* mean times of the first external contact, and the respective angles from the sun's vertex for direct image :—

	h.	m.	s.	°	′
Greenwich	2	0	42·2	126	59·4
Edinburgh	2	1	7·7	130	49·3
Dublin	2	1	9·6	131	21·2

For a limited area like that of these islands we may apply to these times and angles, the method of distribution of predictions given by Littrow, and subsequently by Woolhouse. Putting the latitude of any place within the above area = 50° + L, and its longitude in minutes of time = M, + if *east* of Greenwich, − if *west*, we get the following equations :—

G.M.T. of first external contact ... } = 2h. 0·62m. + [8·7453] L − [8·1402] M.

Angle from sun's vertex, direct image... } = 126°·3 + [9·669] L − [9·136] M.

The quantities within the square brackets are logarithms, but of course if preferred the factors for L and M may be expressed as numbers. As an example of the application of these formulæ, suppose the time of first contact and the corresponding angle are required for Norwich, the position of which place may be taken in latitude + 52° 38′, longitude 1° 18′ or + 5m. 12s., we have then

L = + 2°·633 M = + 5·20m.

	+ 8·7453				− 8·1402
Log. L ...	+ 0·4205		Log. M ...		+ 0·7160
	+ 9·1658				− 8·8562
No.	+ 0·146		No.		− 0·072
	− 0·072				
	2 0·62				
	2 0·69	or	h. m. s. 2 0 41	G.M.T.	
	Longitude E		5 12		
			2 5 53	Norwich M.T.	

For the angle—

	+ 9·669	− 9·136	+ 1·23
Log. L	+ 0·421	Log. M + 0·716	− 0·71
	+ 10·090	− 9·852	126·3
			126·8 ... angle from vertex.

So that according to the calculation the limb of the planet comes into first contact with that of the sun at 53° from his lowermost point towards the left, as we view the phenomenon with the naked eye. It will be remarked that there is less than a half minute difference in absolute time between Greenwich and Dublin, and considering the possibility of error of many seconds in any prediction that can be made for geometrical contact and the difficulty of always determining what is geometrical contact in the observations, our formula for time of first contact is more than a sufficient one.

For first *internal* contact, it may be assumed that 21 minutes have to be added to the time of external contact at any place in these islands; while for the angle from N. point of first external contact may be taken in all cases 147°.

In the national ephemerides the times of the contacts are given for a particular meridian as they would be noted at the centre of the earth, and formulæ are appended to reduce these geocentric times to any point upon the earth's surface. It is obvious that where, as in a transit of Venus, predictions are required for such widely distant stations, this method possesses the greatest convenience.

NOTES

THE following are the Lecture arrangements at the Royal Institution for the ensuing Session :—The Christmas Lectures will be given by Prof. Tyndall, on Light and the Eye. Before Easter—Prof. W. C. Williamson on the Primeval Ancestors of Existing Vegetation, and their Bearing upon the Doctrine of Evolution; Prof. R. S. Ball, four lectures on the Supreme Discoveries in Astronomy; Prof. Dewar, nine lectures on the Spectroscope and its Applications; Mr. R. Bosworth Smith, four lectures on Episodes in the Life of Lord Lawrence; Dr. W. H. Stone, three lectures on Singing, Speaking, and Stammering; Mr. H. H. Statham, two lectures on Music as a Form of Artistic Expression. After Easter—Courses will be given by Professors Tyndall, McKendrick, A. Geikie, and Turner (of St. Petersburg). The Friday Evening Discourses will probably be given, among others, by Mr. R. B. Smith, Dr. G. J. Romanes, Sir W. Thomson, Mr. M. D. Conway, Prof. W. C. Williamson, Mr. W. H. Pollock, and Prof. Tyndall.

A COMMITTEE, consisting of the Right Hon. J. T. Ball, LL.D., D.C.L., the Very Rev. W. Reeves, D.D., Dean of Armagh, J. L. E. Dreyer, Ph.D., Astronomer of Armagh Observatory, has been appointed by the Governors of the Armagh Observatory to raise a fund for the purpose of erecting a memorial instrument in the observatory at Armagh, where the late Rev. Dr. Robinson spent fifty-eight years, engaged in those scientific investigations with which his name will be for ever associated. The Committee addresses its appeal not only to the inhabitants of Ulster, or of Dublin, but to Robinson's friends and admirers all over the United Kingdom. The services rendered to astronomy by Dr. Robinson are well known, and doubtless many of our readers will be glad to aid in paying a tribute to his memory. It is proposed that the memorial take the form of an equatoreal refractor, say of eight or nine inches aperture, which could be had for about 500*l*., and could find room in one of the existing domes at Armagh. With such an instrument, much valuable and interesting work could be done. Subscriptions should be sent to Dr. J. L. E. Dreyer, Observatory, Armagh.

We regret to announce the death, on November 24, of Mr. Andrew Pritchard, M.R.I., F.R.S. Edin., &c., of Highbury, London, whose name will be best remembered in connection with several improvements of the microscope, the use of "test objects," and as being the author of "A History of Infusoria," the fourth edition of which, enlarged to nearly 1000 pages, was published in 1861. Born in London in December, 1804, he was almost entirely brought up by his grandfather, one of the chief cashiers in the Bank of England. On the foundation of the Mechanics' Institution in Southampton Buildings, by Dr. Birkbeck, Mr. Pritchard entered as a student. The microscope was then a very imperfect instrument, and Mr. Pritchard worked hard at the achromatisation of lenses, and was the first to propose to take advantage of the high refracting power of the diamond, ruby, and sapphire for the manufacture of single lenses, these giving good definition without the coloured borders incidental to ordinary flint glass. Between the years 1829 and 1837 he published several works on the microscope, in which he was aided by Dr. Goring, particularly the "Microscopic Illustrations," "Micrographia," and the "Microscopic Cabinet," for which several good plates were prepared. In the year 1836 Mr. Pritchard was elected a Member of the Royal Institution, being proposed by Faraday, and in the previous year joined the British Association at Dublin, taking part in the deliberations of this body until comparatively recent times. In 1873 the Royal Society of Edinburgh conferred upon him their fellowship, in recognition of his scientific attainments, as evidenced by his great work, the "History of Infusoria," a memorial of patient industry and biological research.

The Lancashire friends of the late Prof. Jevons are to hold a meeting at the Manchester and Salford Bank on Thursday next, to consider a proposal for a Jevons memorial. It has been suggested that an appropriate form of the memorial would be the establishment of a Professorship of Political Economy at the Victoria University, Manchester. Prof. Jevons was a Lancashire man, and was associated for many years with the Owens College and with the Manchester Statistical Society.

Mr. Barnard, of Nashville, Tennessee, and Prof. Wilson, of the Cincinnati Observatory, both noticed that the nucleus of the comet had separated into three fragments on the morning of October 5. While this separation was not observed at other observatories, probably owing to cloudy weather, we learn by the last steamer from Central America, that on the same morning the comet, as visible to the naked eye, at Escuintla, Guatemala, was divided into five distinct bodies, thus leading many to suppose that a whole family of celestial visitants had suddenly appeared. Subsequent observations in different parts of the world have led to the belief that the fragments were re-united. This statement appears in the *Panama Star and Herald*.

The transit of Venus, on December 6, will be observed at Paris with the heliostat in several places, to exhibit the phenomenon to a large audience. M. Joubert, director of the Observatoire Populaire of the Trocadero, is taking steps for that purpose, and will send out special invitations. Lectures will be delivered during the transit. M. Janssen, before leaving for Oran, left instructions for similar observations to be exhibited before a number of visitors at Meudon Observatory. A requisition has been sent to M. Bouteiller, the president of the Municipal Council, asking him to order that the leading pupils of public schools and their principal teachers should be invited to Montsouris Observatory in order to witness the transit.

We are glad to learn that Prof. Mendeleeff has published a new edition (the fourth) of his "Principles of Chemistry." The new edition is thoroughly revised, and contains many important additions and modifications, bringing it up to the latest data of science. The high standard of this book is well known. The aims the author has pursued may be seen in the following words of his preface: "By comparing the past of the science with the future, the particulars with the generalisations, and our necessarily limited experience with our natural tendency towards the infinite, and by refraining from asking the student to accept without test any doctrine, however attractive, I tried to develop in the reader the faculty of independent judgment on scientific subjects which is necessary for a true use of science, and for acquiring the possibility of working for its further development." The work may be regarded as not merely a text-book of chemistry, but an exposition of the methods of natural science altogether.

Algeria is becoming increasingly popular as a winter resort for invalids affected with chest disease; but probably not many of our readers are aware that in the same easily accessible country gout and rheumatic patients may find what is scarcely to be met with in Europe, a comfortable residence with abundance of waters adapted to their special complaints. At Hammam R'Irha, about sixty miles south-west of Algiers and fifteen miles in a direct line from the coast, such patients will find waters both for bathing and drinking comparable with those of the best European resorts, and in addition a climate which renders outdoor exercise a pleasure all the winter through. Hammam R'Irha is beautifully situated among the hills of an outlying spur of the Lesser Atlas, and we understand has every possible convenience and comfort that invalids can require. Naturally enough the people of Algiers look with some jealousy on this pleasant spot as a rival, and attempt we believe to ignore it; but in the opinion of the highest authorities on the subject of climate and waters, no place can equal Hammam R'Irha as a winter resort for gout and rheumatic patients. As it becomes better known we are sure it will grow in favour, especially with English and Americans, who will find on the spot competent medical advice. The station is within three or four hours' rail of Algiers.

The remarkable phenomenon which was seen on Friday week in several parts of this country, was also seen in Sweden. At Eskibstuna, 54 miles south of Stockholm, it was observed three hours after sunset in the western heavens, it being dark at the time, about 45° above the horizon, and was then hidden in a lurid cloud of purple colour. When approaching the zenith an oblong object, somewhat resembling a bow, became distinctly visible, which gradually passed out of sight. The stars were visible through the object. The moon in her first quarter shone faintly in the south, 45° elevation above the horizon, while heavy clouds covered the eastern and northern skies. Auroræ were frequent and intense all over Scandinavia during the week.

Herr Bernhard Blechmann, a pupil of Prof. Stieda, of Dorpat, has been making researches on the anthropology of the Jews. He took 100 Jews of West Russia and the Baltic Provinces, and as a result of his observations, he finds that there are both blonde and dark Jews of the primitive type, that Jews have narrower chests than Europeans under similar conditions; that there are two types, Spanish and Germano-Polish; and that they appear to be brachycephalic.

The third German "Geographentag" will be held at Frankfort on March 29-31, 1883. As at former meetings, both the scientific and educational aspects of geography will receive attention, and intending contributors of papers should communicate with Prof. Rein, Marburg, before the end of January. There will, as usual, be an exhibition of teaching *matériel* in geography, which will be open for two or three weeks.

Immense forest fires are reported from the neighbourhood of St. Petersburg. Near Pawlowsk and the villages Skolpino, Stepanowka, and Podberesche near Gatchina, then along the

Warsow railway line between Pljusse and Pleskau, also along the Moscow Railway line the forest was on fire. Thousands of people had been ordered out to try and extinguish the flames, but all attempts in this direction proved futile, the only thing that could be done was to confine the limits of the fires.

DR. KING, the Superintendent of the Royal Botanic Gardens, Calcutta, has recently issued his report for the year 1881–82. The Calcutta Garden may be said to be the centre of botanical work in India, and none can probably claim a greater antiquity, as the report before us is stated to be the ninety-fifth annual report of these Gardens. Like its predecessors the report opens with a description of the changes and improvements in the Garden itself, points which are, of course, only of local interest. On the subject of india-rubber yielding plants—a subject of very great importance—Dr. King says: "Clara rubber (*Manihot Glaziovii*) continues to grow well here; our trees are beginning to seed, and from their produce I was able to distribute during the year a good many seedlings to tea-planters in Assam, Chittagong, and elsewhere. A species of *Landolphia*, which is one of the sources of the rubber collected in Eastern Africa, has (thanks to the exertions of Sir John Kirk, Her Majesty's Consul-General at Zanzibar) been introduced to the Garden. From the seeds sent by Sir John Kirk a number of young plants have been raised, and these at present look very healthy. The cultivation of the plant yielding Para rubber (*Hevea brasiliensis*) has been abandoned, as the Bengal climate proves quite unsuitable for it. Of *Castilloa*, another South American rubber-yielder, we have as yet only eight plants, but it is being propagated as fast as possible." Another important subject is that of the production of materials for paper-making, and of these plantain fibre seems to have occupied some attention. It seems that during the dry months, simple exposure of the sliced stems to the sun is a sufficient preparation for the paper-maker, provided the paper-mill be on the spot. What is still wanted is some cheap mode of removing the useless cellular tissue, so that the fibre may be shipped to England without the risk of fermentation during the voyage. The cultivation of the plantain for its fruit is so universal over the warmer and damper parts of India, and its growth is so rapid, that the conversion into a marketable commodity of the stems at present thrown away as useless would be an appreciable addition to the wealth of the country. The paper mulberry of China and Japan (*Broussonetia papyrifera*) is being tried in the Garden, as well as in the Cinchona plantations in Sikkim, as it is well known that the bark yields a splendid paper material. A plant which appears to be at present unknown, but which Dr. King thinks will prove a species of *Eriophorum*, is also favourably reported upon. Under the head of "Other Economic Plants," mahogany, the rain-tree, and the Divi Divi, are said to be in considerable demand. A large interchange of seeds and plants has been effected during the year, with other parts of India, as well as with England and the Colonies.

NO further news of the wreck alleged to have been seen near the Island of Waigatz has come to hand. Capt. Burmeister, of the *Louise*, who parted from the *Dijmphna* and the *Varna* in September last, is of opinion that the vessel seen is the *Varna* in her winter-quarters, simply with masts and yards lowered, which seem to be corroborated by the recent discovery, that the original message says *west* of Waigatz Island, where the wreck could not have drifted.

PARTS 11 to 16 of Dr. Chavanne's edition of Balbi's Geography (Vienna, Hartleben) have appeared; they are largely devoted to the Austro-Hungarian monarchy.

WE need scarcely mention that Oxford is the seat of the New Science Club, to the meeting at Trinity College in connection with which we referred last week.

IN the last sitting of the Syndicat d'Électricité M. Jablochkoff described a new element which he has invented, and which consists of sodium for the electro-positive plate, the negative being, as usual, carbon. M. Jablochkoff does not use any exciting liquid but merely sends into his elements by the instrumentality of an aspirator, a current of air saturated with moisture. He says that soda is dissolved and falls to the bottom of the box where his elements are kept so that it may be easily collected and sold at a high price, being pure except for a small quantity of carbonate and of nitrate. According to his statement the electromotive force of this element is about 4 volts.

THE additions to the Zoological Society's Gardens during the past week include a Green Monkey (*Cercopithecus callitrichus* ♀) from West Africa, presented by Mrs. Gretton; a Northern Lynx (*Felis lynx*) from the Carpathian Mountains, presented by the Count Constantin Branicki; an Isabelline Lynx (*Felis isabellina*) from Tibet, presented by Capt. Baldock; a Forster's Milvago (*Milvago australis*) from Falkland Islands, presented by Dr. A. M. McAldonie; an Annulated Snake (*Leptodira annulata*) from Honduras, presented by Mr. R. E. Seabrooke; a Short-tailed Wallaby (*Halmaturus brachyurus* ♀) from West Australia, three Blue-crowned Hanging Parrakeets (*Loriculus galgulus*) from Ceylon, deposited; a Moloch Monkey (*Callithrix moloch*) from Brazil, two Snowy Owls (*Nyctea nivea* ♂ ♀), European, a Shore Lark (*Eremophila alpestris*), British, purchased; a Great Bustard (*Otis tarda*), European, received in exchange.

ON THE TRANSITS OF VENUS.[1]

TRANSITS of Venus usually occur in pairs; the two transits of a pair being separated by only eight years, but between the nearest transits of consecutive pairs more than a century elapses. We are now on the eve of the second transit of a pair, after which there will be no other till the twenty-first century of our era has dawned upon the earth, and the June flowers are blooming in 2004. When the last transit season occurred the intellectual world was awakening from the slumber of ages, and that wonderous scientific activity which led to our present advanced knowledge was just beginning. What will be the state of science when the next transit season arrives God only knows. Not even our children's children will live to take part in the astronomy of that day. As for ourselves, we have to do with the present, and it seems a fitting occasion for noticing briefly the scientific history of past transits, and the plans for observing the one soon to happen.

When the Ptolemaic theory of the solar system was in vogue, astronomers correctly believed Venus and Mercury to be situated between the Earth and the Sun, but as these planets were supposed to shine by their own light, there was no reason to anticipate that they would be visible during a transit, if indeed a transit should occur. Yet, singularly enough, so far back as April, 807, Mercury is recorded to have been seen as a dark spot upon the face of the Sun. We now know that it is much too small to be visible to the naked eye in that position, and the object observed could have been nothing else than a large sun-spot. Upon the establishment of the Copernican theory it was immediately perceived that transits of the inferior planets across the face of the Sun must occur, and the recognition of the value of transits of Venus for determining the solar parallax was not long in following. The idea of utilizing such transits for this purpose seems to have been vaguely conceived by James Gregory, or perhaps even by Horrocks; but Halley was first to work it out completely, and to him is usually assigned the honour of the invention. His paper, published in 1716, was mainly instrumental in inducing the governments of Europe to undertake the observations of the transits of Venus of 1761 and 1769, from which our first accurate knowledge of the Sun's distance was obtained.

When Kepler had finished his Rudolphine tables they furnished the means of predicting the places of the planets with some approach to accuracy; and in 1627 he announced that

[1] An address delivered before Section A of the American Association for the Advancement of Science, on August 23, 1882, by Prof. Wm. Harkness, Chairman of the Section, and Vice President of the Association.

Mercury would cross the face of the Sun on November 7, 1631, and Venus on December 6 of the same year. The intense interest with which Gassendi prepared to observe these transits can be imagined when it is remembered that hitherto no such phenomena had ever greeted mortal eyes. He was destitute of what would now be regarded as the commonest instruments. The invention of telescopes was only twenty years old, and a reasonably good clock had never been constructed. His observatory was situated in Paris, and its appliances were of the most primitive kind. By admitting the solar rays into a darkened room through a small round hole, an image of the Sun nine or ten inches in diameter was obtained upon a white screen. For the measurement of position angles a carefully divided circle was traced upon this screen, and the whole was so arranged that the circle could be made to coincide accurately with the image of the Sun. To determine the times of ingress and egress, an assistant was stationed outside with a large quadrant, and he was instructed to observe the altitude of the sun whenever Gassendi stamped upon the floor. Modern astronomical predictions can be trusted within a minute or two, but so great did the uncertainty of Kepler's tables seem to Gassendi that he began to watch for the expected transit of Mercury two whole days before the time set for its occurrence. On the 5th of November it rained, and on the 6th clouds covered the sky almost all day. The morning of the 7th broke, and yet there was no respite from the gloomy pall. Gassendi continued his weary watch with sickening dread that the transit might already be over. A little before eight o'clock the sun began to struggle through the clouds, but mist prevented any satisfactory observation for nearly another hour. Towards nine the sun became distinctly visible, and turning to its image on the screen, the astronomer observed a small black spot upon it. It was not half as large as he expected, and he could not believe it was Mercury. He took it for a sun-spot, and carefully estimated its position at nine o'clock, so that he might use it as a point of reference for the planet, if indeed he should be fortunate enough to witness the transit. A little later he was surprised to see the spot had moved. Although the motion was too rapid for an ordinary sun-spot, the small size of the object seemed to forbid the idea that it was Mercury. Besides, the predicted time of the transit had not yet arrived. Gassendi was still uncertain respecting the true nature of the phenomenon when the sun again burst through the clouds and it was apparent that the spot was steadily moving from its original position. All doubt vanished, and recognizing that the transit, so patiently watched for, was actually in progress, he stamped upon the floor as a signal for his assistant to note the sun's altitude. That faithless man, whose name has been forgotten by history, had deserted his post, and Gassendi continued his observations alone. Fortunately the assistant returned soon enough to aid in determining the instant of egress, and thus an important addition was made to our knowledge of the motions of the innermost planet of the solar system.

After this success in observing Mercury, Gassendi hoped he might be equally fortunate in observing the transit of Venus on December 6, 1631. He knew that Kepler had assigned a time near sunset for first contact, but the tables were not sufficiently exact to forbid the possibility of the whole transit being visible at Paris. Alas, alas! these hopes were doomed to disappointment. A severe storm of wind and rain prevailed on December 4th and 5th, and although the sun was visible at intervals on the 6th and 7th, not a trace of the planet could be seen. We now know that the transit happened in the night between the 6th and 7th, and was wholly invisible at Paris.

Transits of Venus can occur only in June and December, and as the two transits of a pair always happen in the same month, if we start from a June transit the intervals between consecutive transits will be 8 years, 105½ years, 8 years, 121½ years, 8 years, 105½ years, and so on. This is the order which exists now, and will continue for many centuries to come, but it is not always so. The path of Venus across the sun is not the same in the two transits of a pair. For a pair of June transits, the path at the second one is sensibly parallel to, and about twenty minutes north of, that at the first; while for a pair of December transits the parallelism still holds, but the path at the second one is about twenty-five minutes south of that at the first. Hence it happens that whenever Venus passes within about four minutes of the sun's centre at a June transit, or within about eight minutes at a December transit, she will pass just outside the sun's disk at the other transit of the pair, and it will fail. Thus the intervals between consecutive transits may be modified in various ways. If the first transit of a June pair fails, they will become 129½ years, 105½ years, 8 years, 129½ years, etc. If the second transit of a June pair fails, they will become 113½ years, 8 years, 121½ years, 113½ years, etc. If the first transit of a December pair fails, they will become 8 years, 113½ years, 121½ years, 8 years, etc. If the the second transit of a December pair fails, they will become 8 years, 105½ years, 129½ years, 8 years, etc. And finally, if either the first or second transit of a pair fails both in June and December, they will become 113½ years, 129½ years, 113½ years, 129½ years, etc.

When Kepler predicted the transit of 1631, he found from his tables that at her inferior conjunction on December 4, 1639, Venus would pass just south of the sun, and therefore he believed the second transit of the pair would fail. On the other hand, the tables of the Belgian astronomer, Lansberg, indicated that the northern part of the sun's disk would be traversed by the planet. In the fall of 1639 this discrepancy was investigated by Jeremiah Horrocks, a young curate only twenty years old, living in the obscure village of Hoole, fifteen miles north of Liverpool, and he found, apparently from his own observations, that although Kepler's tables were far more accurate than Lansberg's, the path of the planet would really be a little north of that assigned by Kepler, and a transit over the southern portion of the sun would occur. He communicated this discovery to his friend William Crabtree, and these two ardent astronomers were the only ones who had the good fortune to witness this, the first recorded transit of Venus.

Horrocks had great confidence in his corrected ephemeris of Venus, and it forbade him to expect the ingress of the planet upon the sun before three o'clock in the afternoon of Sunday, November 24, old style (December 4, new style); but as other astronomers assigned a date some hours earlier, he took the precaution to begin his observations on the 23rd. The 24th seems to have been partially cloudy, but he watched carefully from sunrise to nine o'clock; from a little before ten until noon; and at one o'clock in the afternoon; having been called away in the interval by business of the highest importance—persumably the celebration of divine service. About fifteen minutes past three he was again at liberty, and as the clouds had dispersed, he returned to his telescope and was rejoiced to find Venus upon the sun's disk, second contact having just happened. Only thirty-five minutes remained before sunset, but during these precious moments he made determinations of the position of Venus which are even yet of the highest value. Crabtree was less fortunate. At his station, near Manchester, there was but a momentary break in the clouds a quarter of an hour before sunset. This sufficed to give him a glimpse of the transit, and he afterwards made a sketch from memory.

The years sped swiftly by, and as the transit of 1761 approached, Halley's paper of 1716 was not forgotten, although he himself had long been gathered to his fathers. In deciding to what extent his plans could be followed, it was first of all necessary to know how nearly the real conditions would approximate to those he had anticipated. Passing over a paper by Trébucket calling attention to errors in Halley's data, Delisle was first to point out the exact conditions of the transit, and the circumstances upon which the sucess of the observations would depend. In August, 1760, less than a year before the event, he published a chart showing that inaccurate tables of Venus had misled Halley, both as to the availability of his method, and in the selections of stations. The occasion could be more effectively utilized by a change of plan, and Delisle considered it best to observe at suitably selected localities from many of which only the ingress, or only the egress, would be visible. Ferguson, in England, seems to have arrived independently at similar conclusions.

The two methods proposed respectively by Halley and Delisle have played so important a part in the history of physical astronomy that it will not be amiss to state briefly the distinction between them. The sun causes Venus to cast a shadow which has the form of a gigantic cone, its apex resting upon the planet, and its diameter continually increasing as it recedes into space. All the phenomena of transits are produced by the passage of this shadow cone over the earth, and as each point of the cone corresponds to a particular phase of a transit, any given phase will encounter the earth, and first become visible, at some point where the sun is just setting; and will leave the earth, and therefore be last visible, at some point where the sun is just rising. Between these two points it will traverse nearly half the earth's circumference and in so doing will consume about twenty minutes.

The only phases dealt with by either Halley's or Delisle's method are the external and internal contacts, both at ingress and at egress. Delisle's method consists in observing the times of contact at stations grouped about the regions where either ingress or egress is soonest and latest visible. The longitudes of the stations must be well determined, and then by combining them with the observed times of contact the rate at which the shadow cone sweeps over the earth becomes known, and from it the solar parallax results. At many of the stations best suited for Delisle's method, only the beginning or only the ending of the transit will be visible; but for the application of Halley's method, both the beginning and the ending must be seen. The theory of the latter method is so complicated that it is difficult to explain it briefly and at the same time accurately; but the the following considerations will suffice to indicate its nature. The duration of a transit at any point on the earth's surface depends partly upon the length of path, and partly upon the velocity, of that point while within the shadow cone. The length of path is affected by the latitude of the point, and the velocity by the earth's diurnal motion, which in some regions accelerates, and in others retards, the progress of the shadow. The result is that throughout one-half the earth's surface the duration of the transit is lengthened, while throughout the other half it is shortened; the maximum lengthening and shortening occurring at the respective poles of the hemispheres in question. Although these poles are not situated at the extremities of the earth's axis, it usually happens that one of them is shrouded in night; but upon the sunlit side of the earth, from which alone observations can be made, localities may exist at some of which the duration of the transit will be twenty minutes or more greater than at others. This inequality is the condition upon which Halley's method depends, and when such localities are accessible it may be advantageously applied. Briefly then, Halley's method consists in observing the duration of a transit at two or more stations so selected as to give durations of widely different lengths; while Delisle's method consists in employing a common standard time to note the instant when the transit begins, or ends, at two or more stations so chosen as to give very different values for that instant.

The transit of 1761 was visible throughout Europe and was well observed by astronomers in all parts of that continent. Besides this, England sent expeditions to St. Helena and to the Cape of Good Hope; and English astronomers observed at Madras and Calcutta; French astronomers were sent to Tobolsk, Rodriguez, and Pondicherry; Russians to the confines of Tartary and China; and Swedes to Lapland. No less than 117 stations were occupied by 176 observers; and of these, 137 published their observations. When this mass of data was submitted to computation, the result was far from satisfactory. Values of the solar parallax were obtained ranging from 8.49 seconds to 10.10 seconds; and in their disappointment the astronomers of the eighteenth century concluded that too much reliance had been placed upon Delisle's method.

The transit of 1769 drew on apace; and, to avoid a repetition of the fancied mistake of 1761, attention was directed almost exclusively to Halley's method. The conditions of the transit were carefully discussed by Hornsby in England, and by Lalande and Pingré in France; and it was found that its duration would be greatest in Lapland and Kamschatka, and least in the Pacific Ocean, California and Mexico. Astronomers were dispatched to all these regions. England sent the famous Capt. Cook to Otaheite, France sent Chappe to California; the King of Denmark sent Father Hell to Lapland; and in addition numerous observations were made in Europe, North America, China, and the East Indies. The preparations were most elaborate, and the result better than in 1761, but still not satisfactory. The black drop and other distortions disturbed the contacts in this transit as they had done in the previous one, and the values of the parallax deduced by the best computers ranged from 8.43 seconds to 8.85 seconds.

Thus the matter rested till 1825 and 1827 when Encke published abstracts of his discussion of the transits of 1761 and 1769, from which he deduced a parallax of 8.58 seconds. This discussion was not printed in full till 1835, when it immediately commanded the attention of astronomers, and its result, which Encke had modified to 8.57 seconds, was universally accepted for more than a quarter of a century. As time wore on, certain gravitational investigations led to a strong suspicion that the sun's distance had been over-estimated by at least three million miles, and the observations of Mars at its opposition in 1862 converted this suspicion into a conviction. The eighteenth century transits were again rediscussed and a parallax of 8.83 seconds was found from them by Powalky in 1865, and 8.91 seconds by Mr. E. J. Stone in 1868. Newcomb's paper, in 1867, also produced a marked impression.

The transit of 1874 was then approaching, and in the discussion as to how it should be utilized Halley's and Delisle's methods once more played a prominent part. It was recognized that the uncertainty in the observed times of contact of the eighteenth century transits was largely due to the black drop, and the causes of that phenomenon were carefully considered. Among them, most astronomers believed that irradiation played an important, if not the principal, part; but at the same time there was a general feeling that the telescopes of a century ago were bad, and that the magnificent instruments of the present day would give better results. In view of all the circumstances it was determined that the contacts should be observed with equatorially-mounted achromatic telescopes of from 4 to 6 inches' aperture or with reflectors of not less than 7 inches' aperture, and that magnifying powers of from 150 to 200 diameters should be employed. The Germans and Russians adopted heliometers of about three inches' aperture for making exact determinations of the positions of Venus during transit, but other nations did not follow their example.

Photography, an agency undreamed of in the eighteenth century, was also available, and all saw the desirability of employing it; but there was much difference of opinion as to how should this be done. The European astronomers preferred instruments modelled upon the Kew photoheliograph, whose objective has 3.4 inches aperture and 50 inches focus, giving an image of the sun 0.482 of an inch in diameter, which is enlarged by a secondary magnifier to 3 93 inches. On the other hand, the American astronomers contended that photographs taken with such instruments would be affected by troublesome errors due to the secondary magnifier, that position angles could not be measured from them accurately enough to be of any use, and that it would be exceedingly difficult to determine the exact linear value of a second of arc. They advocated the use of horizontal photoheliographs, which are free from all these disadvantages; and the instruments which they adopted had apertures of 5 inches, and focal distances of 38½ feet, giving images of the sun slightly more than 4 inches in diameter. Notwithstanding this radical difference of opinion respecting the best form of photoheliograph, the astronomers of the old and new worlds were in perfect accord as to how the instruments should be employed. Between the first and second contacts, and again between the third and fourth contacts, photographs about five minutes square, showing the indentation cut by the planet into the sun's limb, were to be taken at intervals of a few seconds; and from these it was hoped the true times of contact could be deduced with great accuracy. Between the second and third contacts, pictures of the entire sun were to be taken at short intervals, and the positions of Venus relatively to the sun's centre were to be obtained from them by subsequent measurements. In the latter case, the photoheliograph took the place of a heliometer, and was superior to that instrument in its power of rapidly accumulating data.

The question of instrumental outfit having been disposed of, stations were selected, and parties dispatched to almost every available point. The United States, England, France, Germany, Russia, Holland,—in short, nearly all the nations of the civilized world,—took part in the operations. The weather was not altogether propitious on the day of the transit, but nevertheless a mass of data was accumulated which will require years for its thorough discussion. When the parties returned home the contact observations were first attacked, but it was soon found that they were little better than those of the eighteenth century. The black drop, and the atmospheres of Venus and the Earth, had again produced a series of complicated phenomena, extending over many seconds of time, from among which it was extremely difficult to pick out the true contact. It was uncertain whether or not different observers had really recorded the same phase, and in every case that question had to be decided before the observations could be used. Thus it came about that within certain rather wide limits the resulting parallax was unavoidably dependent upon the judgment of the computer, and to that extent was mere guesswork. Attention was next directed to the photographs, and soon it began to be whispered about that those taken by European astronomers were a failure. Even yet I am not aware

that the Germans have published anything official on the subject; but the English official report has appeared, and it frankly declares that "after laborious measures and calculations it was thought best to abstain from publishing the results of the photographic measures as comparable with those deduced from telescopic view." From the way in which these photographs were taken, Sir George Airy saw that they could not yield position angles of any value, and therefore differences of right ascension and declination could not be determined from them; but they did seem capable of giving the distance between the centres of Venus and the sun with considerable accuracy. Upon trial this proved not to be the case. No two persons could measure them alike, because "however well the sun's limb on the photograph appeared to the naked eye to be defined, yet on applying to it a microscope it became indistinct and untraceable, and when the sharp wire of the micrometer was placed on it, it entirely disappeared." In short, the British photographs are useless for the present, but Sir George Airy hopes that in the future some astronomer may be found who will be capable of dealing with them.

We turn now to the American photographs. They present a well defined image of the sun about 4.4 inches in diameter, and are intended to give both the position angle and distance of Venus from the sun's centre. A special engine was at hand for measuring them, but when they were placed under the microscope only an indistinct blur could be seen. Here again was the same difficulty which had baffled the English, but fortunately its cause was soon discovered. The magnifying power of the microscope was only 37½ diameters, which seemed moderate enough, but was it really so? The photographic image of the sun was about 4.4 inches in diameter, and this was magnified 3.31 times by the objective of the microscope, thus giving an image 14.56 inches in diameter. To yield an image of the same size, a telescopic objective would require a focus of about 1563 inches, and if the eye-piece of the microscope, which had an equivalent focus of 0.886 of an inch, were applied to it, a power of 1764 diameters would be produced. This then was the utterly preposterous power under which the image of the sun was seen when the photograph was viewed through the microscope, and no useful result could be expected from it. Means were immediately provided for reducing the power of the microscope to 5.41 diameters, and then the photograph seen through it appeared as the sun does when viewed through a telescope magnifying 255 diameters. After this change all difficulty vanished, and the photographs yielded excellent results. The measurements made upon them seem free from both constant and systematic errors, and the probable accidental error of a position of Venus depending upon two sets of readings made upon a single photograph is only 0.553 of a second of arc. To prevent misunderstanding it should be remarked that this statement applies only to pictures taken between second and third contact, and showing the entire sun. The small photographs taken between first and second contact and again between third and fourth contact, proved of no value.

These investigations consumed much time, and before the result from the American photographs was generally known, an international convention of astronomers was held in Paris to consider how the transit of 1882 should be observed. The United States was not represented at this conference, and guided only by their own experience, the European astronomers declared that photography was a failure and should not be tried again. They knew that the contact methods are attended by difficulties which have hitherto proved insurmountable, but under the merciless pressure of necessity, they decided to try them once more. Unfettered by the action of the Paris Conference, the United States Transit of Venus Commission took a very different view of the case. Its members knew that the probable error of a contact observation is 0.15 of a second of arc, that there may always be a doubt as to the phase observed, and that a passing cloud may cause the loss of the transit. They also knew that the photographic method cannot be defeated by passing clouds, is not liable to any uncertainty of interpretation, seems to be free from systematic errors, and is so accurate that the result from a single negative has a probable error of only 0.55 of a second of arc. If the sun is visible for so much as six minutes between the second and third contacts, by using dry plates thirty-six negatives can be taken, and they will give as accurate a result as the observation of both internal contacts. These were the reasons which led the American Commission to regard photography as the most hopeful means of observation, and thus it happens that the astronomers of the old and new worlds differ radically respecting the best means of utilizing one of the most important astronomical events of the century. The Europeans condemn photography, and trust only to contacts and heliometers; the Americans observe contacts because it costs nothing to do so, but look to photography for the most valuable results.

In 1716, Halley thought that by the application of his method to the transit of 1761, the solar parallax could certainly be a determined within the five hundredth part of its whole amount. Since then, three transits have come and gone, and the contact methods have failed to give half that accuracy. From the photographic method, as developed by the U. S. Transit of Venus Commission, we hope better things, and perhaps fifty years hence its results may be regarded as the most valuable of the present transit season. In 1874, as in 1761, exaggerated views prevailed respecting the value of transits of Venus, but no competent authority now supposes that the solar parallax can be settled by them alone. The masses of the Earth and Moon, the moon's parallactic inequality, the lunar equation of the earth, the constants of nutation and aberration, the velocity of light, and the light equation, must all be taken into account in determining the solar parallax, and it cannot be regarded as exactly known until the results obtained from trigonometrical, gravitational, and phototachymetrical methods are in perfect harmony. It may be be many years before this is attained, but meanwhile practical astronomy is not suffering. Its use of the solar parallax is mainly confined to the reduction of observations made at the surface of the earth to what they would have been if made at the Earth's centre; and for that, our present knowledge suffices. The real argument for expending so much money upon transits of Venus is that being an important factor in determining the solar parallax, their extreme rarity renders it unpardonable to neglect any opportunity of observing them. Let us do our whole duty in this matter that posterity may benefit by it, even as we have benefited by the labours of our predecessors.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

OXFORD.—The professoriate has been strengthened by the election of Dr. Burdon Sanderson to the new Chair of Physiology on the Waynflete foundation in connection with Magdalen College. The Biological side of the Museum will now be divided into two departments.

The Brakenbury Natural Science Scholarship at Balliol College has been awarded by the Examiners to Mr. Walker Overend, of the Yorkshire College of Science and St. Bartholomew's Hospital.

CAMBRIDGE.—Messrs. J. W. Hicks and F. Darwin are appointed members of the Botanic Garden Syndicate; Dr. Ferrers (Master of Caius), and Prof. Stuart, of the Museums and Lecture-Rooms Syndicate; Prof. Stuart is also specially reappointed to the Local Examinations and Lectures Syndicate; Dr. Ferrers and Mr. Routh are appointed on the Observatory Syndicate; Prof. Humphry and Mr. Vines, on the State Medicine Syndicate; Mr. Trotter, on the Special Board for Medicine; Mr. Besant, on the Special Board for Mathematics; Mr. Shaw, on the Special Board for Physics and Chemistry; Mr. Vines, on the Special Board for Biology and Geology.

Messrs. J. C. Saunders and J. W. Hicks are approved as Teachers of Botany and Chemistry respectively for the purpose of certificates for Medical Students.

The following colleges have offered open exhibitions or scholarships for natural science, with examinations in December or January next: Trinity, examination, December 12, one exhibition of 50*l.* for two years; candidates to be under nineteen on March 25 next. St. Johns, one exhibition, 50*l.*, for three years, examination December 12; Caius, Jan. 8; Christ's, Emmanuel, and Sidney, January 12, a joint examination; candidates for all these must be under nineteen years of age. Particulars may be obtained from the tutors of the respective colleges.

GLASGOW.—The following appointments to Scholarships, &c., have been made in accordance with the results of the Competitive Examinations:—George A. Clark Scholarship in Mental Philosophy (£200 for four years), John S. McKenzie, M.A.; William Ewing Fellowship in Mental Philosophy (£80 for three years), James A. McCallum, M.A.; Eglinton Fellowship in

Mathematics and Natural Philosophy (£100 for three years), John Weir; James Ferguson Bursary in Mathematics (£70 for two years), William Weir; Breadalbane Scholarship in Mathematics (£50 for three years), James Hamilton, M.A.; John Clark (Mileend) Scholarship in Natural Science (£50 for four years), William Huntly, M.A.; John Clark (Mileend) Scholarship in Classics (£50 for four years), James McMillan.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, November 16.—On *Megalania prisca*, part 4, by Prof. Owen, F.R.S.—The author, referring to a remark during a discussion following a previous communication (April, 1880), on the great horned Saurian of Australia, viz. that the skull then described might have belonged to a Chelonian, not to the genus and species founded on fossil vertebræ from localities remote from the formation yielding the cranial evidence, proceeded to describe his latest received fossils from the river-bed in Darling Downs, which included, besides evidences of the pelvis and limbs of *Megalania*, also dorsal vertebræ identical in size and character with those on which the former existence of such large Saurian had been predicted (1858). The contiguity of the last discovered vertebra, by Mr. G. F. Bennett, to the cranial and caudal fossils previously found and transmitted by him to the author, and the absence of any remains of a Chelonian reptile in the whole extent of the dried up bed of the river so perseveringly explored by that gentleman, would permit no doubt, the author believed, as to the conclusions which had been admitted in the previous volumes of the *Philosophical Transactions*.

Linnean Society, November 16.—F. Crisp, LL.B., Treasurer, in the chair.—Mr. O. T. Olsen and Surgeon J. N. Stone, R.N., were elected Fellows.—Dr. W. C. Ondaatje exhibited and made remarks on some Ceylon plants, among these, the fruit of *Randia dumetorum*, a remedy for dysentery; the leaves of *Sethia acuminata*, anthelmintic, and the resin of *Semecarpus gardneri*, from which a black varnish is prepared.—Mr. W. T. Thiselton Dyer called attention to a specimen of *Cycas beddomei*, a new species from Southern India.—Mr. F. P. Balkwill exhibited a series of British Foraminifera under the microscope, and said a few words on the special mode of mounting the same.—Mr. F. J. Hanbury showed a large fungus grown in a City wharf cellar, and which Mr. G. Murray pronounced to be a species of *Lentinus*.—Mr. C. Stewart exhibited a specimen of *Pilobolus*, explaining his observations on the projection of its sporangia.—Mr. J. G. Baker read a paper on the flora of Madagascar. It contains descriptions of 140 new species of polypetalous dicotyledons, obtained by the Rev. R. Baron and Dr. G. W. Parker. Some are of widely-diffused tropical genera, such as *Eugenia*, *Crotalaria*, &c.; others are of more familiar temperate types—*Alchemilla*, *Clematis*, and *Polygala*. Still others are characteristic of the Cape flora now noted for the first time from Madagascar, such as *Sphedamnocarpus* and *Sparmannia*. There is an interesting new genus of Malphigiaceæ (*Microsteira*) allied to the American *Hiræa*. Representatives of *Hibbertia* and *Rulingia* are interesting, from their being characteristically Australian genera. Mr. Baron has rediscovered *Rhodolæna alterola*, a showy plant, originally found by Du Petit Thouars a century ago. Dr. Parker has paid special attention to the drugs, esculents, and timber trees of the island, and catalogued 300 native names of the same.—A note by Mr. E. P. Ramsay, on the type specimen of Finsch's Fruit Pigeon was read.—Dr. Maxwell Masters read a communication on the Passifloræ collected in Ecuador and New Granada by M. Ed. André. Of *Tacsonia* 9 species are mentioned; of *Passiflora* 29 species, four being new. Some are of special interest structurally, the excellence of the specimens enabling ample examination of the curious flower structure to be made.—A paper was read on cerebral homologies, by Prof. Owen. He compares the brain of the locust and the cuttle-fish with that of the fish, and other higher forms, and summarises as follows:—That the homologies of the primary divisions of the brain in molluscs are the parts known in Articulates as the supra- and sub-œsophageal ganglions, with their commissural cords. That the topical relations of these parts to the gullet are the same in both great divisions of invertebrates; and that the homologies of the aforesaid parts with the primary divisions of the vertebrate brain are affected solely by the altered relation thereto of the gullet and mouth.—A paper was read on *Cassia lignea*, by W. T. Thiselton Dyer.—Thereafter, the sixteenth contribution to the molluscs of the *Challenger* Expedition by the Rev. R. Boog Watson, was read, in which were described the families Fissurellidæ and Cocculinidæ.

Chemical Society, November 16.—Prof. Dewar, vice-president, in the chair.—It was announced that a ballot for the election of Fellows would take place at the next meeting (December 7).—The following communications were made:—Contributions to the chemistry of tartaric and citric acids, by the late B. J. Grosjean. This paper has been compiled by Mr. Warington from the laboratory note-books left by the author. It contains investigations as to the loss of water by different specimens of citric acid, the determination of citric acid in lemon, bergamot, lime, and orange juices, the influence of heat on solutions of a totartaric acid, influence of sulphuric acid on the crystallisation of tartaric acid, action of solutions of potassium and sodium sulphates on calcium tartrate, determination of free sulphuric acid in tartaric acid liquors, determination of tartaric acid by precipitation as bitartrate, &c.—Contributions to the chemistry of bass fibres, by C. F. Cross and E. J. Bevan. The authors detail further experiments, showing that lignified fibres are to be regarded as a chemical whole rather than the mixture which was necessitated, viz. the incrustation theory.—On the oxidation of cellulose, by C. F. Cross and E. J. Bevan. By the action of boiling 60 per cent. nitric acid, cellulose is converted into an amorphous substance $C_{18}H_{26}O_{16}$, oxycellulose.—On the analysis of certain vegetable fibres, *Ananassa*, *Musa*, *Phormium*, *Linum*, *Urtica*, &c., by C. S. Webster.—On the constitution of some bromine derivatives of naphthalene (third notice), by R. Meldola. The author concludes that Glaser's α dibromnaphthalene and Meldola's metadibromnaphthalen are isomeric, and not identical. The author has also obtained by the diazo reaction β dibromnaphthalene, m.p. 81°, a new tribromnaphthalen, m.p. 113–114, a second melting at 63°, &c.—On the constitution of lophin (second notice), by F. R. Japp. The author brings forward fresh proofs that this body has the constitution of an anhydrobase, and not that ascribed to it by Radziszewski.

Geological Society, November 15.—Dr. J. Gwyn Jeffreys, F.R.S., vice-president, in the chair.—John Edmund Thomas and Joseph Williams were elected Fellows of the Society.—The following communications were read:—The drift-beds of the North-west of England and North Wales; part 2, their nature, stratigraphy, and distribution, by T. Mellard Reade, C.E., F.G.S. The author stated that the first part of this paper, read in 1873, treated of the low-level boulder clay and sands, specially in relation to the contained shells. Since that time he has been diligently collecting information to enable him to treat of the nature, origin, and stratigraphy of the drift lying between Liverpool and St. Bees and Liverpool and Carnarvonshire. The author's conclusions are that an ice-sheet, radiating from the mountain district of the English lakes and the south of Scotland, produced the planing and grooving of the rock and the red sand and rubble *débris*; then the ice melted back into local glaciers, and the submergence began. The low-level boulder-clay and sands were, during a slow submergence, laid down probably at depths of from 200 to 300 feet, and the author considers that all the phenomena can be satisfactorily accounted for by ordinary river-action and fraying of the coasts by the sea, combined with frost and ice due to a severer climate bringing down the materials of such river-basins to the sea, while icebergs and coast-ice sailed over, dropping on the sea-bottom their burdens of erratic stones and other materials from the mountain-districts of the north. He pointed out, also, that the great majority of the well-glaciated rocks were specially those that could be traced to the high lands. This fact was forced upon his notice after making a large collection of glaciated boulders and pebbles. Among the rocks he had been able to identify, with the help of Prof. Bonney and Mr. P. Dudgeon, of Dumfries, Scawfell granite (Eskdale, of Mackintosh) was the most abundant granite; then came grey granites from Dumfries, syenite from Buttermere, which occurred all over the area described, and up to 1200 feet on the Macclesfield Hills, and syenite from Cannockfell. Other probable identifications were also named. The whole series of rocks from the Silurian to the New Red Marl were represented in the low-level boulder-clay; a few flints also occurred, and one piece of what was believed to be chalk. The paper concluded with an appendix by Mr. David Robertson,

giving a list of the Foraminifera and other organisms found in the various beds of boulder-clay in the Atlantic Docks, Liverpool.—On the evidences of glacial action in South Brecknockshire and East Glamorganshire, by Mr. T. W. Edgeworth Davy. Communicated by Prof. J. Prestwich, F.R.S. The area which is included in this paper is about 200 square miles, extending north and south from the Brecknockshire Beacons to a line between Cowbridge and the mouth of the Rhymney, of which the Cly valley has been more particularly studied. Most of the rocks in this district, and particularly the Millstone Grit, retain traces of glacial markings. The whole area has a *moutonnée* aspect.

Anthropological Institute, November 14.—Mr. Hyde Clarke, vice-president, in the chair.—Mr. R. W. Felkin exhibited a Darfur boy who was rescued from slavery and brought to England by him in 1879.—Mr. Francis Galton exhibited a box about the size of a backgammon board, containing a geometric series of test weights for comparing the sensitivity of different persons. The test lay in ascertaining the smallest difference that could be perceived when handling them. The lowest weight was 1000 grains, which gives no uncertain sense of heaviness, and the highest weight was far short of what would fatigue the hand. Consequently, by Weber's law, the difference in the sense of heaviness produced by handling any two of the weights is the same, or nearly so, whenever those weights are separated by the same number of terms. For example, a person who could just and only just distinguish between the 4th and the 8th weight would do the same as regards the 2nd and the 6th, and the 6th and the 10th, the number of terms interval being 4 in each case. Again, as the only interpretation possible to the phrase that "the sensitivity of A is r times as great as that of B," is that A can perceive r grades of difference when B can only perceive one, it follows that the relative sensitivity of two persons is inversely proportionate to the number of terms between any pair of weights that they can respectively just discriminate. The unit of ratio was 2 per cent., but in the earlier terms there was a sequence of half units. The weights were made exactly alike in outward appearance; they were common gun-cartridges, stuffed equably with shot and wads and closed in the usual way. The term in the series to which each weight belonged was written on the wad that closed it. It was shown that the best economy of time was to present the weights in threes, to be sorted in their proper order. By making a proper selection, a wide range of testing power could be obtained by 30 cartridges ranged in 10 trays. The same principle admits of being extended to testing the delicacy of other senses, as taste and smell. Some provisional results were mentioned: (1) that intellectually able men had, on the whole, high powers of discrimination; (2) that men had more discriminating power than women; (3) that highly sensitive women did not seem able to discriminate more grades than others, though both sensation and pain were induced in them by lower stimuli; (4) that the blind, as a whole, were not peculiarly sensitive to this test, but rather the reverse. A discussion followed, in which Prof. Croom Robertson, Dr. Camps, Mr. Sully, D. Mortimer Granville, Dr. Mahomed, Mr. C. Roberts, Prof. Thane, and others took part.

Royal Horticultural Society, November 14.—Dr. M. T. Masters in the chair.—*Proliferous Flowers:* The Rev. G. Henslow exhibited a *Rhododendron balsamiflorum aureum*, with flowers arising from the centre of the pistil. The latter organ had dehisced longitudinally, and a cluster of malformed orange-coloured petals protruded from the orifice. He observed that every flower on one bush in his garden, of a common pink kind, had, during the last season, formed a blossom within the pistil, though in the latter case the flowers so formed had perfect as well as petaloid stamens. In every case the flower sprang from the axis at the base of the ovary. *Carnation:* a blossom with a secondary flower arising from within the calyx. *Blue-bell:* Each flower was borne on a pedicel of about two inches in length, and produced a secondary flower from the axil of a perianth leaf. In the place of one flower a complete raceme had grown.—*Solomon's Seal*: Leafy racemes occupied the positions of normal flowers.—*Monstrous Flowers:* He also showed the following:—*Pistillody of calyx in Violets*, in which the organs were in part or entirely virescent and malformed, having the sepals abortively ovuliferous, and the petals often laciniated. The sepals bore papiliform structures on the margins and midribs, resembling rudimentary ovules. The only recorded instance of ovuliferous sepals was that of the garden pea, figured and described in the *Gard. Chron.* 1866, p. 897. *Pistillody of stamens:* He showed drawings illustrating various stages of ovuliferous stamens of the Alpine poppy. *Syngenesism* in *Diplotaxis tenuifolia:* The anthers of every flower cohered laterally, so that the pollen could not escape; the consequence being that in no case did a flower set seed. *Placental protrusion* in *Begonia:* Portions of the placentas covered with ovules had protruded externally from the summit of the ovary, apparently being due to hypertrophy.—*Chrysanthemum:* Dr. Masters showed a blossom, half the florets being white, the other half yellow, a diameter separating the two kinds.

Cambridge

Philosophical Society, November 13.—On the structure of the spleen, by Mr. J. N. Langley.—On the continuity of the protoplasm in the motile organs of leaves.—Dr. W. H. Gaskell exhibited two pieces of muscular tissue from the ventricle of a tortoise, one of which had been taught to execute rhythmical contractions.

Paris

Academy of Sciences, November 20.—M. Jamin in the chair.—A letter was read from the Minister of Public Instruction, giving an *arrêté* which fixes the conditions of the next Volta prize, to be awarded in 1887 (see p. 89).—Results of experiments made at the Exhibition of Electricity on incandescent lamps, by MM. Allard and others. In general and for the spherical mean intensity of 1·20 Carcel, only about 12 to 13 Carcels per h.p. of arc, or 10 Carcels per h.p. of mechanical work, can be counted on, from incandescent lamps. Electric candles give 40 Carcels per h.p. of arc, regulators nearly 100, so that, generally, the economic values of the three systems are nearly as 1, 3, and 7.—Researches on the iodide of lead, by M. Berthelot.—On the decomposition of cyanogen, by the same.—Researches relative to the vision of colour, by M. Chevreul.—On the relation of lunar to solar action in the phenomena of the tides, by M. Hall.—Chemical studies on Silesian beet (continued), by M. Leplay.—Electro-chemical deposits of various colours, produced on precious metals, for jewellery, by M. Weil. He presented pieces of gold and silver jewellery, polychromised industrially with oxides of copper, by his processes. The colours resist friction, dry or moist air, air vitiated by sulphuretted hydrogen or coal gas, and light. M. Edm. Becquerel recalled the colorations obtained by his father with oxides of lead and iron.—On a *sulphocarbometer* for determining the quantities of sulphide of carbon contained in alkaline sulphocarbonates, by MM. Gélis. A glass flask filled with a solution of bisulphite of soda or potash, has on its neck a metallic sleeve with internal screw-thread; into this is screwed a corresponding metallic tube with stopcock under the terminal bulb of a graduated and closed glass tube holding the sulphocarbonate to be examined. On opening the cock, the liquids mix. The reaction is completed when the sulphocarbonate becomes quite colourless; then the height of the column of sulphide of carbon is noted, and the weight of the sulphide of carbon that was in the sulphocarbonate may be deduced.—Results of treatment adopted in Switzerland with a view to destruction of Phylloxera, by M. Mayet (see p. 89).—On two standards of the *aune* and the *pied de Roi* recently found by M. Wolf. He found them in the maritime arsenal of Cherbourg. They are at present the sole representatives of an attempt at unification of French measures long before the birth of the metric system, and the only models of ancient measures preserved in their integrity.—Observations of the planet (216) Cleopatra, and of the great comet of 1882, at Paris Observatory (equatorial of the western tower), by M. Bigourdan.—Observations of the same comet at Algiers Observatory, by M. Trépied.—On the same, by M. Jaubert. He notes (from the Popular Observatory) that the central part, or true tail, had a paler envelope, which nearly ceased to be visible as the comet rose above the horizon and the tail shortened—except a part nearest α Hydræ, which seemed brighter than at first.—On the solar energy, by M. Rey de Morande. The great uniformity of terrestrial vegetation till the Cenomanian epoch, and gradual differentiation since, according to latitude, the gradual invasion of southern regions by trees with caducous leaves, and disappearance of all vegetation in Polar regions, are phenomena explicable by gradual contraction of the sun, but inexplicable by gradual cooling of the earth.—On the works of Frederic Houtman, by

M. Veth.—On the functions of a single variable similar to the polynômes of Legendre, by M. Hugoniot.—On the motion of a system of two electrified particles of ponderable matter, and on the integration of a class of equations with partial derivatives, by M. Lévy.—Production by the dry way of some crystallised uranates, by M. Ditte.—On the second anhydride of mannite, by M. Fouconnier.—Action of tri-ethylamine on symmetrical trichlorhydrine, and on the two isomeric dichlorhydric glycides, by M. Reboul.—Note on the study of *longrain*, and the measures of schistosity in schistous rocks by means of their thermic properties, by M. Jannettaz. The large axis of the isothermal surface is parallel to the *longrain* or second cleavage, and the small axis is perpendicular to the first cleavage or plane of schistosity.—Lithine, strontian, and boric acid in the mineral waters of Contrexeville and of Schinzmark (Switzerland), by M. Dieulafait.—Experiments on the calcination of alunite in powder, for manufacture of alum and sulphate of alumina, by M. Guyot.—On the anastomoses of striated muscular fibres in invertebrates, by M. Jousset de Bellesme. They insure simultaneous contraction (*e.g.* in gastric glands).—On the functions of the digitiform or superanal gland of Plagiostomes, by M. Blanchard. It appears to be a true pancreas.—Evolution of the epithelium of poison glands in the toad, by M. Calmels.—On two tertiary *Plagiaulax*, obtained in the neighbourhood of Rheims, by M. Lemoine.—On the *Tingis* of the pear-tree, by M. Carlet.—Some letters on the recent aurora were communicated.

BERLIN

Physiological Society, November 10.—Prof. Du Bois-Reymond in the chair.—Dr. J. Geppert gave an account of some experiments which he and Dr. A. Fraenkel had made on the effect of rarefied air on the organism, in order to test the statements which Prof. Paul Bert had made on respiration in rarefied air, and the accompanying deficiency of oxygen in the blood. The animal experimented on—a dog—was unfettered in a box of sheet iron, with a glass window, in which it was possible to produce every desirable pressure with an air-pump, and the ventilation could easily be accomplished during the attained rarefaction. If the gas pressure in the box was sinking, by degrees, the animal did not show any change in its behaviour or its functions until the pressure was reduced to 38 cm. Then and at a further lessening of the pressure, the animal became restless, the respiration grew deeper and faster; again, at a further rarefaction of air, the movements became uncertain and giddy; at a pressure of 25 cm., one-third atmosphere, the animal fell asleep like a normal sleeping animal, and could remain so six or seven hours without any hindrance to his later complete restoration; occasionally awakened, the animal had severe paroxysms of dyspnœa, which, however, soon passed, and it fell again fast asleep. By further rarefaction, nearly to 15 cm., severe paroxysms of dyspnœa and convulsions very soon caused the death. Nearly the same appearance and the same succession of phenomena aëronauts have described during balloon ascensions: in the first stage a quite normal feeling, then accelerated and deeper respiration, faintness of the limbs, which increased to paralysis; during the increasing inability of moving the voluntary muscles, drowsiness begins, from which there was no awakening if the balloon still rises to more rarefied regions, as was the case with the unhappy aëronauts Crocé-Spinelli, and Sivel. These symptoms differ in no way from the phenomena described in these experiments, but the stages begin much sooner, and the 25 cm. pressure at which the dog only fell into a deep sleep is the extreme limit of available rarefaction for the aëronaut. The cause of this more early beginning of the stages of disease may be first the low temperature of the higher regions which Mr. Glaisher showed to sink till −20°, and otherwise the continuous muscular activity causing stronger effects of the lower degree of rarefaction. Quite another appearance is presented by the mountain disease which is characterised by nausea, choking, and vomiting, besides the strong respiratory movements and increased heart's action. Dr. Geppert supposes that neither the often but moderate degree of rarefaction (60 cm. pressure) nor the trifling want of oxygen is the *vera causa*, but, as Mr. Dufour has already asserted, the extreme weariness of the body. (In the discussion which followed Dr. Geppert's communication, Prof. Du Bois-Reymond observed that some years ago he had advanced and proved the theory that the mountain disease, especially the vomiting on ascending high mountains, was a reflex phenomenon due to the very strong dazzling of the eyes by the vast intensely white and brightly insolated snow-fields.) Again, Dr. Geppert has made many measurements on the absorption of the oxygen by the arterial blood at varying gas tensions. The manner of blood-letting, the measuring of its volume, and the gas analysis, were much exacter and less objectionable than in the corresponding experiments of Mr. Bert, particularly for the measuring of the blood volume, an ingenious apparatus was used. The results of these experiments were that the proportion of oxygen in the arterial blood remained normal with decreasing oxygen tension, till the gas pressure was sunk to 40 cm. At further sinking of gas-pressure the proportion of oxygen in the blood decreased, and the deficiency of oxygen grew very considerable. Finally Dr. Gepper concluded that in the action of rarefied air on the proportion of the oxygen in the blood the physical absorption plays not so much a part as rather the chemical affinity for hæmoglobin for the oxygen.—Prof. Munk then reported briefly on experiments executed by Mr. Orshansky in his laboratory on the influence of anemia on the electric excitability of the brain; the anemia was produced by pouring the blood out of the femoral artery, and the excitability was tested in that part of the brain-surface which is the centre of motion of the fore and hinder legs, partly with the constant, partly with the inductive stream. In the first stages of the bleeding there was no change of excitability, then it increased, till about one-seventh of the total blood volume was poured out, then any further loss of blood continuously decreased the excitability, till finally, when about two-thirds of the blood was gone it sunk to zero. In every stage of anemia the maximum of corresponding change of excitability never appeared immediately, but some time after bleeding. Through all the changing of stages of excitability, except when the irritability was sunk to zero, re-creation and return to the normal state took place after an interval. No certain relation between the blood-pressure after the bleeding, and the rate of irritability corresponding to that state of anemia could be established.

VIENNA

Imperial Academy of Sciences, November 2.—T. Horbaczewski, on the synthesis of uric acid.—V. Patelt, on the development of the mucous membrane of the large intestine.—A. Tarolimek, on the relation between tension and temperature of saturated vapours and saturated carbonic acid.—E. Weiss, computations of the positions of the cometary nebulæ discovered by T. J. Schmidt, of Athens, on October 9.—Hr. Weidel and K. Hazura, on cinchonine.—R. Wegacheider, on isovanilline.—T. v. Oppolzer, on the criterion relating to the existence of three solutions of the cometic problem.—T. Wiesner, studies on withering leaves and leaf-shoot, a contribution to the knowledge of the transplantation of plants.

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THURSDAY, DECEMBER 7, 1882

RECENT RESEARCHES IN THE METAMORPHISM OF ROCKS

IN the heart of many mountain-ranges, and likewise spreading over wide hilly areas of the northern part of our hemisphere, lies the strikingly distinct series of rocks to which the name of The Crystalline Schists has been given. The passing traveller who knows nothing of geology cannot fail to be struck with their strange, crumpled and gnarled beds, through which streaks of white quartz wind and twist in a network of interlacing veins. Sheets of the naked rock often present a silvery sheen as sunlight falls across them, and this glistening aspect may be traced down in the minutest flakes of silvery mica that lie packed in parallel leaves throughout the mass.

No group of rocks has given rise to more discussion than the Schists. An account of the oscillations of opinion regarding their origin would form a curious and interesting chapter in the history of geological speculation. They have been looked upon as parts of the aboriginal crust of the planet—traces of the first solid film that formed upon its fiery surface. By one school of writers they are believed to be original chemical precipitates from the waters of the primeval ocean. By another they are treated as masses of sedimentary or other material which have been crystallised and altered into their present condition by a process to which the name Metamorphism has been given. Between these two doctrines, with their various modifications, the pendulum of geological opinion has vibrated for somewhere about a century, and vibrates still. In England and America indeed, owing mainly to the commanding influence of Lyell, the metamorphic theory has so entirely prevailed that most English-speaking geologists have come to accept it as a demonstrated truth, and to look back upon the Wernerian doctrine of chemical precipitates as a singular and happily obsolete vagary of the geological imagination. They have written text-books in which that doctrine is not even so much as honoured with an allusion to its ever having existed, though here and there a solitary protest has now and then been raised among us in favour of the other view, like that uttered by De la Beche as far back as 1834, and those of Dr. Sterry Hunt in later years. In Germany, on the other hand, the old Wernerian dogma has always had its staunch adherents, but in gradually diminishing numbers, the theory of the metamorphic origin of the crystalline schists having been warmly espoused there also by an ever-increasing body of observers.

For some years past what has been called the orthodox metamorphic doctrine has been called in question by various writers who have cast doubts on the observations which were believed to prove the fact that wide areas of rock, originally of fragmentary or detrital composition, had undergone a conversion into crystalline schists. The time-honoured doctrine of chemical precipitates, tricked out in the finery of modern chemical analysis, has been resuscitated and defended with the warmth of the most devoted partisanship. Within the present year, however, several memoirs have appeared which powerfully support the doctrine of metamorphism, and as effectively oppose the rival hypothesis. The aid of the microscope, as well as of chemical analysis, has been invoked: new facts and arguments have been adduced, and the nature of the changes involved in metamorphism have been more clearly made known. Whether or not there may be any crystalline schists in the earliest or Archæan rocks of the earth's crust, which had their origin in the chemical precipitates of a primeval ocean, may remain a question for future discussion. But recent researches with all the manifold appliances of modern petrography demonstrate beyond the possibility of all further cavil, that ancient sedimentary strata have undergone such an alteration as to have assumed a more or less completely crystalline condition, that numerous silicates have been developed in them, often also with foliation, that these changes are seen round bosses of granite and other eruptive masses (contact metamorphism), but also far more strikingly over wide regions where eruptive rocks cannot have induced them (regional metamorphism), and that in the latter case the alteration is always connected with evidence of enormous mechanical pressure of the strata. To one or two of the more important recent papers, brief reference may here be made.

The Silurian schists, with their fossils and remarkably compressed conglomerates in the Bergen district, have been made the subject of a remarkable memoir by Mr. Hans Reusch.[1] In this essay the author traces the passage from ordinary shales into fine phyllite-schists and mica-schists, in which crystalline aggregates of mica have been porphyritically developed. In some of the altered fossiliferous beds microscopic crystals of rutile and tourmaline have appeared. The fossiliferous limestones have been converted into marble, wherein, however, the organic forms can still be detected. The fossils which occur in certain mica-schists, and have been specifically determined, leave no doubt that the whole series of rocks belongs to the lower part of the upper Silurian system. Yet they include intercalated bands of gneiss, hornblende-schist, talc-schist, and other foliated rocks. The author connects the crystalline condition of these masses with the effects of the enormous mechanical pressure which they have undergone, as shown, for example, by the extreme flattening of the pebbles in some of the associated conglomerates.

The Silurian rocks of the Christiania district have long been famous for the illustrations they afford of the phenomena of contact-metamorphism. They have been subjected to a detailed investigation by Mr. W. C. Brögger, lately of the Geological Survey of Norway, and now Professor of Geology in the University of Stockholm. He has lately published what we hope is only an earnest of the valuable work we have yet to expect from him.[2] His monograph embraces the stratigraphy, palæontology, structure, eruptive rocks, and contact-metamorphism of the district. This last-named feature is more minutely traced out than has yet been attempted for that region, though only a beginning in the study has been made, Mr. Brögger deeming it

[1] "Silurfossiler og Pressede Konglomerater i Bergensskifrene." (Christiania: *Universitets programm*, 1882). This memoir was recently noticed in these columns (NATURE, vol. xxvi. p. 567).

[2] "Die Silurischen Etagen 2 and 3 im Kristianiagebiet und auf Eker." (Christiania: *Universitätsprogramm*, 1882).

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better to publish his first results now than to wait for leisure to extend and complete them. He points out, as had already been done by Kjerulf and others, that while there is a general alteration as the rocks approach the eruptive masses of granite and syenite, the special type of alteration depends in each case upon the original capacity of the rock for metamorphism. He has traced the Silurian zones from their ordinary unaltered condition until they assume their most metamorphosed character against the granite, and he compares the chemical composition and microscopic structure of the unaltered and altered strata. He points out that certain bands of rock appear to be endowed with a remarkable capacity for withstanding the effects of metamorphism. Thus the *Dictyograptus*-shales may be observed close to the granite and in the midst of the most intensely-metamorphosed beds, yet comparatively little changed. They become paler in colour and perhaps somewhat harder and more compact, but their graptolites are as well preserved, down even to the minutest details, as they are at a distance from the contact-zone. The dark alum-shales are converted into hard compact bluish "Knotenschiefer" and chiastolite-slates, still retaining their fossils. The chiastolite crystals may even be seen traversing the graptolite-stems, which are otherwise as well preserved in these as in the ordinary unaltered shales. The remarkable development of silicates in the Christiania limestones, where these rocks have been converted into marble near the granite, has long been a classical instance of contact-metamorphism. Mr. Brögger gives some interesting observations of his own among these rocks. He notes the occurrence of recognisable fossils even in those parts of the marble where the silicates have been abundantly developed, and he points to the suggestive fact that where a fourth or fifth part of the marble is made up of red garnet, the latter mineral, in well crystallised rhombic dodecahedra, may be found inclosing the valve of an *Orthis calligramma*.

The alternation of comparatively little-changed graptolite shales with fine crystalline schists and forms of hornfels, which Prof. Brögger reports from so many localities, is a fact of great significance in relation to the problem of the origin of the crystalline schists. That the crystalline character has been superinduced upon what were once ordinary marine mechanical sediments admits now of no doubt. The extent of the change appears on the whole to depend on the one hand upon the liability of the rock to metamorphism, and on the other upon relative proximity to the eruptive rock. The preservation of organic remains in the altered bands is exceptional, and depends, according to our author, 1st, upon the greater permanence of the substance of the organisms, the chitin of the graptolites, for example, being apparently undistinguishable in the altered beds from the same substance in the ordinary shales; 2nd, upon the replacement of the hard parts of the organisms by mineral matter, either before or during the process of metamorphism; and 3rd, upon the filling up of the original cavities of the fossils by some mineral, as graptolites by pyrites, and the interior of brachiopods by wollastonite, or upon the inclosing of the organisms in a crystalline matrix as in the case of the impressions of shells in garnet, just referred to. But, as a rule, fossils disappear even from the most richly fossiliferous bands as these are traced across the altered zone. Mr. Brögger modestly regards his observations as still too limited to warrant him in theorising on the phenomena of contact metamorphism. But the admirable methods he has followed, connecting in one broad microscopical and chemical research both the altered and unaltered condition of the same rock, mark a new starting-point for the further study of that great geological problem—metamorphism.

There is one further incidental but pregnant statement in this Memoir to which reference must here be made. So far back as the years 1875 and 1877 Prof. Brögger, in the course of his field-work in the Geological Survey of Norway, established the existence of graptolite-bearing beds among the crystalline schists of the Hardanger region. He now publishes some details of the section there visible, from which we learn that the graptolite band (*Dictyograptus*-schiefer) occurs among some black little altered alum-slates lying at the very base of the enormous series of crystalline schists forming the Norwegian highlands! The alum slates pass under some bluish quartzose sandstone, overlaid by a white impure marble (possibly the Orthoceratite limestone), which in turn is covered by greenish micaceous clay-slates (phyllites). Above these basement strata come more and more crystalline schists, comprising diorite-schists, hornblende-schists, garnetiferous mica-schists, foliated rocks of many varieties, and true gneisses—the two last mentioned rocks sometimes several thousand feet thick. We learn further that in 1877 the same observer, in harmony with Naumann's observations, established the fact that the enormous series of crystalline schists of the Norwegian mountains is younger than the second stage of the Silurian (or Cambrian) rocks of the Christiania district. He refers to his friend Mr. Reusch's discovery of Upper Silurian fossils from the crystalline schists of Bergen, as a confirmation of his former supposition that the whole of the vast succession of crystalline schists in the Norwegian mountains is a metamorphic series.

When we remember that on the opposite side of the peninsula similar primordial fossiliferous strata emerge from underneath the vast overlying schists and crystalline rocks of the Swedish uplands,[1] it is evident that an enormous area of regional metamorphism extends across Scandinavia. The close parallel between the structure of this region and that of the Scottish Highlands is one of the most striking facts in the geology of North-Western Europe. In both areas recognisable Silurian fossils occur at the very base of the vast metamorphic series, and the rocks become progressively more and more crystalline as they are traced from bottom to top.

A third remarkable paper by Père Renard, of the Royal Museum, Brussels, must be cordially welcomed as one of the most important contributions of modern petrography to the study of metamorphism.[2] It deals with a portion of the singular belt of crystalline schists which runs through the French and Belgian Ardennes. Dumont as far back as the year 1848, published an account of these rocks, the significance of which that accurate observer fully perceived. He showed that they occur in his

[1] See A. E. Törnebohm, Bihang till Svensk. Akad. Handl., 1873.

[2] "Les Roches Grenatifères et Amphiboliques de la region de Bastogne," par A. Renard. *Bulletin du Musée Royal d'Histoire Naturel de Belgique*, tome i. 1882.

Coblentzian division of the Lower Devonian rocks of that region, that they pass insensibly into ordinary sedimentary rocks, but towards their axis have been metamorphosed into more or less crystalline compounds in which various silicates (garnet, hornblende, mica, &c.) have been developed. He observed fossil plants and animals in some parts of these altered rocks. In one of his specimens of rock full of garnet, Sandberger determined the presence of the characteristic Devonian shells, *Spirifer macropteris* and *Chonetes sarcinulatus*. Nothing can be more emphatic than the testimony borne by Dumont to the age of these rocks and the fact of their metamorphism. His essay upon them is hardly known to geologists generally, but it deserves to rank as one of the most precise and detailed contributions ever made by a field-geologist to the study of the phenomena of metamorphism.[1] His observations have been singularly confirmed by those of M. Renard. The metamorphic phenomena of the Ardennes are repeated on a greater scale in the extension of the Devonian rocks eastward into the basin of the Rhine, where they have been admirably described by Lossen,[2] whose pregnant memoirs on this and other geological problems deserve the closest study of the student.

Bringing all the assistance which chemical analysis and microscopical investigation now supply to the study of the origin of rocks, M. Renard, in the present communication, which fitly opens the first number of the newly-organised *Bulletin du Musée Royal de Belgique*, presents us with a detailed description of the garnetiferous and hornblendic rocks of Bastogne in the south-eastern portion of the Belgian Ardennes. It is impossible to give any adequate *résumé* of this memoir within the space here available. But attention may be directed to one or two of its more interesting features.

At the outset it should be noted that the band of metamorphosed strata here referred to occurs along a line of plication running in a general east-north-east and west-south-west direction; that it is not associated with any visible eruptive rocks, that it dies away into ordinary unaltered greywacke and shale on the outside, and becomes more and more crystalline towards the axis, until it presents the most intense metamorphism anywhere to be found in Belgium.

In subjecting to microscopic examination thin slices of some of these altered rocks, M. Renard noticed that the quartz-granules, presumably of clastic origin, have lost the liquid inclusions so generally found in the quartz-granules of old sedimentary strata. This fact (already observed by Sorby in the case of sandstone invaded by dolerite) seems to indicate that the sand-grains have not escaped the influence of the changes which have so profoundly affected the other constituents of the former sediment. The original carbonaceous matter of the rocks, now altered into graphite, is spread as a fine dust among the other constituents, generally coating the minerals, sometimes inclosed within them, frequently accumulated at certain points into black, brilliant irregular bands, occasionally as hexagonal flakes. This aggregation of the carbon recalls the way in which the graphite occurs in Archæan limestones. The garnet crystals are marked by a singularly interesting arrangement of lines of crystalline inclusions disposed along the crystallographic axes of the inclosing crystals. In certain rocks the garnets (about three millimetres in diameter) are traversed by a series of paralleled joints or fissures which run in a given direction through all the crystals. These cannot, of course, be cleavage lines. They are attributed by M. Renard to fracture produced by mechanical pressure, and he remarks that the minute flakes interspersed through the ground-mass of the rock are oriented in the same direction.

Taking a general view of the microscopic structure of these rocks the author divides the constituent minerals into two groups: those which represent more or less distinctly the original sediment of which the rocks were formed, and those which have been subsequently developed by metamorphism. The quartz grains, for example, have preserved the closest resemblance to those of the ordinary normal arenaceous rocks of the lower Devonian series. The presence of graphite and anthracite likewise connects these crystalline masses with the sandy strata containing diffused carbonised vegetable matter. But on the other hand the crystalline structure and the presence of such minerals as garnet, hornblende, mica, titanite, and others connects these undoubtedly Devonian rocks with the crystalline schists of the Archæan series, as possibly both referable to the like series of physical and chemical changes.

M. Renard unhesitatingly discards the doctrine of direct chemical precipitation. He admits that the evidence of the physical structure of the country, as Dumont so well enforced, demonstrates that these crystalline rocks lie in the Devonian system and pass laterally into ordinary sedimentary accumulations. He further insists that the study of the minute structure of the rocks under the microscope confirms, in the most satisfactory manner, the view of that geologist that the actual condition of the masses has been produced by metamorphic action, in what way soever this action may have been induced. He connects the metamorphism with the proofs of great plication traceable through the altered Devonian rocks of the Ardennes. The mechanical action involved in the process would, he believes, predispose the sedimentary materials to a more or less complete recrystallisation. As it crushed them under the enormous pressure and partly was itself transformed into heat, it would set into active motion the chemical affinities of the various mineral substances. In this way sand might finally pass into quartzite, argillaceous mud into phyllade or phyllite-schist, sandy clay into more or less schistose micaceous quartzites; the calcareous matter would enter into combination to form the various lime-silicates so characteristic of these garnetiferous and hornblendic rocks; while the carbonaceous ingredient, losing some of its constituent elements, would separate out as graphite.

M. Renard's testimony to the theory of metamorphism is all the more valuable, as it has been extorted from him by the irresistible logic of facts against his own previous convictions. He has now furnished to this theory fresh evidence in its support, showing how well the observations by which it is established in the field are sustained by minute petrographical analysis. Every one interested in geological research will hope that the paper he has

[1] "Memoire sur les terrains Ardennais et Rhénan." *Mem. Acad. Roy. de Belgique*, 1848.

[2] "Geognostische Beschreibung des Taunus," &c. *Zeitschrift der Deutsch. Geo. Gesell.*, 1867, p. 509.

now published is only the first of a series on the same subject with which he will enrich the literature of the science.

ARCH. GEIKIE

HUMAN MORPHOLOGY

Human Morphology; a Treatise on Practical and Applied Anatomy. By Henry Albert Reeves. Vol. I. The Limbs and Perinæum. (London: Smith, Elder, and Co., 1882.)

THE author of this work is evidently very ambitious. In his preface he tells us that his primary wish was to produce a treatise in which he would deal thoroughly with the anatomy of man, and then compare his structure with that of other vertebrates, giving directions as to the dissection of the type-forms chosen in illustration. Further, being dissatisfied with anatomical nomenclature and classification generally, more especially with the terms at present in use in myology, he attempted a revision in this department.

As he proceeded with his task, however, he found that the labour, time, and knowledge necessary for carrying out so extensive a piece of work was too great, and that he had better relinquish his original idea and leave it for execution to more competent labourers.

But even after departing so far, and wisely as we think, from his first conception of what a student's text-book should be, he has found it necessary still further to withdraw from his original plan, and to excise much that he had written on anomalies of arrangement, various paragraphs on dissections which are out of the student's usual course to perform, and to reduce in quantity the sections on the practical applications of anatomy.

Had the author carried out his original idea of what a handbook for students and practitioners should be, he would have produced an encyclopædia of anatomy, and not a text-book for daily use.

But after all this renunciation of so much of the author's primary conception of what is required in a practical work on anatomy, sufficient is left to form a most voluminous treatise.

The volume before us extends to 719 large octavo pages. It comprises only the anatomy of the limbs and perinæum, and we are promised two additional volumes, each of between six and seven hundred pages, in order to complete the work.

It seems to us that the author even yet has not attained a proper idea of what the contents of a book should be, which, to use his own words, "is to be chiefly used *while the student is dissecting*." He has not sufficiently discriminated between the material that should find a place in a text-book of systematic anatomy and that which properly belongs to a practical treatise. We are quite in unison with him in the propriety of omitting all illustrations and detailed description of minute or microscopic anatomy. But we should have gone still further and cut out the historical sketch, the bibliography, the chapter on anatomical technics, which together would have subtracted between 60 and 70 pages from the volume. Also we should have condensed the descriptions and reduced in amount the sections on variations in the arrangements of the bones, muscles, and other soft parts.

A sketch of the rise and progress of anatomy, and a copious bibliography are not required by the student at the dissecting table. On the other hand they are both interesting and useful in a systematic treatise. The variations in arrangement, more especially in the muscular and vascular systems, which have been observed and recorded, are so multitudinous, that they would require a special treatise for their description. What the student has to deal with in his ordinary work, are the commoner departures from the usually described arrangements, such as a third head to the biceps muscle, the high division of the brachial artery, the variations in the place of origin of the obturator, the profunda, the circumflex arteries, and so on. These and such like ought to find a place in all works on practical anatomy, but the more unusual forms are best reserved for such special treatises as Macalister's Catalogue of Muscular Anomalies, or Quain's description of the Arterial System, to which the student, who is desirous of obtaining a more intimate acquaintance with variations in structure, ought to be referred.

A knowledge of anatomical technics also is undoubtedly of primary importance to professed anatomists. But is one student in five hundred ever called upon to inject a body, either with a preservative fluid, or with a coloured arterial or venous injection? This work is done for him either by the demonstrator, or by the practical assistant in charge of the rooms. To introduce therefore into a work intended for medical students generally an account of methods, which they are never required to carry out, seems to us to be uncalled for.

The author directs especial attention to the number and quality of the illustrations. As regards their quality, with a few exceptions they are artistically rendered. But we think they are far too numerous, and by their number, and the size of many of the cuts, they have largely contributed to the unwieldy bulk of this treatise. Too many illustrations in a book to be used at the dissecting table are apt to draw the student's attention away from his part, and to make him rely upon the pictorial representation rather than on his own efforts to display the organ or region in the subject itself.

In our judgment a handbook of practical anatomy ought to be of such a size, that the student can without inconvenience carry it to and from his work. The instructions for the order of the dissections should be clear and concise. The descriptions of the parts should not be too elaborate. The illustrations should be well selected, with a view to guide the student in the method of his work, and to show him what he has to look for, and where it has to be seen. This treatise fails to comply in many respects with these conditions, and much as we may commend the author for his industry and good intentions, we are afraid that he has produced a work which will have only a restricted field of usefulness.

OUR BOOK SHELF

Common British Insects. Selected from the Typical Beetles, Moths, and Butterflies of Great Britain. By the Rev. J. G. Wood, M.A., &c. Pp. i.-284. 8vo. (London: Longmans, Green, and Co., 1882.)

AFTER glancing through this book the question uppermost in our mind is: Why does it exist? The highly-ornamented cover, and the repeated title thereon, lead one

to expect a popular treatise on all orders of insects, an idea at once dissipated by the title-page. There are other books covering the same ground that would answer the young student's purpose as well as this. Judging it in comparison with the multitudinous other compilations from the same pen, we have no very particular fault to find. It is sketchy, but in some respects it compares favourably, especially in some of the explanations concerning the *Coleoptera*. Some of the illustrations are good, others wretchedly bad, and unrecognisable without the explanations. When comparing the "nervures" in the wings of a butterfly with the "rays" in the fins of a fish (p. 178), the writer should have explained the minute structure of both.

The real point at issue in connection with books of this nature is their effect. They are eminently rudimentary, and not elevating. Let us take instances from the book now under review. At p. 14, after an explanation of the terminology of the external skeleton of a beetle, we read:—"At first some of these terms may appear to be harsh, repulsive, and difficult to master. In reality they are not so, and a knowledge of them is absolutely necessary to any one who wishes to understand the description of an insect." This is a very sensible remark. Yet throughout the book the utmost favour is bestowed upon absurd meaningless "English" names. The culminating point of absurdity is reached at p. 276. Amongst the small moths the author "figures" one (under a misspelt generic name), and because it (out of several hundred other fortunate little moths) has received no "popular" name, he terms it the "*Brown Dolly*"!

Anthropo-Geographie oder Grundzüge der Anwendung der Erdkunde auf die Geschichte. Von Dr. Friedrich Ratzel. (Stuttgart: Englehorn, 1882.)

We have had occasion to speak of the wide extension which geographical science has taken in Germany, and of the broad and intricate field which it covers. The work before us is a good example of this. It is the first of a series of geographical handbooks, which is to include "General Geology," by Prof. von Fritsch; "Oceanography," by Dr. von Boguslawski; "Geographical Distribution of Animals," by Prof. L. von Graff; "Climatology," by Dr. Hann; "Glaciers," by Prof. Heim; "Volcanoes and Earthquakes," by Prof. von Fritsch; and "Botanical Geography," by Dr. Oskar Drude. Dr. Ratzel's volume must not be mistaken for a treatise on Anthropology. That subject it only incidentally includes, its main purpose being to point out in detail the light which geography sheds upon history and the development of social and political economy. The author discusses the various conceptions of geography, its place among the sciences, the human element in geography, and the relations between geography and history. After a brief introduction on these points, the author proceeds to consider, in the second part, natural conditions, and their influence on mankind. Under the head of position and aspect of the dwelling-places of man, pointing out the parts which continents, islands, and peninsulas have played in the distribution of the human species and in history, he devotes a chapter to states and the various conditions which determine their boundaries, and in another discusses the distribution of centres of population. In a chapter on conditions of space he discusses the subject of great and small states, and the connection between the extent and power of states, and has some specially interesting remarks on what he calls the continental type of history. In a section on surface-forms, the author treats of such subjects as the inequalities of the earth's surface and of the contrast, ethnologically and historically, between mountainous and flat countries—of plains, steppes, and deserts. To the important subject of coast-lines, and the dependence of a country's development on their form, a chapter is devoted, and two to the historical importance of water, in its various forms of sea, lakes, rivers, and marshes. Considerable space is, of course, given to climate and to the animal and plant world. One of the most interesting chapters is that on "Natur und Geist," in which Dr. Ratzel attempts to show the great influence of a people's surroundings on their mental and moral development. In two concluding chapters the author gathers up the lines of discussion, referring especially to the subject of human migration, its influence on history, and its effect on the mixture of races; and finally points out the practical bearings of his subject. Thus it will be seen that, whether the subject comes legitimately under the conception of geography or not, Dr. Ratzel has written a work of great interest and of much utility to the historian who wishes to treat history in a scientific spirit. It is both instructive and attractive reading.

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 ensure the appearance even of communications containing interesting and novel facts.*]

Mimicry in Moths

I observed here, a few days ago, a case of mimicry which interested me much, and may deserve mention. The weather has been such as is usual on this part of the Riviera at this season. There has been a very hot sun, with sometimes a very cold "mistral" wind. Insect life is abundant, and not a few of our summer *Sylviadæ* seem to secure a very good living. Flies are a plague. Mosquitos are not wanting. Bees are busy, and large dragonflies hunt continually. But there is one order of insects "conspicuous by its absence," and that is the *Lepidoptera*. Neither the diurnal nor the nocturnal species have been visible.

I was much surprised, therefore, one day last week to see a large insect of this order come from above the olive trees overhead, with the wild dashing flight of the larger moths. Attracted apparently by the sheltered and sunny recess in which I was sitting and by the scarlet geraniums and bignonias which were in full flower in it, the moth darted downwards, and after a little hovering, settled suddenly on the bare ground underneath a geranium plant. I then saw that it was a very handsome species, with an elaborate pattern of light and dark chocolate browns. But the margins of the wings, which were deeply waved or dentated, had a lustrous yellow colour, like a brilliant gleam of light. In this position the moth was a conspicuous object. After resting for a few seconds apparently enjoying the sun, it seemed to notice some movement which gave it alarm. It then turned slightly round, gave a violent jerk to its wings, and instantly became invisible. If it had subsided into a hole in the ground, it could not have more completely disappeared. As, however, my eyes were fixed upon the spot, I soon came to observe that all the interstices among the little clods around it were full of withered and crumpled leaves of a deep blackish brown. I then further noticed that the spot where the moth had sat was apparently occupied by one of these, and it flashed upon me in a moment that I had before me one of the great wonders, and one of the great mysteries of nature. There are some forms of mimicry which are wholly independent of the animals themselves. They are made of the colour and of the shape which are like those of the surrounding objects of their habitat. They have nothing to do except to sit still, or perhaps to crouch. But there are some other forms of mimicry in which the completeness of the deception depends on some co-operation of the animal's own will. This was one of these. The splendid margins of the fore-wings, with the peculiar shape and their shining colour had to be concealed; and so, by an effort which evidently required the exertion of special muscles, these margins were folded down—covered up—and hidden out of sight. The remainder of the wings were so crumpled up that they imitated exactly the dried and withered leaves around.

Knowing the implicit confidence in the effectiveness of this kind of concealment, which is instructive in all creatures furnished with the necessary apparatus, I proceeded to try and test this very curious psychological accompaniment of the physical machinery. I advanced in the full sunlight close up to the moth—so close that I could see the prominent "beaded eyes" with the watchful look—and the roughened outlines of the thorax, which served to complete the illusion. So perfect was the deception that I really could not feel confident that the black spot I was examining was what I believed it to be. Only one little circumstance reassured me. There was some hole or interstice in the outer covering, through which one spot of the inner brilliant margin could be seen shining like a star. Certain now as to the identity of the moth, I advanced still nearer, and finally I found that it was not till the point of a stick was used to move and shake the earth on which it lay, that the creature could believe that it was in danger. Then, in an instant the crumpled leaf became a living moth with powers of flight, which would have defied capture.

I recollect that many years ago Mr. Wallace kindly showed me a butterfly from the Eastern Archipelago whose upper wings were of a brilliant colour, but which, by the simple act of alighting on a branch, and of folding or closing its wings, became transformed into the perfect likeness of a growing leaf—a likeness so perfect that even the closest inspection only discovered new items of resemblance—inasmuch as the leaf-stalk, as well as the venation of the leaf, were all perfectly represented both in the structure and in the colouring of the under-surface of the wings.

I confess that the number and intricacy of the correlated growth and instincts which are involved in the e phenomena strike me more and more as wholly outside the sphere of mere physical causation—by which I do not mean that physical causation has not had its own share of instrumentality in the matter, but that it affords no satisfying explanation of all the elements involved. The ordinary phrases of the Natural Selection Theory appear in the light of such facts to be little better than lean and empty formulæ. ARGYLL

Cannes, November 29

Double Flowers

I AM indebted to Baron von Mueller for the communication of double flowers of *Tetratheca ciliata*, which possess interest on several grounds, although the changed appearances they present are not infrequent. It may be well to premise (1) that the plant, like all its fellows of the same order (Tremandraceæ), is native to extra-tropical Australia; (2) that, under ordinary circumstances, it has 4 free sepals, 4 free petals, 8 free stamens in a single row, and a two-celled ovary; (3) that "doubling," in a strict sense, is brought about by the multiplication of petals, or by the more or less complete substitution of petals for stamens, or pistils, or both.

The Australian origin of the plant in question is so far of interest, in this connection, that it affords one more illustration of the occurrence, under natural conditions, of double flowers in a division of the globe where, according to the late Dr. Seemann, such forms are rare. The rarity, however, I believe, is not so much in the existence of such flowers, as in the number of observers, at any rate we now know of several cases of the kind.

Some of the flowers sent by Baron von Mueller were double by multiplication of petals, *i.e.* there was a second row of petals inside the first, others were double not only by multiplication of petals, but also by the partial substitution of petals for stamens; thus in one of these last-mentioned flowers, there were four sepals, three rows of petals, one of the innermost row being partly staminoid, and eight stamens in a single row. Of these eight stamens, six were perfect and the remaining two partially petaloid, one lobe of the ordinarily 4-celled anther being destitute of pollen, but enlarged into a relatively large petal-like lobe with inflected margins. So that according to the old notion, this flower affords an instance both of progressive and of retrogressive metamorphosis, of enhanced and of arrested development associated with compensatory changes. On the hypothesis revived by Mr. Grant Allen—for it is no new notion—the two outer rows of petals would be stamens flattened out of all knowledge, while the inner row and the staminal whorl would, I presume, also afford him evidence of the truth of his opinion. For my own part I prefer to adhere to the established order of things, in which the horse precedes, rather than follows the cart, and I do so because to do otherwise would be to run counter to what we know of the homologies of the foliar and floral organs, of leaf-buds and flower-buds, and to ignore or rather to reverse what we know of the mode and order of development of flowers in general.

Not being aware of the precise order of evolution in the flower in question, I can only reason from analogy when I express my opinion that the changes it presents and the order of arrangements of its parts from the leaves on the flower-stems up to the pistil are more consistent with the generally adopted views of morphology than they are with Mr. Grant Allen's. According to his views, so far as I understand them, I can see no reason why the sepals as well as the petals should not be flattened stamens, and if the sepals why not the bracts? if the bracts why not the leaves? The theory would thus do away with the possibility of indigestion in plants, or at least the primordial plant, could not have been troubled in this way, for it would have had no digestive organs.

I have only to add that the flowers in question offered no explanation of the great peculiarity presented by the existence of a single row of stamens in number double that of the petals. Possibly this may be the result of bifurcation at a very early stage of development. It was hardly to be expected that they would throw any light on the equally curious "obdiplostemonous" arrangement in the nearly-allied genus *Platytheca*, in which there are two rows of stamens, the outermost being superposed or opposite to the petals, instead of being alternate with them, as is usually the case in stamens so placed. A possible explanation of this in a sense partly consistent with Mr. Allen's views would be to consider the petal as in this case an outgrowth from the stamen, and not a separate organ, a view that has been propounded in the case of Primulaceæ and some Malvaceæ. MAXWELL T. MASTERS

Fruit of Opuntia

DR. ERNST'S abnormal fruit of Opuntia, as figured at p. 77, appears to be similar to one described and illustrated by Zeccarini (*Abhandl. d. math. phys. Class.*, B. iv., Abth. 1., tab. ii.) in the case of *Cereus serpentinus*, but as Dr. Ernst gives no details as to the arrangement of the vascular bundles, it is impossible to say that the two cases are exactly parallel. The resemblance to certain gourds (Cucurbits), wherein the upper part of the fruit protrudes beyond the dilated end of the flower-stalk, may also be pointed out. MAXWELL T. MASTERS

Hawk Moth Larva

I FORWARD a sketch of the larva of a hawk moth found in the Khasi Hills, Assam, in the position it assumes when disturbed. Its resemblance to a snake will be at once evident.

The head (just visible in the sketch) and two first segments of the body are retracted, and the third pair of leg

pale horn colour have a rough resemblance to lower jaw or teeth. Small imperfect ocelli in the third segment might be taken for nostrils. The ocellus on the 5th segment, which however, is not so conspicuous as that on the 4th, rather spoils the general effect.

The colour is olive brown reticulated with black and imitates a reptile's scales very perfectly. The lower parts are black,

and a portion of the anterior segments dirty yellowish white. I do not yet know the perfect insect. The larva feeds on the wild balsam. The general colour of this larva at once reminded me of two abnormally coloured larvæ of the common death's-head moth that I had brought to me from a potato field in Jersey some years ago, together with others of the ordinary colour.

One was full grown and another half grown. The general colour of these was brown with fine black markings and without a trace of green. The anterior segments were a pale dirty cream colour. There were no ocelli or diagonal stripes on the sides.

I have not seen recorded any similar case of abnormal colouring in the larva of the death's-head moth, but the fact is interesting as indicating a common ancestry in two moths which are probably now classed in different genera.

E. R. JOHNSON
Surgeon Major, Bengal Medical Department
Shillong, October 16

[The form of death's-head larva alluded to is not uncommon; it is a dimorphic condition and finds its parallel in many larvæ of Sphingidæ. ED.]

The Fertilisation of the Common Speedwell

ALTHOUGH it is the wrong time of the year for observing flowers, it will perhaps not seem out of place to draw the attention of your readers to the fertilisation of the common Speedwell (*Veronica officinalis*). The flowers in the plant hang downwards, so as to bring the nearly flat corolla a little under the perpendicular. The two stamens project outwards and downwards on each side of the pistil, which also hangs down, but not so much as the stamens. These latter are very much narrowed at the base. The flower is in this species, proterandrous, and the corolla, as soon as the stamens have shed their pollen, becomes slightly loose.

At first sight seems quite impossible for either cross or self-fertilisation to take place, as the stamens are quite away from the pistil, and, owing to the position of the flower, insects are compelled to alight in front.

One morning last summer, however, in considering the structure of the flower, &c., I was led to conclude that the explanation must lie in the insect's mode of settling upon it, and accordingly watched two or three plants. In about half an hour's time I had the pleasure of seeing a large fly in the act of fertilisation. As the corolla was flat, and the flower hung down, there was no foothold there, so the insect clasped each of the stamens with its forefeet. Being thin at the base, they were drawn together, and the anthers meeting just below the pistil, dusted the front of its head with the pollen.

On comparing a large number of flowers, I found that when just open, the pistil stood up above the point at which the two anthers would meet, but that in older flowers, especially after the anthers had shed their pollen, it was inclined downwards. If this observation is verified, it will show a most striking adaptation for preventing self-fertilisation.

I may add that in one of the smaller flowered species, *V. hederæfolia*, the stamens and pistil are quite close to each other, so that self-fertilisation must here be the rule. The corolla is also not so easily detached. A. MACKENZIE STAPLEY
The Owens College, Manchester, November 20

Wartmann's Rheolyzer

YOU gave in NATURE a report on "Wartmann's Rheolyzer." I beg to say that I invented and constructed the same apparatus long ago, and described it in the "Sitzungsberichte d. Wiener kast Akademie d. Wissenschaften," July, 1877, under the name of "Rheonom." Some months after that a fair report of my paper appeared in "Beiblätter zu Wiedemann's Annalen." My instrument was for some years in the hands of several physiologists. Prof. Yeo was present when I made experiments with it in Prof. Ludwig's laboratory in Leipzig in the year 1878, and Prof. E. du Bois-Reymond has it also in his collection of physiological and physical instruments for more than five years. There is no doubt that Prof. Wartmann was not acquainted with my apparatus when he described his, but I cannot be expected to see my invention ascribed to another and keep silent. So you will oblige me very much in correcting the above-mentioned mistake in your paper. ERNST VON FLEISCHE
Vienna, Währingerstrasse 11, November 30

Pollution of the Atmosphere

THERE was a letter in NATURE some time since, calling attention to the pollution of the atmosphere by the burning of coal; and it was calculated that in the year 1900, all animal life would cease, from the amount of carbonic dioxide; but the author had overlooked the fact that the rain is continually cleansing the atmosphere of this, and the fall of this rain on the ground, and the combination of this with various salts; besides, the oceans alone would absorb their own bulk at normal pressure, but at an increased pressure of, say half a mile deep, would dissolve more than we are likely to need for hundreds of years.

But there are other products of combustion, or rather of incomplete combustion, that are not brought down in this manner by rain, as hydrogen and the hydrocarbons, chiefly marsh-gas and ethylene. The latter has, I believe, been observed by the spectroscope on the Alps, and was supposed to have come from space.

Since the year 1854 (as near as I can estimate) there has been burnt 10,000 million tons of coal; and if we say (in its consumption by household grates, leakage by gas-pipes, &c.) 1-100th escapes, then 100 million tons of hydrogen and hydrocarbons are floating in the atmosphere, or 1-10,000,000th part in bulk; if we say the average proportion of hydrogen to be ·45, and of marsh gas ·35, and of ethylene ·4, we have ·84 per cent. of gases that are lighter than air, and it is more than probable that the law of diffusion of gases, as demonstrated with jars, does not apply to the atmosphere. The cases are not parallel: in the air we have unconfined space, pressure, and temperature diminishing infinitely, conditions favourable to the lighter and the gas with the greater amount of specific heat rising and maintaining its elevation, especially as we know that in *large* halls carbonic dioxide is found in larger quantities on the floor. According to Prof. Tyndall's researches, hydrogen, marsh gas, and ethylene have the property in a very high degree of absorbing and radiating heat, and so much so that a very small proportion, of only say one thousandth part, had very great effect. From this we may conclude that the increasing pollution of the atmosphere will have a marked influence on the climate of the world. The mountainous regions will be colder, the Arctic regions will be colder, the tropics will be warmer, and throughout the world the nights will be colder, and the days warmer. In the Temperate Zone winter will be colder, and generally differences will be greater, winds, storms, rainfall greater. H. A. PHILLIPS
Tanton House, Stokesley, November 23

A Modern Rip Van Winkle

WHEN Mr. Evans asks whether it is impossible for "the so-called flint implements and flint flakes to have been formed by natural causes" he surely must have had a scientific nap of forty or fifty years. He can answer his question by going to any good museum and inspecting the beautifully and clearly manufactured implements which the Curator will show him.

November 28 SALTBURN

GOOLDEN'S SIMPLE DIP-CIRCLE

A DIPPING-NEEDLE suitable for the requirements of schools and science classes has long been a desideratum, there having been no instrument obtainable hitherto which would at a moderate cost afford results of sufficient accuracy. Between the mere needle suspended in a simple stirrup of brass, and the delicate and complicated dip circles of standard pattern there has been no intermediate form of instrument. This deficiency, has, however, been remedied by Mr. Walter Goolden, M.A., Science Master in Tonbridge School, who, in conjunction with Mr. C. Casella, has designed the form of portable dip-circle depicted in the figure, which possesses several novel points. The needle, which is 3½ inches in length, is poised upon an accurate axis working in sapphire centres, and magnetised once for all. In order to ensure the coincidence of the centre of gravity with the centre of suspension, two very light adjustible counterpoises are fixed to the needle, one of them being capable of being moved parallel to the length of the needle, the other lying at right angles to the first, and

adjustible in a direction to the right or to the left. The metallic circle within which the needle revolves is graduated on both faces, and is inclosed within an air-right case. The instrument turns upon a vertical support above a solid metal plate standing on three levelling-screws. A small loose level, which can be placed upon this levelling-plate, accompanies the instrument. The main novelty in Mr. Goolden's instrument, consists, however, in the arrangements by which the angle of dip may be determined without having either a horizontal graduation or a horizontal compass needle upon the apparatus. It will be seen by reference to the figure that the vertical axis of the instrument is furnished with a spring-arm, which can be clamped to it by turning a screw, and that there are four metal studs affixed to the stand at equal distances apart, into any one of which the pin at the end of the spring arm can be pressed down. These arrangements serve to facilitate the following adjustments. Having levelled the instrument the spring-arm must be unclamped and the pin at the end of it pressed down into the conical hole in one of the studs. While this is so held with one hand the vertical circle is turned upon its axis with the other hand *until the needle points directly*

Goolden's simple dip-circle.

vertically downwards to 90°. In this position, which is of course exactly magnetically East-and-West, the vertical circle is clamped by a turn of the screw. The position is verified by turning the whole circle and spring arm together upon the axis until the pin meets the opposite stud, when the needle will again point vertically downwards. The East-and-West position being thus verified, it is clear that the magnetic meridian will lie in a plane at right angles to this. Hence the next process is to turn the circle round and press the pin into one of the two studs which lie at right angles to the pair already employed. The position of the needle in the circle is then read off. The circle is once more turned through a complete semicircle, the pin pressed into the opposite stud, and another reading is taken: the mean of these two being accepted as the true angle of dip. It will be seen that the usual elaborate processes of eliminating possible errors by reversing the needle-axis upon its bearings and reversing the magnetism of the needle itself are not attempted. Everything will therefore depend upon the accuracy of the adjustments of the instrument before it leaves the maker's hands. As it is, it is claimed that the readings are correct to within 10 minutes of arc.

THE COMET

MR. CHANDLER has made another approximation to the orbit of this comet, and now finds the following ellipse (*Science Observer*):—

Perihelion Passage September 17·2304 Greenwich M.T.

Longitude of perihelion	276° 28′ 26″·8	M. Eq. 1882·0.
,, ascending node	345 50 34·0	
Inclination	38 5 3·8	
Log. perihelion distance	7·8835636	
Eccentricity	0·9999700	

Retrograde.

The period of revolution corresponding to this ellipse is about 4070 years; in the middle of November there was a decided difference between the calculated and observed positions, part of which may be due to a cause to which Mr. Chandler has already drawn attention, viz. that the same point in the head of the comet may not have been always observed. We may now say pretty confidently that a short period of revolution is inconsistent with the motion of this comet, and consequently that it is not identical either with the great comet of 1880 or with that of 1843. Nevertheless we must repeat that there are indications of sensible perturbation during the flight through the coronal regions of the sun.

Mr. Gill sends us some particulars relating to the early Cape observations of this comet. It was first detected by Mr. Finlay at five o'clock on the morning of September 8, as he was returning to his house from the observatory. He went back and compared the nucleus with a small star in its immediate neighbourhood. On the following morning the comet was observed again, and the same day Mr. Gill sent the following telegram to Sir James Anderson, Chairman of the Eastern Telegraph Company:—"Kindly tell Astronomer Royal, Greenwich, that bright comet was observed here yesterday morning by Finlay. Right Ascension this morning nine hours forty minutes, increasing daily nine minutes, Declination one degree south, increasing half degree south daily." Mr. Gill acknowledges his indebtedness to the courtesy and liberality of Sir James Anderson for the free transmission of many previous messages. Unfortunately this one notifying the discovery of the comet in some way miscarried, and did not reach Mr. Christie's hands, so that the first intimation of the visibility of the comet came from Mr. Cruls at Rio de Janeiro, who, however, so far from being a discoverer, has informed the Academy of Sciences of Paris, through M. Faye, that he received notice of the comet's presence from another quarter on September 10; it was not seen at the observatory of Rio till 5h. 15m. a.m. on September 12.

Cloudy weather prevailed at the Cape between September 10 and 17, and very few observations could be procured, and those had to be made by measuring the difference of altitude and azimuth from bright stars. On Sunday, September 17, the comet was easily visible with the telescope in full sunshine, and in close proximity to the sun. It was followed during the day by Mr. Finlay and Dr. Elkin, and towards afternoon was found to be rapidly approaching the sun. As the distance diminished "all appearance of tail was obliterated, only a round disc about 4″ in diameter remained visible, but this was intrinsically as brilliant as the surface of the sun, if not more so. Still closer this disc approached to the sun's edge, and its disappearance there was observed just like that of a star when it was occulted by the bright limb of the moon." Both Mr. Finlay and Dr. Elkin observed the disappearance, but though the former was using much the more powerful telescope, he only saw the nucleus five seconds longer than Dr. Elkin; the comet had passed on to the sun's disc (not behind it, as Major Herschel erroneously assumes in NATURE last week), but no appearance whatever of its presence there could be perceived. Mr. Gill himself was not able to arrive at this unique observation, having proceeded to Simon's Bay to meet Capt. Morris, R.E., on his way in the *Liguria* to Brisbane to observe the transit of Venus, who returns to South Africa as chief Executive Officer of the Geodetic Survey of the Cape Colony and Natal; but

on the morning of the following day he observed the comet rise just before the sun at Simon's Bay, and says he will never forget the beauty of the scene. Many drawings of the comet were made at the Cape Observatory, and some photographic pictures were obtained with the assistance of Mr. Allis, of Mowbray. To obtain a perfect picture of the more delicate details of the comet, an exposure of not less than half an hour was found to be necessary.

The following places are abbreviated from an ephemeris calculated by Mr. Chandler from his last elliptical elements :—

At Greenwich mean noon.

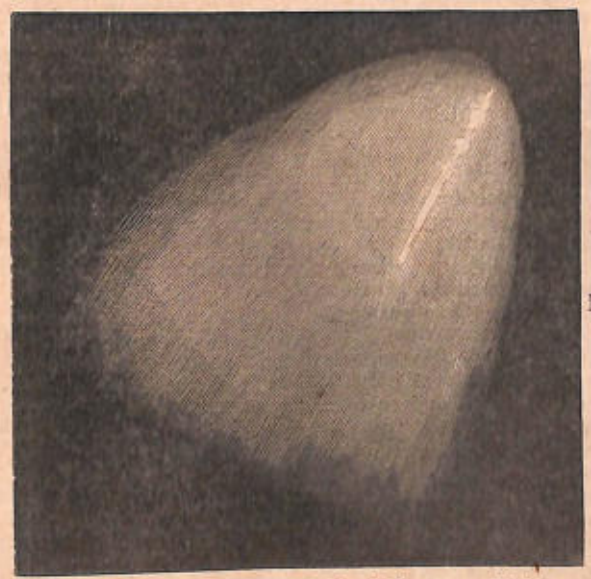
	Right Ascension.	Declination.	Log. distance from Earth.	Log. distance from Sun.
	h. m. s.	° ′		
December 7	8 31 41	−29 42·7	0·1868	0·3110
9	8 25 28	29 57·6		
11	8 19 10	30 9·8	0·1917	0·3250
13	8 12 48	30 19·1		
15	8 6 24	30 25·5	0·1978	0·3384
17	7 59 58	30 28·9		
19	7 53 33	30 29·3	0·2051	0·3512
21	7 47 9	30 26·8		
23	7 40 49	−30 21·4	0·2137	0·3635

Up to Nov. 6 the comet discovered by Mr. Barnard had been sought for unsuccessfully at the Cape Observatory.

We have received the following communications on the comet :—

WITH the permission of Vice Admiral Stephen C. Rowan, U.S.N., Superintendent of the Observatory, I send you a sketch made at 17h. Washington Mean Time, November 15, with the 26-inch Washington equatorial. At the time of observation the head of the comet was about 45 minutes east of the meridian.

As it is extremely difficult to represent such an object faithfully in a woodcut, I will call attention to the following points :—The nucleus presents a very woolly, nebulous appearance, with a main point of condensation, almost circular; near its following end, and about 18″ from this towards the tail, a second point of condensation, prolonged about 54″ in the direction of the tail in a narrow ridge of light. This ridge which has heretofore appeared broken up into four or five beads, is now a continuous line of light with, perhaps, in one or two places, faint indications of condensation. The nucleus is decidedly eccentric with regard to the general direction of the head, and the head is flattened on the *north-following* side.



Comet *b*, 1882, November 15·7, U.S. Naval Observatory, Washington.

The position-angle of the major axis of the nucleus was 309°·4. The distance between the centre of the two main points of condensation, from a series of measures with the filar micrometer was 18″. A magnifying power of about 200 diameters was used. On November 17·7 the extreme length of the nucleus was found by Commander Sampson to be 74″.

The following meridian observation for position was obtained on November 15·7 with the transit circle ;—

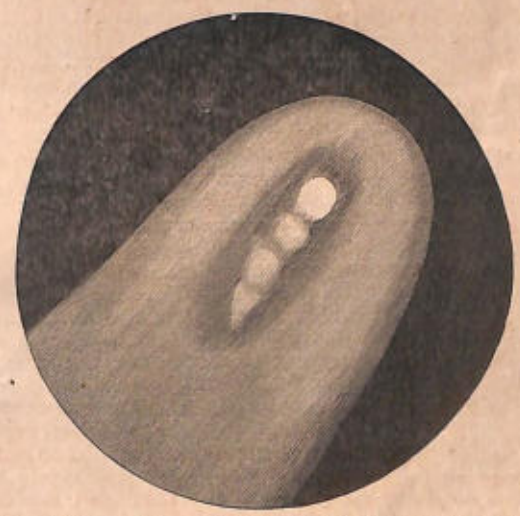
1882 November 15·74 (Washington M.T.)

R.A.	9h.	27m.	50s.·72
N.P.D.	114°	49′	18″·9

The part observed was the main point of condensation near the following end of the nucleus. The observation is corrected for refraction, but not for parallax.

WILLIAM CRAWFORD WINLOCK,
Assistant Astronomer, U.S. Naval Observatory

THE drawing represents the appearance of the great comet at 5 a.m. on the morning of October 12 this year. I delayed the publication of my observations on this morning in the hope of securing some more views, but the bad weather prevented any further observations of this object here. The drawing shows distinctly four condensations in the nucleus, whose angle of position on the 12th was about 102°. Its length was 40″·3, as measured with the filar micrometer on the great refractor. The visible length of the tail was estimated at 21°. No doubt



The Great Comet seen in the Markree Refractor, October 12, 1882, 5 a.m., by W. Doberck.

it was really much greater. Its southern side was well defined. As seen with the naked eye the nucleus shone as brightly as a star of between the first and the second magnitude. On the morning of the 6th I had seen the end of the tail, which was then apparently 15° long, present a feature very like that indicated in Major Herschel's drawing (NATURE, vol. xxvi. p. 622), but I am not sure of this, as the sky was partly covered with cirro-cumulus clouds.

On October 28, at 5h. 45m. a.m., the angle of position of the nucleus was about 113°, and its length amounted then to 67″. The tail was less curved than on the 12th.

Markree Observatory, December 2 W. DOBERCK

FUNCTION OF THE MEMBRANA FLACCIDA OF THE TYMPANIC MEMBRANE

WHY should a smart blow, as, for instance, with the palm of the hand on the side of the head, or on the wing of the ear, cause rupture of the membrana tympani?

It was in endeavouring to trace the connection between these events, of no very uncommon occurrence, that I was led to the discovery of a most important factor in the physiology of the ear, and one which gives a new and more rational significance to the mechanism of the ossicles and membrane. In the shape of anatomical details I have nothing new to adduce, but in exhibiting the relationship of a series of minute particulars hitherto enigmatical and glanced at separately and only casually by anatomy, I have obtained a valuable result for otology. I must here present those details in the order most convenient for a brief demonstration, giving only the main features.

The membrana tympani, though but a single membrane, consists of two portions. The lower is firm and transparent, and of conical shape, being attached along its centre to the handle of the malleus, and fixed round its whole circumference to the sulcus tympanicus. The upper is comparatively loose, and much less transparent, and being in reality mainly fastened to the skin of the upper wall and only slightly to the bone, there being here no sulcus, but only a smooth margin (margo tympanicus), is easily displaced with a little gentle pressure outwards or inwards. Between the two there is a line of dense fibres forming a ligament, called by Helmholtz the anterior ligament of the membrane, and towards the anterior border of which the short process of the malleus is inserted. With this marked limiting line there is thus a striking difference in the character and mode of attachment of the two portions of membrane, and this reaches to the very foundations of the structures, and is the most remarkable feature in their development. It is to be remembered that the superior arch of bone, forming at its inner end the tympanic margin alluded to, is part of the squamous bone, which is characterised by the general smoothness of its surface—a character it preserves along the whole upper wall of the osseus meatus, not excepting its termination at the porus acousticus externus, where it presents a smooth bevelled edge. But the os tympanicum which forms the inferior arch of bone is contradistinguished by the general unevenness or asperity of its surface, not only being hollowed out by the sulcus at its inner end, but along the whole floor, maintaining a roughness which culminates in its rugged edge at the porus externus. Nature, in constructing the meatus, selects one bone for its smoothness, another for its roughness, and the evident intention is, that what is laid on the one surface shall adhere, what is laid on the other shall glide over it. While, therefore, the lower portion of the drum of this ear is fixed by its connection with the os tympanicum, the upper portion is loosely connected with the os squamosum, which affords it a movable surface. Helmholtz believes that the lower firm portion is alone concerned with sound-waves, the upper lying above the handle of the malleus, and having therefore no direct connection with the chain of ossicles. On this ground, in his treatise on the mechanism of the membrane and ossicles, he leaves the membrana flaccida out of consideration altogether, and no physiologist, as far as I am aware, has ever hinted at its function. Having from the foregoing description obtained an insight into its relation with the bone, it must now be viewed in connection with the skin lining the upper wall of the passage, which is quite distinct in character from that covering the rest of the osseous passage, and next needs to be specially noticed.

Prof. Henle says: "The skin which covers the external meatus has originally the appearance and structure of the cutis, and retains this character along *the upper wall* beyond the *rounded rim* of the squamous bone which helps to complete the porus acousticus externus up to the site of the membrane, whereas in the rest of the circumference the skin, in passing from the cartilaginous to the osseous meatus, abruptly changes its character, decreasing in thickness and assuming the peculiar silvery glance of a fibrous skin."[1] Thus along the whole passage the skin on the upper wall retains its ordinary character, being elastic and movable, and having, as noticed by Von Fröltsch, the same kind of loose connective tissue glands and hair cysts as any other part, whereas the movability of the remaining portion ceases with the cartilaginous meatus, as beyond that it ceases to be true skin.[2] Add to this that the one lies on a roughened, the other on a smooth surface, and this singular deviation in apparently so simple a matter and in so minute a particular, must strike the examiner as significant of purpose. If we next turn to the arrangements at the porus acousticus externus, it becomes manifest.

What is noticeable in regard to the rim of bone constituting the porus is simply corroborative of what has already been said. Thus, whereas the under semicircle is comparatively rough and uneven, and projects slightly beyond the upper semicircle, the latter has a smooth-rounded edge bevelled in the manner of bone over whose margin a tendon plays. It is to the curved uneven lamella of the under circumference known as the auditory process that the cartilaginous meatus is principally attached. This is effected by means of strong, slightly movable ligamentous tissue, or rather, as Henle puts it, "by means of a compact cartilaginous substance richly interspersed with elastic ligamentous tissue, which fills up the rough interspaces of the lamella and extends the lower portion of the osseous canal about two millimeters."[3] The upper semicircle, on the contrary, is closed simply by a dense fibrous membrane, there being here a large deficiency of cartilage (Quain). The difference is that while below the osseous canal blends insensibly into the cartilaginous with only dawning facility for movement, above it terminates abruptly, admitting there and then a large measure of movement.

Thus then it appears that from the membrana flaccida of the membrane, which is easily movable at its margin, we have a piece of movable skin running over a smooth polished surface along the whole upper meatus of the bone, which is here bevelled off, and is immediately continuous with the movable membranous roof of the cartilaginous portion of the external passage. The movable piece of skin serves, after its manner, the purpose of a tendon, and the muscle which mainly plays upon it is attached to this upper membranous wall at its point of junction with the osseous meatus.

Of this muscle Henle gives the following account:—"Of the lateral portion of the musculus epicranius (occipito-frontalis), the musculus epicranius temporalis is a very thin bundle of fibres, and is anterior to and smaller than the attollens auriculam, which forms the remainder of the lateral portion. It has its tendinous origin below the root of the zigoma, near the rim of the osseous canal, to the capsule of the inter-articular cartilage (operculum cartilagineum), and to a tendinous arch through which the vasa temporalia pass into the deep structures. Its muscular fibres spread out in parallel lines forwards and upwards, some of them stretching to the border of the frontalis, and of the orbicularis oculi, and so partly curving upwards around the lateral border of the frontalis, and intermixing with the upper fibres of the orbicularis, they are finally inserted into the glabella."[4]

It will thus be observed that, when the muscle contracts, it raises the membranous roof of the canal upwards and slightly forwards, making the movable patch of skin glide outwards, and so telling upon the membrana flaccida, which is, even in the adult, almost in a line with the upper wall, and is therefore so much the more easily influenced by such a movement. When the delicacy of the parts concerned are borne in mind, it will be obvious that no extensive movement is thus indicated, and in a

[1] "Anatomie des Menschen," Z. B. s. 732.
[2] "Diseases of the Ear," Roosa's Translation, p. 53.
[3] *Loc. cit.* p. 729.
[4] *Loc. cit.*, s. 136.

more complete demonstration a good deal further illustrating the actual movement, has to be said on that head. Here we have space only for a general outline.

The muscle, of course, has no isolated voluntary action, but its effect is brought into play when the eyebrows are forcibly raised by the contraction of the occipito-frontalis. Indeed, although itself really a muscle as described, much of its effect is derived after the fashion of an elastic tendon connected with the great epicranial muscle. It is further assisted by the consentaneous action of certain small muscles of the auricle, notably the attollens auriculam. Its movement is quite perceptible to the finger placed in the sulcus, between the pinna and side of the head, and to an experienced eye its effect on the membrane is distinctly visible through the speculum when the occipito-frontalis is made to contract.

It would be beyond the scope of a single paper to enter into a demonstration of the effect of this movement of the membrana flaccida on the membrane and ossicles—but it can be shown that, in opposition to the so-called tensor tympani muscle, it helps to bring the umbo or deepest part of the membrane outwards, thus tending to reverse the cone, and bring the membrane generally into a more vertical position, relatively to the lower wall of the meatus. This is beyond all question its position for acutest hearing, and it is thus important to observe that by the single contraction of the occipito-frontalis muscle, both eyes and ears are brought simultaneously into the attitudes of strained attention. Hence, in endeavouring to hear as well as to see intently, we involuntarily raise the eyebrows in order to t[ens] upon the drum of the ear.

A smart blow administe[red] on the side of the head, as is too often thoughtlessly done by schoolmasters and parents in correcting chil[dren], may cause sudden spasmodic action of the muscle, and thus, through the action of the mechanism descri[bed], serious injury or even rupture of the drum.

JOHN M. CROMBIE

WEIGHTS AND MEASURES

THE Board of Trade lay before Parliament an Annual Report of their proceedings and business under the Weights and Measures Acts, &c., and their Report for the current year has just been issued.

It is required by law that the three Parliamentary copies of the Imperial Standards of measure and weight, which are deposited at the Royal Mint with the Royal Society, and in the Royal Observatory, respectively, should be compared with each other once in every ten years. The period for such decennial comparisons having recently arrived the Board took the necessary steps for the removal of these Standards to their office. The methods of comparison adopted and the actual differences between the Standards are shown in a memorandum by Mr. H. J. Chaney, which is attached to the Report. It appears that the comparing apparatus in use at the Standards Office is found to require alteration, and that in considering the changes necessary to be made the Board have had the valuable assistance of a Committee of the Royal Society, composed of Sir G. Airy, Major-Gen. A. R. Clarke, and Prof. Stokes. It is really important that a department which is charged with the care and use of our national standards, should have the best apparatus, and we trust, therefore, that the Report of the Committee may be speedily and fully carried out.

Reference is also made to the papers issued by the Comité International des Poids et Measures, Paris, and the Report acknowledges the assistance the Standards Department has received from these papers, particularly with reference to the measurement of heat and the determination of volume and weight. This country is the only civilised country which has not joined the Comité International, and taken part officially in their proceedings, although it would appear that it has not failed to avail itself of their labours.

The two ancient standards of the metric system, the Toise du Perou and the Toise du Nord, are stated to be still at the Paris Observatory, in a good state of preservation, as also are the measures used by Borda, Brisson, and Lavoisier. By a decree of the Sultan, the metric system came into force in Turkey on March 1st last, and the equivalents of the old and new Turkish weights and measures are stated in this Report.

The Board have had their attention directed to the question of a uniform system of screw threads, as well as to that of a standard wire gauge. Reference is made to the want of uniformity in the system of screw threads used in the construction of scientific and optical instruments. It is hoped that the attention which is now being given to this question may result in the adoption of a standard system of screw threads. Any step which tends to lessen the high cost of construction and of repair of scientific apparatus is to be welcomed.

From time to time, as science advances and commerce extends, it is found that new kinds of standards are needed, and the attention of the Department has therefore been this year called to the expediency of adopting new photometric tests for gas, and also as to possible means of measuring electrical energy. In the proposed Bill for amending the enactments for regulating the sale of gas, and of dealing with the mode of testing the illuminating power of gas, we trust that Mr. Vernon Harcourt's new air gas-flame test, on which Dr. Williamson and Dr. Odling have reported, may receive favourable consideration.

Under the Petroleum Acts rules are laid down for determining the "flashing-point" of oils, or the temperature at which they begin to give off inflammable vapours, but it appears by the Report that Dr. Foerster has lately called attention to the omission in these rules of any allowance for variations of atmospheric pressure. The rules in this respect evidently, therefore, require some amendment.

The Report also contains much information valuable to local inspectors and others practically interested in weighing and measuring.

ON THE PROPOSED FORTH BRIDGE

IN offering some remarks (which I trust may be final) merely explanatory of preceding notes on this proposed structure, I shall refer generally to my letter of October 19 (NATURE, vol. xxvi. pp. 598-601).

First, I have to modify the force of my expressions relating to the danger arising from the use of certain long struts to support very heavy end-pressures. My remarks were the consequence of error in the engraved longitudinal vertical plan, circulated (I understood) under the authority of the Official Board. In this plan, by the indiscretion of the engraver, the tubular struts of 340 feet length and 240 feet length respectively, are drawn clearly and distinctly as unconnected in their entire length with any other braces. In other parts of the plan, each connection of that class is indicated by a rose; but there is no such mark upon these rods. A person scrutinising the plan might well feel alarm at the prospect of unbraced rods 340 feet long, intended to support end-pressures exceeding 600 tons. But Mr. Fowler has kindly informed me that the plan is erroneous, and that there is connection at each place where the strut crosses a brace, and that the flexible length of the strut is thus reduced to 170 feet. This diminishes the danger of buckling in a vertical plane so greatly that I imagine it may be passed without further notice. Still I remark that the danger of buckling in a horizontal direction, with a length of 340 feet, remains undiminished, unless it is counteracted by bracing not known to me.

In regard to some effects of the wind, the following comparison between the proposed Forth Bridge and the

late Tay Bridge may be interesting. I suppose that equal trains are upon the two bridges; and I assume that the force of the wind on the Tay Bridge train tore one pier from its foundation-attachment. (I imagine that the ruin of the bridge commenced thus). The height of the centre of the Tay Bridge train was about 92 feet, and the momentum of the wind was, therefore, wind × train × 92 feet. (The reader will easily interpret my brief notation). To resist this there were three pairs of attachments to the foundation, with lever-widths of 10 feet, 22 feet, 10 feet, respectively. So that, supposing the holding powers of each attachment the same, we must have had for momentum of resistance, one Tay-attachment × (10 + 22 + 10) feet. At the instant of breakage, this was equal to the momentum of the wind, or to wind × train × 92 feet. So that one Tay-attachment $= \frac{92}{42} \times$ wind × train = 2·19 × wind × train. If we treat the proposed Forth Bridge in the same manner, we must use, length of lever about 660 feet, and two pairs of attachments of the cantilever to the pier (if I read the plan correctly), at distances of 30 and 120 feet. And thus we shall have the equation at a moment of breakage.

One Forth-attachment × (30 + 120) = wind × train × 660; or one Forth-attachment must = 4·4 × wind × train, or double that required for the Tay Bridge.

A numerical value (possibly subject to modification) may be given thus:—Suppose the surface of a train to = 3000 square feet. With the Government scale of 56 lbs. for high wind, the lateral pressure = 75 tons; and, using leverage numbers as above, one Forth-attachment = 330 tons. And this is the strain which each attachment must be able to sustain in respect of resistance to the effect of wind upon a train. I imagine that this has been provided, at least in great measure; but I think it desirable that attention should be called to the magnitude of the forces here concerned.

The able and experienced engineer who has undertaken the prosecution of this great work, will, I am confident, recognise the possibility of serious inconvenience (yet unforeseen) arising from the points to which I have alluded in NATURE, vol. xxvi. p. 599—the novelty of plan, at least in this country—the magnitude of plan—the want of experience in a rising scale of magnitude. Should the bridge be erected successfully, I can imagine that many difficulties on small points might arise. For instance:—all matter yields to force; the brackets of furlong-length, could not strictly preserve their form under the passage of a train; the connection of the end of one bracket with the beginning of the next is not very perfect, and I can hardly imagine that trains could be run through at speed (which, as I understood, is one of the conditions to be secured).

I still prefer the principle of suspension. I would propose for further consideration the modifications which I have suggested in NATURE, vol. xxvi. p. 600, for giving enlarged width with diminished height to the top of the piers, and for use of wire in forming the suspension-chains.

G. B. AIRY

The White House, Greenwich, December 4

NOTES

MONDAY'S sitting of the Paris Academy of Sciences was one of unusual interest. M. Jamin, who was in the chair, delivered an eloquent address on the services rendered to science and to the Academy by M. Dumas, and presented to the illustrious Perpetual Secretary the medal subscribed for by his admirers as a testimonial on the occasion of the fiftieth year of his nomination as an academician. The medal is accompanied by silver and bronze replicas. The whole of the audience, which was very numerous, broke into enthusiastic plaudits. When the enthusiasm subsided, M. Dumas returned thanks, which he did with masterly eloquence.

WE regret to announce the death of the Rev. James Challis, M.A., F.R.S., Plumian Professor of Astronomy and Fellow of Trinity College, which took place on Sunday morning at his residence in Cambridge, after a long illness. The late Professor was born in 1803, and educated at Trinity College, where he graduated B.A. in 1825 as Senior Wrangler and first Smith's prizeman. In 1836 he was elected Plumian Professor of Astronomy in succession to Mr. (now Sir) G. B. Airy, and also held the important post of Director of the Cambridge Observatory. The latter post he resigned in 1861, and was succeeded by Prof. Adams. He was at the time of his death the Senior of the Professors at Cambridge, and until about two years ago personally discharged the duties of his professorship, when increasing age and infirmities compelled him to appoint a deputy. Prof. Challis has published a considerable number of scientific works, including twelve volumes of astronomical observations.

THE death is announced of Dr. Gustave Svanberg, formerly Professor of Astronomy and Director of the Observatory of Upsala University. He died on November 21, in his eighty-first year.

NEWS from Aden reports the death of Marchese Orazio Antinori, the well-known zoologist and African traveller, who had recently started on a new expedition to the Upper Nile. He was seventy-one years of age.

ELABORATE preparations were made in various parts of America to observe the transit of Venus yesterday. The Western Union Telegraph, to facilitate observations, arranged to transmit Washington time wherever desired, in order to secure accuracy in recording results. Some enthusiastic astronomers had proposed general prayer in the churches on Sunday last for clear weather.

M. W. DE FONVIELLE has published the first number of a new astronomical journal, called "Les Passages de Venus," which explains the great astronomical event, and is being sold in the streets of Paris at 1 sou, with illustrations indicating the phases, and giving instructions for their observation in France. The editor states that he trusts that the second number will appear at the right date, June 8, 2004, and the third in June, 2012, and so on, as long as there will be on the earth rational beings intelligent enough to take an interest in the transit of Venus. He congratulates himself on having established a "periodical" which will be perhaps the most durable foundation of his age.

A SWISS Geological Society has lately been formed. It is an offshoot from the Helvetic Society of Natural Sciences. While a permanent section of this, it will have its own life, its committee, its funds, its distinct *séances*, and its publications if thought desirable. It will have members who do not belong to the mother society; will send a delegate to the preparatory assembly of the latter, and will have the right of presentation of members. The number of adherents of the new society is already over sixty. It has absorbed the *Congress der Feld Geologen* and the *Comité d'Unification géologique*. Among other things it will encourage excursions along with discussion on the ground, and will represent Switzerland in the International Geological Congresses. The Society has testified its respect for MM. Studen, Heer, and Merian, by (exceptionally) giving them the title of Honorary Members.

THE Council of the British Association, acting under the powers conferred upon them by the General Committee, in accordance with their Report, have appointed the following to be a Committee, "to draw up suggestions upon methods of more

systematic observations, and plans of operation for local societies, together with a more uniform mode of publication of the results of their work," and to "draw up a list of local societies which publish their proceedings," Mr. H. G. Fordham (Secretary), Rev. Dr. Crosskey, Mr. C. E. De Rance, Sir Walter Elliot, Mr. Francis Galton, Mr. John Hopkinson, Mr. R. Meldola, Mr. A. Ramsay, Prof. W. J. Sollas, Mr. G. J. Symons, Mr. W. Whitaker.

COLONEL PREJEVALSKY, the distinguished traveller, intends to resume his explorations in Central Asia in the spring, and to make another attempt to penetrate to the capital of Thibet. He is now suffering slightly from weakness of sight.

PROFESSORS have been appointed to give courses of lectures at the Louvre upon its collections, and the school opens this week. Gaulish antiquities will be expounded by M. Bertrand, curator of St. Germain Museum; Egyptian remains by MM. Pierret and Revillout; Semitic epigraphy and archæology by M. Ledrain; and ancient art by M. Ravaisson.

A "PROJET de Mer Intérieure dans le sud de l'Algérie et de la Tunisse" (occupying the space usually known as "The Schots" or "Les Chotts," which is lower by several feet than the Mediterranean Sea), suggested by M. le Commandant Roudaire, was communicated some time since to the French Government, and was in May last laid by M. de Freycinet before a "Commission Supérieure." This Commission has examined the question under every point of view, antiquarian, political, practical, and commercial, and their labours are recorded in a quarto volume of 546 pages, illustrated by a map. On July 7, 1882, the Commission made the following Report:—

"La Commission,

Considérant que les dépenses de l'établissement de la mer intérieure seraient hors de proportion avec les résultats qu'on peut en espérer,

Est d'avis qu'il n'y a pas lieu pour le Gouvernement Français d'encourager cette enterprise."

IN the course of the coming winter Prof. Emil Selenka hopes to publish a Monograph of the Sipunculacea, in which he will be assisted by Doctors J. G. de Man and C. Bülow. The volume will contain the descriptions of 81 distinct species placed in 10 genera. Some of the species are new. The Monograph will form vol. iv. of Semper's "Reisen im Archipel der Philippinen," and will contain the forms collected by Semper; but in order to make it a more or less complete revision of the group, Dr. Selenka also describes in it the species collected at the Mauritius by Dr. Möbius, those in the Berlin Museum through the goodness of Prof. Peters (this collection contains the types of Grube), those from Stuttgart containing Dr. Klunzinger's Red Sea collection (through Dr. Krauss), those from the British Museum (through Dr. Günther), and those from Göttingen, the types of Keferstein (through Dr. Ehlers). In addition, Dr. Selenka has been indebted for specimens to the liberality of Dr. von Martens, Dr. Hilgendorff, Dr. Krapelin, and Dr. Lang. Dr. Groeffe was able to forward living examples of *Aspidosiphon müllleri*. Besides a general introduction and description of the genera and species, there will be dissertations on the tentacular and blood systems, while special care has been taken about the subjects of the geographical distribution, anatomical relations, and synonymy of the species. The volume will be accompanied by 15 plates with more than 200 partly coloured drawings.

SINCE the commencement of the present Session the Society of Arts meeting room has been lighted by means of electricity. A Siemens dynamo is employed driven by an 8 horse-power Crossley gas engine. Nearly the whole cost of these was defrayed by subscriptions from a few past and present members of the Society's Council. The lamps used are those of Edison, and there are at present fifty of them in the room. The chandeliers now in use have been lent by Messrs. Verity, who are constructing chandeliers to be permanently fitted, now that the number of lights to be used has been decided upon. Temporary fittings have been put up in the council room, and the result having been proved satisfactory, it is in contemplation to arrange for the lighting by electricity of this and other parts of the building.

AN unusually large number of seals have made their appearance in the Baltic, a few miles north of the Samland coast. Should these animals make that spot their permanent residence, the salmon fisheries would be in a sad plight. On the Pomeranian coast the damage to salmon fisheries done by seals is very considerable.

NO less than thirty-four communes in the district of Chambery (Savoie) are now infected by Phylloxera.

A COMMISSION has been appointed by the Prefect of the Seine to reconsider the disposal of the Paris sewage. A deputation will be sent, at the expense of the Municipal Council, to Brussels, Antwerp, Amsterdam, Berlin, and London to report on the matter.

A BRUSSELS paper, *L'Athenæum Belge*, reports some interesting observations made by M. W. Spring regarding the seat and origin of thunderstorms. During the summer 1881 M. Spring ascended the Schnæhorn in the Bernese Oberland during a thunderstorm. He then noticed that for a considerable time no rain fell, but that a vivid formation of hail took place. From time to time the hail fell very much thicker, and in such moments came a bright flash of lightning followed by a tremendous clap of thunder. After a pause rain-drops mixed with the hail. The same observations were made on the summit of S. Giacomo, where he again observed a thunderstorm. He concludes from his observations that the actual seat of thunderstorms, *i.e.* of the aërial electricity is not in moist regions of the atmosphere but in the dry and cold region of hail.

PROF. HEULE, the eminent anatomist, has been elected, in the place of the late Prof. Wöhler, as permanent secretary of the Royal Academy of Sciences at Göttingen.

NEWS from Champagne states that a new enemy to the vine has made his appearance in the shape of a minute fungus, a kind of *Peronospora*, the dangers of which are said to be far more serious even than those of Phylloxera.

DR. C. W. SIEMENS, F.R.S., has consented to distribute the prizes and certificates gained by the successful candidates of the metropolitan centres at the recent technological examinations, as well as by the students of the City and Guilds of London Technical College, Finsbury, and of the City and Guilds of London Technical Art School, Kennington. The distribution will take place on Thursday evening, December 14, at 7 o'clock, at Goldsmiths' Hall, Foster Lane, E.C.

TELEGRAMS from General Nansouty to Admiral Mouchez announce that an avalanche of fresh fallen snow had swept away five labourers who were trying to carry victuals to the Pic du Midi for MM. Henry, who are at that place to observe the transit of Venus. Two of these poor people lost their lives.

THE additions to the Zoological Society's Gardens during the past week include a Bonnet Monkey (*Macacus radiatus*) from India, presented by Mr. W. Nash; a Capybara (*Hydrochærus capybara*) from Venezuela, presented by Mrs. R. H. Fitz-Simons; a European Scops Owl (*Scops giu*), European, deposited.

THE ROYAL SOCIETY[1]

OUR anniversary is in one sense the opening of a new year, in another it is the close of an old one. With one hand we welcome the coming, with the other we bid farewell to the departing guest. In the later parts of my present address I shall have to speak, as on former occassions, of our prospects and hopes for the future. At our more festive gathering in the evening we shall recount some of the victories which have been won over difficulties in the extension of knowledge, and shall rejoice at the gathering of old comrades and friends after our usual period of dispersion. But at the moment of taking my place in the chair to which you have now for the fourth time elected me, I must confess that the sadder side of the picture is the most prominent. We seem almost for the moment to enter the Valley of the Shadow of Death, or, like Dante, to descend to the place of Departed Spirits, and to commune with them once more after they have vanished from the upper world. Each year during my own term of office the numbers lost to us have been greater than the numbers gained; but this year, although the list of deaths is long and comprises not a few distinguished Fellows, they all seem overshadowed by two prominent figures. One of these died in the fulness of years, of honours, and of world-wide reputation; the other in the strength and bouyancy of youth, a buoyancy which appears to have even contributed to his end.

Of Darwin and his works it is not for me to speak. Others, with wider knowledge, after longer intercourse, and with greater authority, have said what was possible at the moment, and the full story of his life is now being written by faithful hands. But I consider it no common piece of fortune to have lived within easy distance of his house: to have been able by a short pilgrimage to enjoy his bright welcome, and his genial conversation, and to revive from time to time a mental picture of that my ideal of the philosophic life.

Of Balfour I knew far less, and his works are beyond my range of knowledge. But such was the fascination of his speech and his demeanour that to have seen him was to desire to know him better. To have been selected at his age as one of the Secretaries of the British Association, a post usually reserved for men of more advanced years and of longer experience, to have been appointed to a professorship founded almost on the basis of his own work, and thereby to have become the coadjutor of his own great master in the Physiological School at Cambridge and all this without one word of cavil or of criticism, was a high testimony to his scientific eminence. But far wider afield, it will be remembered of him, not so much that he was brilliant in intellect, or keen of insight, or varied in his attainments, but that he always found himself among friends, whether in college or in the laboratory, in his own home over the northern border, or on the wild mountain side where he breathed his last.

The list of deceased Fellows comprises other eminent names, many of whom will receive mention in our obituary notices. The list, moreover, serves again to exemplify the variety of qualifications which have opened our doors to election. In Decimus Burton we find an architect of refined taste and cultivated mind; in Stanley Jevons and William Newmarch statisticians of weight, and the former already an authority on political and other philosophy; in Sir Woodbine Parish a geographer, and more than a geographer, a man who by service as well as by study in foreign lands had acquired an unusual amount of first hand and accurate information; in Scott Russell an engineer whose brilliant early strokes of work will be remembered when the difficulties which entangled his later efforts have been long forgotten; in Dr. Robinson a veteran and mentor in science, whose work and whose judgment were alike sound. Of Sir Wyville Thomson mention will be made elsewhere.

To this list of names there was well nigh added yet another, namely, my own. An accident, under circumstances which the issue of events and more mature reflection have shown that I was hardly justified in incurring, has for some time past interfered materially with my usual avocations in life, and thereby, as I fear, with my usefulness to the Society. But the ready and efficient assistance of the other officers has, I doubt not, gone far to supply the deficiency. For myself, I am consoled by the kind expression of sympathy from many, some even unknown, friends; and by the consideration, ever present to my mind, that, except through a combination of circumstances over which I had certainly no conscious control, the result to myself might have been far more serious.

[1] Address of the President, William Spottiswoode, D.C.L., LL.D., delivered at the Anniversary Meeting, November 30, 1882.

The total number of Fellows lost to our ranks during the past year is twenty-two on the home list (one of whom has withdrawn on account of growing infirmities), and four on the foreign list; a result, on the whole, not very different from that of last year.

Of these two fell young, and by accident. Of the remainder, two died between the ages of 50 and 60, four between those of 60 and 70, six between those of 70 and 80; and the remaining five attained ages between four score and 90.

In Liouville we have again lost a veteran mathematician; in Wöhler, a chemist whose years, numbered from the beginning of the present century, reached to a period almost prehistoric in the records of his science.

I am happy to report that the sale of the Acton estate has been completed; and that of the proceeds, amounting to 32,250*l.*, 17,000*l.* has been invested in preference or guaranteed railway stock; and the remainder will be expended in the purchase of ground rents, partly in the City of London, and partly in the western suburbs. The income from the latter source, already representing a very fair interest on the outlay, may be expected materially to increase at the expiration of the existing building leases. Some additional expense was incurred this year in painting a portion of the Society's apartments. A considerable portion still remains to be painted, either next year, or at some not very distant period.

While on the subject of property, I should mention that Her Majesty has sanctioned "the continuance of the occupation of the Royal Observatory at Kew by the Royal Society," upon certain conditions, which have been accepted. The building will be devoted, as heretofore, to the use of the Kew Committee, whose work, it must be remembered, is provided for in the main by the Gassiot Fund.

Last year the Society accepted a portrait of Sir J. D. Hooker, painted by Mr. John Collier, at the request and at the expense of a considerable number of Fellows. I trust that the Society will approve the action of myself and a few others, in this year offering for our collection a portrait, by the same artist, of Mr. Joule.

Mr. A. Le Gros has presented to the Society a bronze medallion head, executed by himself, of the late Mr. Darwin.

The Library has received many valuable contributions both from our Fellows and from others. Among the latter I may mention the completion of "The Lepidoptera of Ceylon," from the Government of Ceylon; G. Retzius' "Gehörorgan der Wirbelthiere," from the author; a new edition of Abel's works, from the Norwegian Government; and facsimile lithographs of some of the late Prof. Clifford's mathematical fragments, and the catalogue in two handsome volumes from the Public Library of Victoria.

The printing of the general part of our library catalogue is in progress; and although, owing to unforeseen difficulties the hope expressed last year, that it would have been now finished, has not been fulfilled, yet there seems little doubt that early next year it may be in the hands of the Fellows.

On the completion of this work the Library Committee contemplate resuming another decade, 1874-83, of the great Catalogue of Scientific papers; and the President and Council trust that the success which has attended the publication of the eight volumes already in existence will justify the Treasury in undertaking the printing of the second supplement when the MS. has been prepared.

In the staff of the Society I have happily no change to report. Of the existing members my own feelings would impel me to say much more; but, while they would probably wish me to be silent, I trust they will pardon me in this one remark: that while recent changes make me less apprehensive of any future alterations, they at the same time make me hope that any alteration may be long postponed.

Although the number of papers presented to the Society during the past year, apart from their contents, does not convey any very important information, yet in continuation of past practice I may perhaps carry on the ten years' table. It is as follows, showing a slight diminution in the past year:—

1873	92	papers	received.
1874	98	,,	,,
1875	88	,,	,,
1876	113	,,	,,
1877	97	,,	,,
1878	110	,,	,,
1879	118	,,	,,

1880.....123 papers received.
1881.....127 ,, ,,
1882.....109 ,, ,,

Among the papers of this year, I may notice the elaborate research by Dr. Debus on "The Chemical Theory of Gunpowder," forming the Bakerian lecture; the careful and long-continued investigations by Professors Liveing and Dewar on the spectra of water, and of carbon, and of mixed vapours.

Nor must I omit mention of Dr. C. W. Siemens' bold and original theory of the conversation of the solar energy, which has already given rise to so much discussion. It will be sufficient for me here to say that upon the questions therein raised the last word has been by no means said; and that, whether the theory be ultimately established, or whether, like a phœnix, it shall hereafter give rise to some other outcome from its own ashes, it will ever be remembered as having set many active minds at work, and will always have a place in the history of Solar Physics.

In Mathematics, definite integrals, and elliptic and the higher transcendents continue to occupy much attention, and in particular our "Transactions" contain an excellent contribution to the theta-functions of two variables, by Mr. Forsyth, of Liverpool. To the theory of invariants, Prof. Malet, of Cork, has given a happy extension in the direction of linear differential equations; but it is unnecessary to speak in detail of papers which either already are, or will shortly be, in the hands of the Fellows. I will only add that the "Philosophical Transactions" for 1882 will probably exceed in bulk, and not yield in interest to, those of any former year.

Looking outside the circle of our own publications, there has been one step gained during the past year, which, although in some sense a matter of detail, is really of great importance and interest. I allude to the paper by Lindemann, "Ueber die Zahl π" ("Mathematische Annalen," Band xx, p. 213). It had long since been shown that both the numbers π and π^2 are irrational; but hitherto no proof existed of the impossibility of effecting the quadrature of the circle by means of the straight line and circle, and ruler and compasses. Regarded from an algebraical point of view, every such construction must depend upon the solution of a quadratic equation, or rather of a series of quadratics whereof the first has for its coefficients rational numbers, and the succeeding members of the series only such irrational numbers as occur in the solution of their predecessors. This being so, the final equation can always be transformed, by transposition of terms and squaring, into an equation of an even degree with rational coefficients. And, consequently, if it can be proved that π cannot be the root of any algebraic equation whatever with rational coefficients, the impossibility of the quadrature of the circle will be thereby also proved. Starting from Hermite's researches ("Comptes Rendus," 1873), in which he established the transcendental nature of the number e, Lindemann has supplied the proof required with reference to the number π. It must be admitted that the proof is neither very simple nor very easy to follow; and it remains only to be hoped that it may some day assume such a form as may influence the minds which still exercise themselves upon the hopeless problem of squaring the circle.

A most important change in the relations between the Society and the Government in respect of State aid to science has been made this year. It will be in the recollection of the Fellows that an experiment was made for a period of five years, during which the sum of 4,000*l.* was annually voted to the Science and Art Department, to be distributed at the recommendation of the Government Fund Commitee of the Royal Society. That experimental period terminated, as then mentioned in my address, last year. The grant to the Science and Art Department has been discontinued, and in the place of it an addition of 3,000*l.* per annum has been made to the Government grant, making 4,000*l.* in all. In concluding this arrangement the following stipulations were agreed to. The increased grant is to be administered by a Committee identical with the late Government Fund Committee; a portion may be devoted to personal grants, subject, however, to special recommendations to the Treasury; and, lastly, unexpended balances may be carried forward from year to year, as has hitherto been the case with the old government grant only. To the stipulation that the increased fund should be administered by the more extended committee the Society felt that no reasonable objection could be offered, because upon it the President and Council are represented in full, and the *ex officio* members are in the majority of cases Fellows of the Society. The object of the second stipulation was, so far as the Society is concerned, to secure at the outset for the personal grants the consent and support of the Treasury, and thereby to preclude the chance of objection being subsequently taken to any of our proposals under this head. The President and Council, however, recognising the importance of great caution in respect of personal grants, have of their own motion appointed a special sub-committee (in addition to the three previously existing), to which all personal applications recommended by any of the other sub-committees are specially referred, and without whose recommendation none can come before the General Committee. To the third mentioned point, viz., the power of retaining unexpended balances, the President and Council attach great value, because that power may enable the Committee to devote more of its funds than heretofore to some of the larger undertakings in scientific inquiry, leaving more of the smaller grants to the special funds already in existence in the hands of the Royal and other societies. The meetings of this Committee will probably take place twice a year, in May and November. In the present year it will not be possible to hold the second meeting before December, but there will be advantages in holding it hereafter in November, as the entire annual grants will then be made by the same Committee, and under the sanction of the same President and Council. In concluding these few remarks on the new arrangements, I cannot refrain from expressing my sense of the obligation under which the Society and Science at large are laid by the sympathetic and intelligent attention bestowed upon the subject by the then Financial Secretary of the Treasury, the late Lord Frederick Cavendish.

Among other subjects referred to the Royal Society by Public Departments I may mention a request from the Board of Trade for advice upon the question of improving the existing means at the Standard Office for the purpose of comparisons. At the request of the President and Council, Sir George Airy, Colonel A. Ross Clarke, and Prof. Stokes acted as a Committee, and drew up a very careful report, the value of which was fully recognised by the Board of Trade. The report suggested certain improvements in the present arrangements; but, having reference to the duties of the Standard Office as defined by Act of Parliament, it was not considered necessary to insist upon extreme scientific accuracy, such, *e.g.*, as that attained by Colonel Clarke himself in his "Comparison of Standards" made at the Ordnance Survey Office at Southampton in 1866.

The arrangements for the observation of the Transit of Venus have been steadily progressing. The parties have now all started for their stations, after their period of training under the superintendence of Mr. Stone at Oxford. An adequate supply of instruments has been secured at moderate cost, and all the accessory parts have been procured and applied by the indefatigable care and forethought of our directing Astronomer.

The English Expeditions for the observation of the approaching Transit of Venus are organized as follows:—

ACCELERATED INGRESS.

Madagascar Observers.—Rev. S. J. Perry. Rev. W. Sidgreaves Mr. Carlisle.

Cape Observatory Observers.—Mr. Gill and Staff.

Aberdeen Road Observers.—Mr. Finlay, First Assistant of the Cape Observatory. Mr. Pett, Third Assistant of the Cape Observatory.

Montagu Road Observers.—Mr. A. Marth. Mr. C. M. Stevens.

RETARDED INGRESS.

Bermuda Observers.—Mr. J. Plummer. Lieut. Neate, R.N. Capt. Washington, R.E.

Jamaica Observers.—Dr. Copeland. Capt. Mackinlay, R.A. Mr. Maxwell Hall.

Barbadoes Observers.—Mr. C. G. Talmage. Lieut. Thomson, R.A.

Besides the observers at these stations, the Canadian Government has arranged to place three 6-inch and some smaller telescopes in the field. Lieut. Gordon of Toronto was sent by the Canadian Government to England to make himself master of the proposed arrangements, and to secure the necessary instrumental equipment.

ACCELERATED EGRESS.

The stations for Retarded Ingress are also available for Accelerated Egress.

RETARDED EGRESS.

Brisbane Observers.—Capt. W. G. Morris, R.E. Lieut. H. Darwin, R.E. Mr. Peek.

New Zealand Observers.—Lieut.-Col. Tupman, R.M.A. Lieut. Coke, R.N.

Besides these observers sent specially from England, the Observatories at Melbourne and Sydney are most favourably situated for observing the Egress. The Directors of these Observatories, Mr. Ellery and Mr. Russell, have promised their co-operation, and their Governments have placed funds at their disposal to cover any necessary expenses.

Unless unfavourable weather should prevent the transit being seen at some of the stations, we may expect some nine or ten pairs of corresponding observations, both at Ingress and Egress, from the British expeditions alone. These observations are certain to be largely supplemented by those made by the observers of other nations; and it is hoped, from close agreement between the instructions issued to the different observers, that the whole may ultimately be available for combination in one general discussion.

The American astronomers, encouraged by the partial success which attended the plan they adopted in 1874, are relying chiefly upon the photographic method; they have sent expeditions to South America and the Cape of Good Hope.

Austria does not take any active part in observing the Transit.

France sends out eight well equipped expeditions, full particulars of which have been published in the "Comptes Rendus" for October 2.

From Holland no special expedition will be sent out, but Lieutenent Heyming, of the Dutch Navy, will observe the transit in the West Indies, probably at Curaçoa.

Italy will confine its operations to observatories in that country.

Russia, also, has decided to send out no expeditions of its own, but it has aided the efforts of other countries by lending a 6·5-inch reflector to the Danish Government, and has placed two excellent 4·3-inch heliometers in the hands of the French astronomers, MM. Tisserand and Perrotin. The considerations which led the Russian Government to this conclusion have been explained in the following paragraphs of a letter from Mr. Struve to myself:

"Experience since 1874 has sufficiently proved that there is no prospect whatever, even with combined international efforts, of obtaining by the present transit a geometrical determination of the parallax of the sun, which would not soon be surpassed in accuracy by other recent methods (for example, that suggested by Mr. Gill), methods which are capable of being repeatedly employed, and that without any costly expeditions.

"Further, although it must be admitted that so rare an opportunity of studying the atmosphere of the planet ought not to be neglected, yet it seems certain that so many and such excellent data will be obtained through the agency of the United States, as well as by other countries having well provided observatories in the southern hemisphere, as well as by other seafaring nations." Under these circumstances Russia has not considered it incumbent on itself to organise any observing parties.

Spain has sent two parties of naval officers, well equipped with 6-inch equatoreals and other instruments, to the Havana and Porto Rico.

Last year I expressed a hope that the difference of longitude between Singapore and Port Darwin in Australia would be determined by Commander Green of the United States' Navy in concert with Mr. Todd. This operation, however, in consequence of some incorrect information furnished to Commander Green as to the intentions of our home authorities in the matter, was not carried out. After various proposals, extending over a period of not less than two years, I am happy to say that it now appears likely that the work will be performed. Through the liberality of the Secretary of State for War an extension of leave has been granted to Lieutenant Darwin, who accompanies Captain Morris to Brisbane to observe the transit of Venus, enabling him to undertake the work. He has received instructions to arrange with Mr. Todd all details of the operation. The publication of the results obtained by Oudemans and Pogson for the difference of longitude between Madras and Singapore has now left only one link wanting, namely, that between Batavia and Port Darwin, to connect Australia with English longitudes. Lieutenant Darwin is eminently qualified for the work; and it seems a happy coincidence that it should fall to his lot to connect astronomically the distant port named after his father with the furtherest ascertained point in that direction. I should not omit to add that Mr. Todd has placed all the telegraphic appliances under his command at the disposal of this service, and it is to be hoped that the determination will prove as useful to the Australian colonies as it will be valuable for the purposes of the transit. The best thanks of the Committee have already been given, but I am glad here publicly to recognise the valuable assistance rendered to the Committee in these long negotiations by the Great Eastern Telegraph Company.

In the course of last year the Treasury made known to the Society that in consequence of Sir Wyville Thomson's ill health, their Lordships proposed that his chief assistant, Mr. Murray, should undertake the general editorship of the Reports of the *Challenger* Expedition; so that Sir Wyville might devote himself more exclusively to the personal narrative. At the request of their Lordships a small Committee, with whom Mr. Murray might consult from time to time, was appointed, consisting of the President and Officers, Sir Joseph Hooker and Prof. Huxley; but before the Committee could meet the lamentable death of Sir Wyville Thomson occurred. They met, however, shortly afterwards, and having added Prof. Mosely to their number, they received from Mr. Murray, who attended, a detailed statement of the existing condition of the whole arrangements conected with the Report. From this statement it appeared that, in addition to the original estimate of 20,000*l.* given by Sir Wyville Thomson, the work actually in progress and entrusted to the several authors required a further sum of about 20,000*l.*, and that if the series should be completed, by describing on the same scale groups as yet unallotted, an additional expense of about 6,000*l.* would be entailed. In forwarding this statement to the Treasury, the Committee stated that, in their opinion, Mr. Murray's estimates were drawn up with great care and judgment, and that in view of the remaining Reports being carried out on the same scale as those already published, they were reasonable and sound. As to the cause of the great discrepancy the Committee felt themselves unable to offer any explanation; the conduct of the whole business having been left in Sir Wyville's hands, without reference to the Society. They further were of opinion that Mr. Murray might safely be entrusted, under the control and supervision of the Committee, with the entire future management of the undertaking.

After some further correspondence it was suggested that Mr. Murray should furnish the Committee with a statement of the existing condition of the Reports and their management, which should form a starting point for the responsibility of the Committee; and that he should keep the Committee well informed from time to time of the progress of the undertaking. These suggestions were cordially accepted by their Lordships, and with the general statement which Mr. Murray submitted in October, the special duties and responsibilities of the Committee have begun.

Since last year, three more volumes of the Report have been published, making six in all. The new volumes form volumes iv. and v. of the Zoology, and volume ii. of the Narrative. The latter volume comprises the magnetic results, the meteorological observations, the report on the pressure errors of the thermometers, and the petrology of St. Paul's rocks. Vol. i. of this section, containing the narrative proper, is partly in type; and will, it is hoped, be issued during the summer of 1883. Other volumes will also appear from time to time.

In connection with this subject, I may mention that the collection of specimens from the *Challenger* Expedition are being received at the British Museum, as the particular portions are released by the progress of the publication of the Report. Those derived from the *Alert* Expedition to the South Pacific Ocean, have been deposited in the Museum by the Admiralty, and are now being arranged and described. Dr. Günther hopes to be able to produce a printed descriptive catalogue of the collection before the expiration of the present year. And I desire here to acknowledge the service rendered to science by the Admiralty in commissioning Dr. Coppinger to accompany that expedition for scientific purposes.

I am indebted to Mr. Murray for the following interesting account of a cruise made last summer to complete some part of the *Challenger* work.

H.M.S. *Triton* was engaged, from the 4th of August to the 4th of September, in a re-examination of the physical and biological conditions of the Faroe Channel.

The chief objects of the cruise were to ascertain by actual

soundings, the character of a ridge running from the north of Scotland to the Faroe fishing banks, and separating, at depths exceeding 300 fathoms, the cold Arctic water with a temperature about 32° from the so-called Gulf Stream water on the Atlantic side with a temperature of 47° F. This ridge was traced in considerable detail by means of cross soundings directly across the channel, and the top was found to be on an average about 260 fathoms, beneath the surface. In the northern half of the ridge, however, a small saddle-back was found with a depth of a little over 300 fathoms, through which some of the Arctic water seemed to flow and to spread itself over the bottom on the Atlantic side of the ridge. The top of the ridge is entirely composed of gravel and stones, but mud and clay are found on either side at depths exceeding 300 fathoms. Many of the stones are rounded, and some of them have distinct glacial markings. They are fragments of sandstone, diorite, mica-schist, gneiss, amphibolite, chloritic rock, micaceous sandstone, limestone, and other minerals. The ocean currents here appear to be strong enough, at a depth of between 250 and 300 fathoms, to prevent any fine deposit, such as mud or clay, being formed on the top of the ridge. All the indications obtained of the nature of this ridge, seem to imply that it may be a huge (terminal?) moraine.

It is worthy of notice that the "Wyville Thomson Ridge" is only a little to the east of the position marked out by Croll from the observations of Geikie, Peach, and others, as the probable limit of the perpendicular ice cliff formed in North Western Europe during the period of maximum glaciation.

The dredging captures show the same marked difference as had previously been pointed out in the fauna of the two areas; those in the cold area being of a distinctly Arctic character, and those in the warm area resembling the universally distributed deep-sea fauna of the great oceans. A fair proportion of new species were also found.

The last trip of the *Triton* took place from Oban, on the 11th September, to the deep water in the Atlantic westward of Ireland. The object of this trip was to get *directly* a determination of the pressure unit of the guages employed in testing the *Challenger* thermometers. The original determinations were made *indirectly* by the help of Amagat's results as to compression of air. The observations taken are not yet reduced, but several successful trials were made at depths of 500, 800, and 1,400 fathoms.

(*To be continued.*)

M. MIKLUKHO-MACLAY ON NEW GUINEA

ON October 11 M. Miklukho-Maclay gave, at the Russian Geographical Society, the first of a series of lectures on his sojourn in New Guinea. These lectures have attracted great audiences. His remarkable collections of household articles and implements of Papuans and of various tribes of the Malacca Peninsula, and the many drawings reproducing scenes of the life, dwellings, graves, anthropological types, &c., of the natives, are exhibited in the rooms of the Geographical Society, and attract many visitors.

M. Miklukho-Maclay left St. Petersburg in 1872, and went on board a Russian ship to New Guinea. He expressed the wish to be left there for at least a year, and it was fifteen months after his being landed that he was taken up by a ship which brought him to Batavia. His stay in New Guinea was beset with difficulties. He lived in a small hut, was short of provisions, which he had to supply by hunting, and his health was quite broken down. But he entered into very close relations with the natives. In Batavia he stayed for several years, and published (in German) the results of his anthropological and ethnological observations among the Papuans, on the Brachycephaly of the same, and on the climate of the "Maclay-coast" in the Batavian scientific journal, *Natuurkundig Tijdschrift voor Nederlandsch Indie*. A paper (in French) on the Vestiges of Art among the Papuans appeared in the *Bulletin de la Société d'Anthropologie de Paris* for 1878. In 1876 he undertook a new journey on board the English schooner *Sea Bird*, and visited the Yap, Pelau, Admiralty, and Ninigo Islands, and went again to the coast of New Guinea, to which his name is now attached. An account of this journey has appeared in the *Isvestia* of the Russian Geographical Society and in *Petermann's Mittheilungen* for 1879. During this second sojourn in New Guinea M. Miklukho-Maclay was lodged more comfortably, and was enabled to pursue scientific investigations (anthropological measurements and anatomical researches) with less difficulty. He also explored in a canoe, with natives, the coast of New Guinea between Cape Croaz and Cape Teliata. Having undertaken his adventurous journey on his own account with but a little occasional support from the Geographical Society, M. Miklukho-Maclay was often in difficult circumstances; but a few years ago a public subscription was opened by the Russian papers, and the Russian Society immediately came to his aid, thus enabling him to continue his researches.

When in search of a place at which to study the customs and life of the primitive people at the lowest stage of culture, M. Maclay chose the north-western coast of New Guinea, close by Astrolabe Bay, which was never visited before by Europeans. Neither Dampier nor Dumont D'Urville, who both passed close by, had landed there. He built his hut between two Papuan villages, on a promontory that was occupied by nobody. At the beginning the Papuans wished him to go back whence he came, and obstinately showed him the sea; sometimes they launched their arrows close by him, but without wounding. By great endurance however, by his good nature, and especially by a continuous self-control and severe watching over his own actions, M. Maclay soon won the confidence of the natives. He always strictly kept his word, even in the most insignificant circumstances, and therefore had afterwards the satisfaction of hearing the natives saying "*Balan Maclay koodi*" ("The word of Maclay is one"). The natives used to call him *Kaaram-lame*, "The Moonman," partly on account of the supernatural capacities they ascribed to him, and partly on account of his having once, when searching for something about his hut in the night, lighted a white signal-fire that was left from the ship which brought him. The first visits of M. Maclay to the Papuan villages were a source of great trouble among the natives; the women were concealed and the men seized their arms. M. Maclay used then to announce beforehand his arrival by loud whistling, and the natives concluded he did not wish to do them harm. By and by he won the confidence of the natives to such an extent that an attack of a hostile tribe having been expected, his neighbours brought their women and children to his hut, to be under his protection. The war was thus prevented, and the authority of the "Moon-man" was sufficient to prevent further wars.

The natives of this coast are at the lowest stage of culture. Before M. Maclay's arrival they did not know the use of metals, all their implements being made of stone, bones, and wood. They did not even know how to make fire. If the fire were extinguished in a hut, it was taken from another; it would be taken from a neighbouring village if extinguished in all the huts of the village at once. Their grandfathers told them of a time when they had no fire; then they ate their food quite raw, and a disease of the gums spread among them. They do not bury their dead. The dead are put in a sitting position, the corpse is covered with leaves of the cocoa-palm, and the wife must keep a fire close by him for two or three weeks, until the corpse is dried. Corpses are buried only if there is nobody to keep the fire.

M. Maclay left the Papuans with regret, when a passing schooner took him, in 1878, to Singapore. He expects for his friends the fate of the inhabitants of the Melanesian Archipelago, where the population rapidly diminishes on account of the "kidnapping" of men and women to sell them into slavery, which is practised to a great extent by crews of ships of all nationalities of the civilised world.

In his second lecture, M. Miklukho Maclay gave further information with regard to the Papuans of New Guinea. Previous anthropologists had admitted the existence of at least two different races in New Guinea, and had made a distinction between the Papuans inhabiting the coast and those of the interior. After several visits to New Guinea, as well to the coast, as to the interior, M. Maclay came to the conclusion that this supposition is not correct. The Papuans of the interior belong to the same race as those of the coast, and there is throughout New Guinea but one single Papuan race. Virchow found it also necessary, on the ground of craniological measurements, to distinguish the Papuans from the Negritos of the Philippine Islands, and to admit that the former are dolichocephalic, and the second brachiocephalic. Hundreds of measurements made by M. Maclay brought him to the conclusion that both types have their representatives even among the purest Papuans of the Maclay coast, and that the transversal diameter of the skulls of Papuans varies everywhere within so wide limits (62 to 86 per cent. of the length of the skull), that no classification can rest on this feature. It was stated also that a special

feature of the Papuans which distinguishes them from other curly-haired races, is that their hairs grow in clusters, separated from one another by sinuous spaces devoid of hair. Extensive researches proved, however, that this cluster-like disposition of hairs does not exist among Papuans, not even among children. Finally, several anthropologists considered the diameter of the curls of the hairs as a feature that may help to establish a distinction between the Papuans and the Negritos; these last have been supposed to have smaller curls than the former, that is, no more than one or two millimetres wide. M. Maclay found, however, that the diameter of the curls of the Papuan also does not exceed one and a half millimetre, and that it varies very much in different parts of the head, so that this feature cannot be taken as a basis for anthropological classification.

After having taken some rest at Buitenzorg, M. Maclay left Batavia in January, 1873, for a third visit to New Guinea. The Malayans of Celebes have carried on an intercourse with New Guinea for more than three or four hundred years; they go there, as well as the inhabitants of the islands Lant, Seram, and Key, for the purchase of slaves, turtles, trepang, and pearl shells. To establish closer relations with the natives, the Malayans of Celebes bring with them Malayan girls, give them as wives to the Papuans, and export in exchange Papuan girls who are married in Celebes. (These relations were described by P. A. Leupe in the "Bijdragen tot de Taal-Land en Volkenkunde van Nederlandsch-Indie" for 1865.) Therefore it is impossible to find pure Papuans on the Papua-Onim and Papua-Notan coasts, and M. Maclay took the resolution to go to the Papua-Koviay coast. The inhabitants of this coast have a very bad reputation as robbers and anthropophagi; but still, M. Maclay hired a Malayan "praw," or "urumbay," that is, a boat thirty feet long, and, with a crew of two Christians from Amboyna, and fourteen Malayans and Papuans, he left the islands Seram-Lamut, and reached the Koviay coast. Triton Bay (where the Dutch had formerly a military settlement) proved to be a beautiful strait, to which M. Maclay gave the name of the Russian Grand Duchess Helena Pavlovna. He discovered also another bay that separates the island Namatote from the mainland of New Guinea. He stopped at Aiva, between these two straits, and his men immediately erected a hut from the "ataps" (a kind of mat made from leaves of the tapioca palm) that were brought in the boat. The inhabitants of this coast proved to belong to the same race as those of the Maclay coast; however, it was easy to perceive, especially among children, unmistakable traces of mixture of Malayan blood. The size of the men on the Maclay coast varies from 1·74 metres to 1·42; the size of full-grown women was 1·32. On the Papua-Koviay coast the size of the men was from 1·75 to 1·48 metres, and the size of the women 1·31. On the Maclay coast the length of the transversal diameter of the skull was from 64·0 to 86·4 per cent. of the longitudinal diameter, and from 62 to 80 per cent. on the Koviay coast.

Leaving ten men at Aiva, M. Maclay went with the remainder of his crew to explore the interior of the mainland. He landed opposite Coira Island, and, crossing a range of mountains 1200 feet high, reached Lake Kamaka-Vallar. He found there a tribe which calls itself Vaasirau, but does not differ from the inhabitants of the coast. The water of the lake was very warm (31° Celsius), and contained an interesting new kind of sponge, belonging to the *Hallichondriæ*. The rains in this part of New Guinea are so copious that Triton Bay is sometimes covered with a sheet of sweet water that can be taken in vessels and used for drinking. As the lake has no outlet, its water rises many years, sometimes fifteen and twenty feet, and covers the trees that grow on its shores; but after a period of rising, the rocks at its bottom give way, and the water is discharged through a temporary outlet, which is soon checked by stones and mud. Returning to the shore, M. Maclay made excursions to the neighbouring islands (discovering coal on Lakahia Island), as well as several other excursions to the highlands of New Guinea. In Telok Bay the boat of M. Maclay was attacked by a number of pirogues of Papuans, but made his escape by rowing all night. But his men at Aiva were not so fortunate. They were attacked by 200 Papuans, who destroyed the hut and killed an old man who was interpreter, as well as his wife and child. A further stay at Aiva was impossible, as the Papuans had poisoned the springs; and so the party went to stay on Aidam Island, where M. Maclay's hunter brought him every day plenty of interesting birds and other animals. The New Guinea kangaroo, *Dendrologus tersinus*, is worthy of mention, as it has to adapt itself to local conditions, strong nails, and lost at the same time the strength of the muscles of the tail; it has become thus a climbing animal and lives mostly in trees. After having taken prisoner the chief of the Papuans who had robbed his hut, (M Maclay went one day with a few men to their camp, and simply ordered them to tie the chief; the Papuans, terrified by the sudden appearance of a white, opposed no resistance), the party returned to the Seram-Lamut Islands, where M. Maclay studied the mixed race from the crossing of Malayans with Papuans. The anthroplogical results of these studies have appeared in the above-mentioned periodical as an appendix to the paper entitled "Meine zweite Excursion nach Neue Guinea," 1874."

The Papuans of the Koviay coast are a very interesting race of aquatic nomads. They were centuries since in relations with Malayans, who came to New Guinea especially to purchase slaves, exported to a great extent to the Malayan Islands. The slaves were formerly purchased among the inhabitants of the sea-coast; but to have more slaves these last have begun to make raids on the highlanders, who took revenge by raids themselves, so that the inhabitants of the coast were compelled to abandon all their villages. They are living now in covered boats, and continually cruise in them along the shore in search of food, landing only during storms, for in the night, at a few well-known places, where they are safe from attacks by the highlanders. The Malayans have introduced among them the use of gold, opium, and fire-arms, and they are very miserable.

From the Koviag coast, M. Maclay returned to Java, but soon undertook a fourth journey to New Guinea, to the southern coast, in order to ascertain the existence of a yellow Malayan race, which was mentioned several times by missionaries and travellers. After an eleven months' cruise on board a schooner, during which he visited the Solomon and Luisiada Islands, M. Maclay stopped on Teste Island, and thence proceeded on board a schooner to Port-Maresby (Anapuata), on the southern coast of New Guinea. During his visits to the neighbouring villages, he perceived, indeed, a mixture of Polynesian blood among the Papuans. These metiss have a lighter skin and uncurled hair. They have also taken from the Polynesians the use of tattooing; all women tattoo themselves as long as they have children, and M. Maclay remarks that not only himself, but also many Europeans, find that the tattooed Papuan women are really better looking than the un-tattooed. They cover themselves with tattooing from the forehead to the feet, and often shave the head to tattoo it. The men are tattooed only to exhibit some of their exploits; by simply looking at a tattooed man you can say how many foes he has killed. The south coast is inhabited by the same Papuans as the other parts of New Guinea. Here also brachiocephalic skulls are not uncommon; but the skulls are also distorted, as the women used to bear loads on their backs, in bags that are attached by a rope to the head. The transversal depression of the bones at the *Satura sagitalis*, which results from this custom, is met with very often, and must be transmitted by heredity.

M. Maclay made a fifth visit to New Guinea on board an English man-of-war, to exercise his conciliating influence on the commander, who was going to burn a whole village and destroy the 2000 inhabitants, in order to punish them for killing four missionaries. The visit was very short.

M. Maclay concluded his lecture with a few remarks on the influence of the whites on the inhabitants of the south coast of New Guinea. Whilst rendering justice to the efforts of the London Missionary Society, who spread, by means of their black staff, the Christian religion, and teach the natives to read and write, M. Maclay pointed out that traders follow immediately the missionaries, and spread among the natives diseases, drunkenness, and the use of fire arms, which completely counterbalance the good influence of the very small amount of knowledge that might be spread by missionaries. The London Missionary Society does not allow its members to be at the same time the bearers of religion and of the above-said "benefits of civilisation"; but several missionaries of other societies appear in both these qualities. M. Maclay hopes, however, that the climate of New Guinea will be a good ally of the natives in their struggle against the white.

THE AURORA

WE have received the following further communications relating to the electric storm and auroral display of November 17:—

HAVING read in the English journals how very extensively and simultaneously the remarkable display of aurora borealis was observed in Europe and the United States, I beg to forward the inclosed report from Prof. Tacchini (see below), taken from a newspaper in Rome, describing that splendid phenomenon as it appeared in this country on the evening of the 17th inst, which probably may interest some of your readers. I would merely add that on the evening in question I was travelling between Spezzia and this city, when my observation was absorbed by the brilliancy of the beautiful phenomenon as seen from a railway carriage, and which accords very closely with the appearance of it in Rome. Soon after sunset the north-western sky was diffused with richly-coloured roseate tints blending into crimson at the horizon, which continued up to 7 p.m. ; the transparency of this apparently roseate cloud was also a very remarkable feature, for the stars of the Great Bear were seen through it with little diminution of lustre ; the sunset was very noticeable, which I remarked before branching from the coast where I had the sea horizon, and I never saw a more distinct and clear disappearance of the sun at sea below the horizon, even to the clearness of the atmosphere. Aurora borealis is so seldom seen in this country that its appearance caused much public curiosity. ERASMUS OMMANNEY

Florence, 12, Lungarno, November 30

THE following account of aurora borealis, seen on the 17th ult., at the Observatory of the Roman College, was sent by Prof. Tacchini to the Roman journals :—

"Yesterday evening (the 17th), a few hours after sunset, a fine aurora borealis appeared on our horizon. Besides the magnificent rosy arch melting away above, I saw, below, the so-called dark segment, which had a most lovely azure-greenish colour.

"At 5h. 50m. the red ribband rose more than 30° above the horizon, but at 5h. 55m. clouds suddenly covered almost the whole of that part of the sky occupied by the aurora, and a storm, with lightning, arose in the north. At 6h. 18m. there was a slight clearance, and through the aurora, which had already paled, shone some of the stars of Ursa Major. The highest point of the dark segment was precisely between the stars α and ζ of that constellation, being about 14° above the horizon, and 17° from the north towards west, therefore nearly in the direction of the magnetic meridian, and with an amplitude of about 45°. The weather continued bad, and at intervals rainy, and at 6h. 32m. were seen the last traces of the phenomenon. From the auroral light only a very faint continuous spectrum could be obtained, but I could not make such observations at the most opportune moment.

"Several falling stars were observed through the aurora. A magnetic perturbation occurred yesterday, and in the night, and continued also to-day ; and, moreover, there is on the sun a large spot, easily visible on using merely a piece of smoked glass.

"The large diameter of this spot is slightly less than the thirteenth part of the apparent diameter of the solar disc. The spot appeared on November 12, at the eastern limb in the sun's boreal hemisphere, and on the 12th and 13th magnetic perturbations occurred. Yesterday I could not observe it well, because of the bad weather ; but the day before, clouds of hydrogen were seen on its nuclei, and this morning still the phenomenon is most brilliant, demonstrating the greater intensity of solar phenomena over the spots in the atmosphere of the sun, which may thus be called solar auroras.

"Again, the magnetic perturbation of yesterday and last night is connected with that vast storm depression, which embraced a great part of Central Europe and especially Italy.

"We will further record here, that in the beginning of last October another aurora borealis was observed, and that then also there were strong magnetic perturbations in the earth, and large spots on the sun, seen on the limb on September 25.

"The Director of the Telegraphs has announced that very great perturbations occurred yesterday on all the lines, and from Belluno, Milan, Turin, Moncalieri, Venice, Porto Maurizio, Parma, Modena, Genoa, Luveno, and Viesti have come telegrams, showing that in the north the phenomena must have been very splendid. From Venice the Director of the Observatory states that yesterday morning at 4 o'clock, gleams of auroral light were observed. " P. TACCHINI

"Observatory of the Roman College, November 18"

I AM afraid you must have been overburdened with auroral communications, but perhaps you will kindly allow me on this occasion a little more space. Mr. E. Dowlen witnessed at Medway, Poynton, Cheshire, but little of that of the 17th ; but on the 13th saw an auroral haze with shafts of white light, at 6 p.m. in the north and north-west. This had been preceded by a rose-red sunset, unlike an ordinary one, and accompanied by magnetic clouds. He also noticed an auroral glow on several subsequent nights.

On Friday last (the 24th) the Rev. W. Pearce saw a fine aurora at West Horsley, about six miles east from here. It commenced about 9h. 15m. by a yellow glow in the north-north-east and north-north-west, which increased in brightness and rose upwards, until at 9h. 30m. the Great Bear was hidden by it. It then changed to a rose tint, and spread laterally ; was at its greatest brilliancy at 9h. 50m., and disappeared at 10h. 15m. Mr. Prince, of Crowborough (who, from the movements of certain insects and the magnetic disturbances, anticipates a severe winter), remarks that the "bright beam" must have been like a row of patches of light he saw on last October 3, southward and nearly parallel with the auroral arch northward. As some of your correspondents seem to ascribe a meteoric character to this beam, I may add I examined it carefully with a large Browning direct-vision spectroscope designed for auroral observations, and found only the well-known citron line, and none other. Also a faint greenish-white continuous spectrum extending a short way from that line towards the violet. This might have been auroral or from moon reflection. I had just previously examined the sky in that direction, and found no auroral line.

Mr. Saxby's letter is interesting in fixing approximately the position and height of the beam, especially when read in connection with Messrs. De la Rue and Müller's vacuum experiments and their table of heights assigned to auroræ, and it is still paradoxical that if such electric displays be within the limits of our atmosphere the air-spectrum is conspicuous for its absence, while it is replaced by one the principal line of which is not found in any other form of matter in the sky or on the earth.

On the other hand this point would not be inexplicable if the aurora be considered a something *per se*, as, for example, phosphorescence (strongly marked in the recent auroræ), excited by the electric discharge. That in such case it might wholly or in great part appropriate the spectrum to itself is shown by the instances of indium, thallium, and some other volatile metals which, when used as electrodes for the condensed spark, give spectra in which the air lines are either absent or faint, and when burnt in the arc have a similar effect on the carbon lines. I have elsewhere pointed out the probability of the aurora being referable to a form of phosphorescence.

The moonlight was unfortunate as regards the masking the fainter lines of the spectrum. I see one record of a faint red line, but except this of no other lines. If any of your readers have fixed the other lines, you will no doubt find space for so important an observation, for it is curious how little we know of the exact positions of these. I believe the measurements of a full set of the auroral lines made by my friend Prof. Vogel of Potsdam, in April, 1872, still remain the only standard, and as we now seem at an auroral period I would earnestly urge upon spectroscopists their special attention to these fainter lines, with a view to fixing their positions. This, too, is important, as there is a suspicion they are not always the same in different displays. The mode of doing this is not, however, very easy. If the spectroscope is of very small dispersion, the lines will be too close for useful measurement. With one of larger dispersion the introduction of a comparison spectrum or an illuminated micrometer scale will swamp the lines. A single illuminated point or line working across the field, the eclipsing the lines successively behind a diaphragm of tinfoil (as suggested by Mr. Lockyer), and a scale photographed on thin glass, through which the lines are seen, and which is itself illuminated by the spectrum, are severally better methods, and might perhaps yield some available results.

Guildown, Guildford, December 1 J. RAND CAPRON

THE unique nature of this meteor must be the excuse for adding another letter on the subject. Your correspondents, Mr. Taylor of Heworth Green, York, and Mr. Elger of Kempton, have kindly answered queries of mine as to the exact place of the passage ; these stations being the most important, after the transit stations of Woodbridge and Old Windsor. After Mr. Saxby's letter of November 30, any farther notice may seem superfluous, were it not that the elements he assigns cannot explain the observations. At York the meteor could not have

appeared at only 8° altitude, and it is described as 6° under the moon, or 19° alt. ; and the passage from Woodbridge to Bristol could not occupy over two hours (at a mile a minute), as the whole difference of time is certainly only a minute or two. We must then seek for more consistent elements.

From the York, Bedford, and Old Windsor observations, the meteor was at about 170 miles elevation, allowing the first station half the weight of the second. Or, combining York and Bristol, which were more nearly simultaneous, it was at over 300 miles elevation. Its visible passage of about 200 miles in length did not occupy two minutes, and was so brief as to be masked by the watch errors of observers ; it therefore moved more than 100 miles a minute. Again, it was two minutes in view, by Greenwich ; and it passed the meridian with at least twice its mean apparent velocity (as most observers mention its lingering in both east and west) ; this, with the least height of 170 miles, gives a minimum of fifteen miles per second for its velocity. Another proof of its height is, that though seen in Sweden, yet it appeared to form and pause at 10° alt., as seen at Bristol and Heworth, and did not come up from the horizon.

Can it be supposed that an auroral ray would sweep over 1000 miles from Sweden to Sidmouth, with a velocity of over fifteen miles a second? This is, however, just the velocity of planetary matter ; and apparently the most probable explanation of it is that it was a cloud of meteorites ("quite unlike an auroral ray," says Mr. Capron) which just escaped grazing the earth's surface. In this case their velocity would be at least over twenty miles a second, moving in about the plane of the earth's orbit, and crossing the earth's path at least at 45°, or more radially. Perhaps some computer will work out the path approximately, as other meteors have been so discussed.

Such a cloud of meteorites must have been at least 130 × 20 miles and 20 miles deep if cylindrical, and was apparently accompanied by a smaller cloud, as seen at Clevedon. As it was seen brightly in the moonlight, and yet scarcely dulled the moon in crossing it, the visual area of the solid mass might be about a tenth of the whole area of the cloud ; so that if the particles were as dark as the moon, the cloud would reflect one-tenth as much sunlight in an equal visual area. If then the mean diameter of the meteors was but 1 inch, their volume would equal a sphere of 800 feet diameter, and would have thrown down a rain of meteors, averaging ninety one-inch balls to the square foot, over a district about twenty miles across.

Falling meteors lose practically all their velocity by friction in the atmosphere, before they strike the earth ; since travelling at even 15 miles a second, they would be heated to over 1,000,000° F. by arrest, and yet they do not show in themselves or by their effects, a sign of a thousandth of this heat. All this heat then is produced in the air ; and if a meteor strike the earth obliquely, it will be checked and fall within a very few miles. All the heating of the air must thus take place within a small area, in whatever way the meteor may strike. The result then of such a meteor cloud as has been just seen, hitting the atmosphere (as it only escaped doing by a quarter of a minute) would be to heat the air for some twenty miles in each direction to about 10,000° F., or still more if the arrest occurs entirely in the upper regions. This hot air would quickly rise, and spread out above the cooler atmosphere, causing a great in-suck along the earth from surrounding parts. On the upper surface it would quickly cool by radiation into space ; and the effects of such a shower to terrestrials would be a terrible gale, blowing towards a centre and upwards, with considerable heat radiating from above.

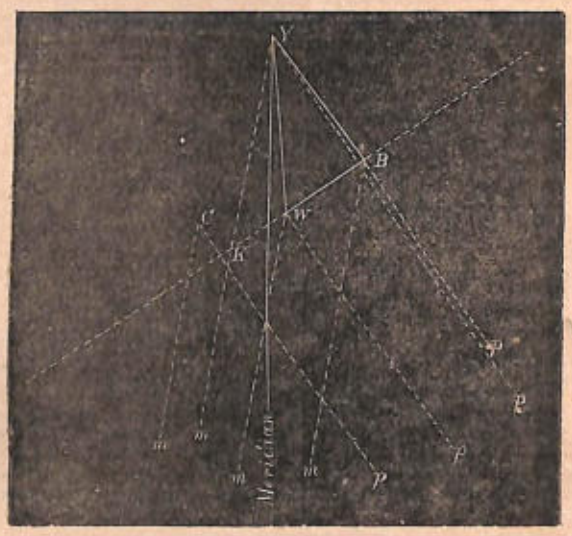
W. M. FLINDERS PETRIE

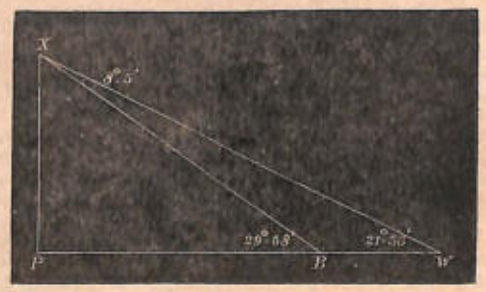
Bromley, Kent, December 2

CONCERNING the apparition during the aurora of the 17th, I ought to have stated the apparent altitude angle between it and the moon when at nearest approach, but as the angle was larger here than anywhere south, it was more difficult to estimate ; but I think it was about 12 moon-breadths, at the very most or 6° (centre to centre). Also I foolishly forgot to note the *exact* time, but it was 4 or 5 minutes past 6 p.m. I saw no repetition of the phenomenon for 5 minutes after, and I then went indoors. It is evident that if it was the same object that was seen to transit the moon's disc both at Woodbridge (near Ipswich) and Windsor, that it must have followed a path from north-east by east to south-west by west (astronomical) since the intersection of its plane of motion with the plane containing York, Woodbridge, and Windsor, lies in that direction. Most of the observers state that it seemed to appear about east, and disappear south of west. Let *Y*, *W*, and *B* represent York, Windsor, and Woodbridge respectively in their relative positions. *C* represents Clifton.

We have $Y B = 162$ miles.
$Y W = 172$,,
$B W = 94$,,
$C K = 40$,,

If it be supposed that the object pursued a *nearly straight path*, keeping at a nearly constant height (and this is not inconsistent with the observations), then it ought to have reached its greatest angle of elevation along lines drawn perpendicular to line *B W* from each place of observation (it seemed to do so at Greenwich, Bedford, and Cambridge, though all the observers do not state whether they reckoned by magnetic or astronomical bearings). The moon was about 8° past meridian, and at York the altitude was about 24°, and at Woodbridge 26° (there being 2° of latitude between). If we consider the angles with respect to the *plane Y B W*, which simplifies matters, then elevation at York = 25°, and at Woodbridge the same ; and as





angle between directions *Y m* and *Y P* = 36°. Then tan of angle of culmination at York will be equal to

$$\frac{\tan (25^\circ - 7^\circ)}{\cos 36^\circ} = \tan (21^\circ 53'),$$

and tan angle of culm. at Woodbridge will be equal to

$$\frac{\tan 25^\circ}{\cos 36^\circ} = \tan (29^\circ 58').$$

I am supposing the angle below the moon to be 7° for the sake of not exaggerating the height.

York and Woodbridge are in a line almost at right angles to *B W*. Then the parallax of the object when seen along this line (being the line of culmination) = 29° 58′ − 21° 53′ = 8° 5′ about.

Thus in diagram No. (2) we have—

$$B x = 160 \text{ miles} \times \frac{\sin (21^\circ 53')}{\sin (8^\circ 5')}$$

and required height $x P = B x \sin (29^\circ 58')$.

This, when worked out, gives the astonishing height of 212 miles above the *plane VWB*. Nor can I see how this result can be lessened in any way, for I have allowed an exaggerated parallax. Again, if the mysterious object was *not* pursuing a path almost straight and parallel to the plane *VWB*, as I have supposed, for the sake of a rough calculation, it must have travelled in a *crooked* one, for which there will be evidence forthcoming no doubt. Now Clifton is forty miles off the line *B W*, and as Mr. A. M. Worthington carefully estimated the depression below the moon from centre to centre to be scarcely $3\frac{1}{2}$ moon diameters, or about $1\frac{3}{4}$ degrees, then at York, which is 160 miles off line *WB*, the depression ought to be $1\frac{3}{4}° \times 4$ nearly = nearly 7° (but it was not so much). I and Mr. Worthington would see it beneath the moon nearly at the same time, he a little later than I. If the height should be anything near 212 miles, then we ought to hear of it being seen overhead in the north of Italy and Southern France, and it would be 200 miles or so in length. I hope that more accurate observations will be forthcoming to enable some scientific man to calculate the path of this strange apparition with some accuracy. Of course, if the thing laid straight along its path, it would appear to observers in England to be curved along its trajectory, as it did to me. I ought to say that at its apparent formation it was partly obscured by cloud in the S.E.E. (astronomical).

Heworth, York, November 26 H. DENNIS TAYLOR

P.S.—Might I be allowed a little more space just to state that my estimate of the meteoroid's depression below the moon is considered far too much by my mother, who, happening to look out at the same time from a window, noticed it beneath the moon. She described it exactly as I had seen it, but did not notice its movement, as she only looked for a few seconds. If there had been two similar appearances at the same time, I do not see how I could have failed to notice them. Mr. S. H. Saxby estimates its height to have been 44 miles, but he will see that if that were so, then I ought to have seen it pass 17° below the moon. One cannot reasonably suppose that a different object of the same nature has been seen from the South of England, from the one that I saw. I see that Mr. A. Batson has observed it crossing the moon exactly from Hungerford, which place is in almost a direct line with York and the moon at the time of observation. Our observations would be simultaneous, and they give a height of 192 miles. The course of the meteoroid would be 22° south of west, almost as Mr. S. H. Saxby states. Being very anxious to obtain more exact data from observers in Yorkshire I sent a letter asking for information from any such to the *York Herald*, but it has not been inserted. Is there anything inherently improbable in supposing this phenomenon to have been at a height of 190 miles, for have not rapid shooting stars now and then been seen incandescent at nearly that height, indicating the existence of an attenuated atmosphere.—H. D. T.

December 3

ON Friday November 17 last, as I was walking along the north side of Lincoln's Inn Fields, at about 6 p.m., my attention was attracted to the moon, which was then shining brightly in a cloudless sky. I observed a broad band of light having somewhat the appearance of a light cloud, only much brighter, moving across the face of the moon from east to west, which was the direction of its (the light's) long diameter. It appeared to me to extend above and below the moon to about the distance of the moon's diameter, and to be in length about four times its own width; when it had passed about half its own length from the moon, it seemed to disappear entirely. The time during which it was visible, I should think, was not more than half a minute, probably not more than a quarter, and its movement across the moon as rapid as that of a cloud when a very high wind is blowing. EDWARD POLLOCK

20, York Terrace, Regent's Park, December 1

A GREAT manifestation of aurora was visible here last night. It attracted my notice at 11 p.m. At the time of observation by me the aurora was very active, projecting white streamers from a point in the south-west, and these, crossing the zenith, faded in the south-eastern sky. There was a stiff, cold north-west wind blowing, and the night was frosty. No prismatic colours were noticeable, only the usual green auroral glow in the north-west sky, where it was crossed by the shooting streamers. A grand band of vapour rested on the western, north-western, and northern horizons. In the east and north-east was a soft blue sky. The display seemed to me to last throughout the night, and to continue through the day; as all day long, at intervals, streamers shot up from a bank of clouds in the north-west horizon. At 5.30 p.m. this evening there was a powerful auroral glare in the west and north-west. After that time a cloud canopy formed and hid the sky. The weather here in the afternoon of Monday was stormy, with a rising barometer and a falling thermometer, wind nearly a gale, hail, rain, and snow falling at intervals. X.

Worcester, November 28

IN NATURE, vol. xxvii. p. 548-9, and 571, will be found accounts of the aurora borealis, as seen by your correspondents on Monday evening, October 2 last. I wish to draw attention to the fact that a grand Aurora Australis of magnificent appearance was visible in Australia on Monday evening, also on October 2, but of course was seen by our Antipodean friends about twelve hours before the one seen at this end of the globe. The reports that I have of the Aurora Australis are from Adelaide, Melbourne, Sydney, Sandhurst, Ballarat, &c. So brilliant was it that the firemen turned out, imagining that there was some enormous conflagration in their neighbourhood. This concurrence opens up the question, was there any connection between these two displays? J. FRANCIS COLE

Westfield, Sutton, Surrey, November 28

BY kindness of Astronomer Royal, Greenwich, I am able to add the exact position of moon at Ramsbury, November 17, inst., at 6h. 2m.:—

R.A. = 21h. 12m. 56s.
N.P.D. = 100° 35′ 7″.

At this time the hour angle of the moon was 35m. 49s., or 8° 57′ 15″ west of the meridian.

The above is the most accurate observation possible for calculating the real position with regard to the earth.

Ramsbury, Wilts ALFRED BATSON

I DO not know whether you will publish more auroral accounts, but if you do, the inclosed seems very interesting. The phenomena, as seen in the north, differed much from *our* views of them. J. RAND CAPRON

Guildown, December 4

"A singular pinkish light appeared in the western sky between 5 and 6 p.m. At the same time I noticed a light of a peculiar yellowish white rising up from the eastern horizon. The general appearance was that of two conical-shaped lights about 40° to 50° wide at base, east and west horizon, their apexes meeting at or about the zenith, z. The whole of the northern sky was more or less illuminated, but much more marked in the transverse streaks extending east and west, or nearly so in the former case, deepening to a rich crimson pink towards the western horizon, and to the eastern horizon a bright yellowish white. Its southern termination was a well-defined sharp outline forming an arc about 30° to 40° from the south horizon, inside which the sky appeared almost black by contrast, the new moon lending additional interest to this peculiar atmospheric display.

" F. R. CLAPHAM

"Austwick Hall, Clapham, Lancaster, December 1"

WITH reference to J. E. Clark's remarks on p. 85, I would remind your readers that Sophus Tromholt, of Bergen, has organised a system of simultaneous observations on auroras, and that he will supply forms for recording them to any observer who will apply for them. I am not aware whether he has yet arrived at any definite results as regards the height of auroras; nor do I know whether he is making this specially a subject for investigation; nor whether he has enlisted the services of many observers in Britain. Surely J. E. C. is in error in saying that a height of 100 miles is far greater than is now usually supposed. In works on auroras, far greater heights are given, and I am not aware that these have ever been disproved. It is obvious that the curious spindle-shaped beam seen on the 17th must have been at an enormous height.

Sunderland, December 4 THOS. WM. BACKHOUSE

The past week has been one of remarkable electrical disturbances. Auroras were visible Tuesday evening, November 14, all Friday night, Saturday evening, Sunday night, Monday morning, and Monday evening. It was cloudy in this vicinity between the 15th and 16th, and if there were auroræ they were not visible. The aurora of Friday evening, following an intense magnetic storm, was remarkably brilliant, and lasted all night.

During the earlier part of the evening all the visible northern hemisphere was covered by it, but later, about midnight, all the visible heavens, to within 20° of the southern horizon, was covered by straight streamers extending from all points of the horizon to the zenith, where they formed a boreal crown of blood-red colour. The streamers were pulsating towards the zenith, making the sight a peculiarly magnificent one. Early in the evening the arc to the north was about 10° in elevation, and then gradually raised, showing the rich folds bordered by a dark fringe of a magnificent waving curtain, until it reached nearly to the altitude of Polaris. The southern boundary, also bordered on the south by the dark band, seemed to be nearly at right angles to the circle of the northern arc. Monday evening, the 20th, all manifestation was confined to the south. In a point in the south-east, near where Foucalhaut then was, rays shot northward past the zenith, but instead of converging, the rays diverged like the fingers of one's hand. The horizon, too, in the south, seemed much lighter than in any other direction. Though moonlight, the rays could be plainly seen to within 5° of the moon. It may be remarked that of the spots on the sun during this period of disturbance, one has been visible to the naked eye.

L. G. CARPENTER

Agricultural College, Michigan, Lansing, Mich, U.S.A.
November 21

The electrical storm seems to have been as violent in America as it was in Europe, as will be seen from Prof. G. L. Carpenter's letter above. The American papers of November 18 contain long accounts of the phenomenon. The *New York Times* says :—

"Yesterday's storm was accompanied by a more serious electrical disturbance than has been known for years. It very seriously affected the workings of the telegraph lines both on the land and in the sea, and for three hours—from 9 a.m. until noon—telegraph business east of the Mississippi and north of Washington was at a stand-still. An aurora borealis was the first evidence of the overcharging of the atmosphere with electric fluid. This appeared at about five o'clock yesterday morning, and was brilliant in the extreme. At the same hour trouble began to be experienced in the action of the telegraph wires. The circuits were broken, and the usual annoyances accompanying such disturbances were manifested. These increased in intensity until nine o'clock, at which hour it became impossible to transmit messages over the wires having an earth circuit—that is, where the ends of the line were grounded. Such lines as had a metallic circuit worked all right throughout the day, however, and so some little business was transacted over isolated lines. The disturbance continued until 1·50 p.m., when the electric storm seemed to have ceased. During the electric storm Mr. Brown, the chief operator, stated it was impossible to work the cables at all, except by cutting off the ground wires and making a metallic circuit by connecting the land ends of two cables. This was done, but even then the cables worked in a very unsatisfactory manner From all the central offices complaints came to the general office of the failure of the lines to work. People who attempted to use the telephones heard a buzzing, ringing noise, rather than any well-defined sound while attempting communication, and occasional words only could be distinguished. A singular fact in connection with the storm was that the wires of the Law Telephone Company did not seem to be affected. Engineer Shaw stated that they had had no more trouble during the day than usual, and attributed this to the fact their lines are all short ones, and therefore less liable to be affected than the longer lines. Their wires are ground circuits, and their freedom from annoyance is a mystery that he can solve in no other way than the one suggested.

From Chicago, under date November 17, the following details of the disturbance were sent to the *New York Times* :—"Officers of the Western Union Telegraph Company there say the electrical disturbance was the most pronounced and wide-spread experienced for years, if indeed it has been paralleled at any time. An electric storm of the greatest violence raged in all the territory from New York to points beyond Omaha, and from Kansas City north to the terminus of telegraphic communication, practically putting a stop to the telegraphic service over the entire area. It first began to be felt about 4 o'clock this morning and increased in intensity till 9.45, when communication from every direction was cut off. This electric storm seemed to go in successive negative and positive waves, alternately neutralising the currents on the wires or increasing their intensity to such a degree as to burn everything up. The switch-board here was on fire a dozen times during the forenoon, and half a dozen keys of the instruments were melted by the current which continued to pass through. The screws burned up and the points parted to their furthest limits. The duplex and quadruplex wires were rendered entirely useless, and at noon only a single wire out of fifteen between this city and New york was in operation, and it was frequently interrupted. Word was received from Milwaukee that the atmospheric electricity coming in on one of its wires from the country had such dynamic power as to keep an electric lamp burning."

Somewhat similar observations were made at Washington. On the Chicago and Cincinnati circuits it was found impossible to work the quadruplex instruments, and they were taken out. The chief operator said that the magnetic interference was greatest on the east and west lines. The officer in charge at the office of the Signal Service, said that great trouble had been experienced in collecting the weather reports on account of the general demoralisation of telegraphic circuits.

Similar reports were sent from Cleveland, Indianopolis, Cincinnati, Milwaukee, Nashville, Bangor, Toronto, and other places. At Cleveland the disturbance was first observed at 4 or 5 o'clock in the morning. From Milwaukee it was reported that "Strong currents of electricity pervaded the atmosphere and actually suspended all telegraphic communication from 9 o'clock in the morning until afternoon. An electric lamp attached to a St. Paul wire produced a brilliant illumination without the use of a battery. Business on 'Change was virtually suspended on account of the lack of telegraphic facilities. At 2 p.m. all the telegraph offices resumed work."

The *Detroit Evening News* states that "telephone communication all over the country was greatly improved, the pronunciation being distinct and much louder than usual, which fact may suggest to electricians an improvement in telephonic communication. Another unusual thing was that the electrical storm prevailed during a cloudy sky and murky atmosphere; heretofore such storms have occurred during a clear atmosphere. With the approach of night and the clearing away of the clouds came a most beautiful spectacle of the electrical agitation of the atmosphere. A more magnificent display of aurora borealis was never seen. It became slightly visible just at dusk, and increased in brilliancy and variety of form, movement, and colour, until midnight, when the whole vast heavens was one grand canopy of dancing flames of every conceivable hue and shape moving in all directions."

At Omaha the aurora was very brilliant, the illumination rendering the night almost as bright as day. At St. Paul the sky was of blood red colour, the display being grand and fearful. Cheyenne reports the illumination at that point as bright as day. At Denver the display in the northern heavens was most brilliant and dazzling. In California the aurora was visible from the northern part of the State as far south as San Diego, and was most brilliant. At Olympia, Washington Territory, the aurora was magnificent, the heavens north and east being brilliantly illuminated.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

LONDON.—At a meeting of the Council of University College on Saturday last : 1. Mr. H. F. Morley was authorised to give a course of advanced lectures on Organic Chemistry. 2. It was resolved to invite Mr. T. W. Rhys Davids to accept the Professorship of Pali and Buddhist Literature, once held by the late Prof. R. C. Childers. 3. It was resolved to ask Mr. R. H. Gunion to take the office of Lecturer on Sanskrit. 4. The resignation of the Chair of Physiology by Prof. Burdon Sanderson was accepted.

MANCHESTER.—A public meeting was held last week to inaugurate a movement for the extension of Owens College by the addition of a museum, which is expected to cost between 50,000*l.* and 60,000*l.* It was stated that there were a few thousand pounds in hand available for the purpose, and it was resolved to ask the public for 50,000*l.* to erect and equip the museum. Fourteen subscriptions of 1000*l.* each and a number of others ranging from 100*l.* to 500*l.* each were announced in the room. Lord Derby, the Duke of Devonshire, Mr. Hugh Mason, M.P., and Mr. Grafton, M.P., each offered 1000*l.*

SCIENTIFIC SERIALS

Annalen der Physik und Chemie, No. 12.—On the volume-changes of water containing salts on heating, and the resulting chemical transpositions, by E. Wiedemann.—On the molecular refraction of sulpho-carbonic ether, with some remarks on molecular refraction in general, by the same.—On the dispersion of colourless transparent media, by A. Wüllner.—Some remarks on the papers of Herren Hasselberg and Goldstein, by the same.—On galvanic elements supposed to consist only of elements, and the electromotive useful effect of chemical processes, by F. Braun.—The electric conductivity of chloride, oromide, and iodide of silver, by W. Kohlrausch.—On methods of multiplication and rejection, by E. Dorn.—Contributions to a knowledge of the relations between fluidity and galvanic conductivity, by C. Stephan.—On the joint action of traction and torsion in metallic wires, by F. Himstedt.—On the connection between the units of magnetism and of electricity, by R. Clausius.—On the theory of Fresnel's integrals, by A. Lindstedt.—On the theory of elastic reaction, by E. J. Michælis.

Journal de Physique, November.—On the methods to employ for determining the ohm, by L. Lorenz.—On the electro-chemical figuration of equipotential systems, by A. Guébhard.—On the liquefaction of ozone, by P. Hautefeuille and J. Chappuis.—On the absorption spectra of ozone and pernitric acid, by J. Chappuis.—Application of instantaneous photography to the study of animal locomotion, by G. Demeny.

Journal of the Russian Chemical and Physical Society, vol. xiv. fascicule 7.—On the action of the cyanide of ammonium on glyoxal, by M. N. Lubavin.—On the decomposition of the acetate of tertiary amyl by heat, by Prof. Menshutkin.—Analysis of the water which accompanies naphtha in wells, and ejected by mud-volcanoes, by M. A. Potilitzin.—On new beds of mineral manure, by M. P. Grigorieff.—Analysis of naphtha coke, by M. A. Lidoff.—Residual elasticity and analogous physical phenomena, by M. N. Hesehus.—Review of Russian chemical literature for the year 1881, by M. N. Lubavin.

Archives des Sciences Physiques et Naturelles, October 15.—On cometary refraction, by G. Cellerier.—On the duration of excitability of nerves after the separation of their nutritive centres, by O. Gorlinsky.—Researches on Iodes, by F. Sandberger.—The grain of the glacier, by E. Hagenbach-Bischoff.

November 15.—Sixty-fifth session of the Helvetic Society of Natural Sciences, held at Linthhal on September 11, 12, 13, 1882.—The prehistoric antiquity of man, by G. de Mortillet.—The origin of cultivated plants, by A. de Candolle.—New researches on the appearances of Jupiter, by E. W. Hough.

Journal of the Franklin Institute, November.—An improved feed-water heater and purifier, by G. E. Strong.—Economical steam power, by W. B. Le Van.—Note on the pendulum, by J. R. French.—Vision by the light of the electric spark, by W. Le Conte Stevens.—Notes on water analysis, by R. Haines.—Report on European sewerage systems, &c., by R. Hering.—Examination of water and air for sanitary purposes, with remarks on disinfection, by R. Hitchcock.—Report of Committee on the Rappleye rheometric governor burner.—The silver and gas dynanometers, by L. H. Sargent.—The American iron trade in 1881.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, November 8.—"Note on the Discovery of Bacilli in the Condensed Aqueous Vapour of the Breath of Persons affected with Phthisis." By Arthur Ransome. Communicated by Dr. W. Roberts, F.R.S.

In the year 1869 the author had examined the aqueous vapour of the breath in health and disease. This vapour was condensed in a glass globe surrounded by ice and salt, and, in condensing, it was found to carry down all the organic matter contained in the breath. It appeared probable that the breath of persons in advanced stages of phthisis would contain the bacillus of tubercle, and that this organism could be rendered visible by Dr. Heneage Gibbes' method of staining.

The aqueous vapour of the breath of several advanced cases of phthisis was accordingly condensed by the above-mentioned method, and each specimen was separately examined.

In order to carry down the organic matter, and to afford a basis to attach the material to the microscopic cover glasses, fresh white of egg, or a little mucus, free from bacilli, was added to the fluid.

No attempt was made to sterilise the fluids, as the ordinary bacteria of putrefaction are not stained by the process used.

In the aqueous vapour obtained from two of the cases, specimens of bacillus were found which took the staining in the same manner as the bacillus found in phthisical sputa and in tubercle.

The organism was not found in several other cases, nor yet in the aqueous vapour condensed in the waiting-room of the Manchester Consumption Hospital.

Physical Society, November 25.—Prof. Clifton, president, in the chair.—A paper by Mr. William Ackroyd, on rainbows produced by light reflected before entering the rain-drops, was read by the Secretary. The author investigated mathematically the rare phenomenon of three bows, and inferred that it would generally take place about sunrise or sunset. Mr. Lecky thought the effect had a simple explanation. It might be said to be due to two suns, one (reflected) appearing to be below the horizon.—Mr. Shellford Bidwell gave an account of some experiments he had made to test the theory of Dr. James Moser, that the action of a selenium cell under light was due to the heat rays making a closer microphonic contact between the selenium and the metal electrode, by expanding the material. He submitted selenium cells to dark heat rays, and found their resistance to *rise*. Under light rays, however, their resistance fell. He therefore concluded that Mr. Moser's theory was erroneous, and that the fall in resistance due to the light rays is the differential result of the rise due to heat and the fall due to light. He also explained the "fatigue" of a selenium cell by use, as caused by its increase of temperature. When the cell cooled again the fatigue disappeared. Dr. Moser and Prof. G. C. Foster made remarks on the paper, the former suggesting experiments to test the reversability of the effects observed by Mr. Bidwell, and the latter seeking to reconcile Mr. Moser's theory with the new data.—Dr. James Moser then read a paper on a general method of strengthening telephonic currents. This consists in forming a primary circuit of the telephone transmitter or derived circuit, a set of induction bobbins in derived circuit, and a changed secondary battery, the whole circuit having a very low resistance. Each primary bobbin has a secondary wound over it, and these secondaries are connected in quantity to the telephone line, which has at its remote end a set of telephones in derived circuit to the earth or return wire. In this way one line wire serves to supply a large number of separate telephones, a hundred being employed by Dr. Moser to transmit music from the Hippodrome in Paris to the Place Vendôme. The system is applicable to long lines; and the induction noises are reduced by subdivision among the separate telephones.

Victoria (Philosophical) Institute, December 4.—A paper by Dr. Miller was read on the references to the Antediluvian period in the cuneiform texts.

Institution of Civil Engineers, November 28.—Sir F. J. Bramwell, vice-president, in the chair.—The paper read was on "American Practice in Warming Buildings by Steam," by the late Mr. Robert Briggs, M. Inst. C.E., of Philadelphia, U.S.

CAMBRIDGE

Philosophical Society, November 27.—On complex multiplication of elliptic functions, by Mr. A. G. Greenhill.—On certain points in the function of the cardiac muscle, by Dr. W. H. Gaskell.—On the development of the Pollinium of Asclepias, by Mr. T. H. Corry.—On some micro-organisms and their relations to disease, by Mr. G. F. Dowdeswell.

BERLIN

Physical Society, November 17.—Prof. Helmholtz in the chair.—Herr Hagen has sought to determine the physical properties, and especially the coefficients of expansion, of metallic sodium and potassium, and he reported on the methods and results of this investigation. Both metals, which, in petroleum, in which they are commonly kept, always present a dull surface of hydrated oxide, Herr Hagen succeeded in keeping, with bright metallic surface, without petroleum, any length of time, in evacuated tubes, after the small amount of oxygen in the residual air had been fixed by a part of the metal in an antechamber. By melting the metal, drops could be formed, from whose heights the capillary constants of the two metals were

found, viz. 34·23 for sodium, and 14·17 for potassium. The two metals, mixed in the ratio of their equivalents, gave an alloy which is liquid at ordinary temperature, and which, on account of its brilliant metallic surface, might be easily taken for mercury; only its greater specific gravity distinguishes the latter at once from the potassium-sodium alloy. This solidifies at about 4°·5 C., and its capillary constant is 17·86. Very careful experiments were made for determination of the coefficients of expansion, and their relation to the temperature, in suitable dilatometers. The linear expansions, deduced from the volume-expansions, were, for sodium, 0·00853, and for potassium, 0·00721; pretty similar values were had in direct measurement of longitudinal expansion in a metal block. This coefficient of linear expansion exceeds that of all other metals, and is about three times the linear expansion of lead.—Prof. Helmholtz then gave a report of this year's International Congress in Paris, from which he had just returned. The Congress having last year come to an understanding on the units occurring in electrical science and "technic," and their designations, the point now was to determine those units exactly, so that practical normal units might be prepared. Attention was first given to the determination of the unit of resistance,—the "ohm" (as most easily practicable); that is, the exact measurement in metres of the column of pure mercury of one square milimetre cross-section at 0° C., the resistance of which is the "ohm." There were already quite a number of measurements by methods which Herr Helmholtz specified in his lecture. The values obtained are: Herr Kohlrausch, 1·0593; Lord Rayleigh, by the British Association method, 1·0624; Lord Rayleigh, by Lorenz's method, 1·0620; Mr. Glazebrook, in Cambridge, 1·0624; Herr H. Weber, in Brunswick, 1·0611; Herren W. Weber and Zöllner, 1·0552; Mr. Rowland, in America, 1·0572; Herr Dohrn, 1·0546. Against these pretty concordant values, however, stood the mean value obtained by Herr F. Weber, of Zürich, by reliable methods, and from experiments agreeing well together, viz. 1·0471, which came so near the older ohm of the British Association, that the Congress, on the motion of Sir William Thomson, refrained meanwhile from forming a definite conclusion. It was rather agreed to recommend the experimenters (1) to compare their resistances with the standard of resistance which the French Government will produce; (2) to compare the induction coils by the method adopted by Herr Kohlrausch with the wire-circuit; (3) in their measurements to avail themselves of the modified and still further to be improved method of Lorenz. The respective governments should finally be urged to support, as much as possible, the national experiments for determination of the "ohm."

PARIS

Academy of Sciences, November 27.—M. Jamin in the chair.—The following papers were read:—Observations of small planets with the great meridian instrument of Paris Observatory during the third quarter of 1882, by M. Mouchez.—Note on the verification and the use of the magnetic maps of Col. Al. de Tillo, by M. Lalanne. He compares magnetic observations (of declination) made by him in 1837, in four localities of the region north of the Sea of Azof, with Col. de Tillo's two maps (for Russia), and notes some defects of the latter (the longitudes of the two do not refer to the same meridian, &c.).—Reply to the objections of M. Decharme to my rational conception of the nature of electricity; proofs of the validity of hypotheses serving as the basis of this conception, by M. Ledieu.—General law of congelation of solvents, by M. Raoult. Every substance, dissolved in a definite liquid compound capable of solidifying, lowers its freezing-point. In all liquids, the molecular lowerings of congelation with different compounds, approach two values invariable for each liquid, and one of which is double, the other (the greater being normal). The normal lowering varies with the nature of the solvent. A molecule of any compound, dissolving in 100 mol. of any liquid, of different nature, lowers the freezing-point of the latter a quantity nearly constant, and near 0°·62.—Chemical study on maize at different epochs of its vegetation, by M. Leplay. Sugar is found in the leaves, and accumulates in the stem till the moment of formation of starch in the grains. It then migrates into the spike, first into the support of the grains, then into the grains themselves, where it is replaced by starch. This migration continues to be fed by the leaves till they disappear, then in great part by the stem—diminishing, however, as the starch is developed. The function of the sugar, then, is to furnish to the grain the elements of starch.—On the conservation of solar energy; reply to M. Hirn's note, by Dr. C. W. Siemens. He estimates the temperature of the photosphere as 3000°, not too high to satisfy the conditions of combustion (M. Hirn's estimate is 20,000°). The theory of diminution of light intensity as the square of the distance seems to be not applicable to the whole of the light of stars. Some wave-lengths less favourable to decomposition, may on this account reach further. As to mechanical resistance of gaseous matter to the planets, he shows reason for thinking it much less than hitherto supposed.—On a theorem of M. Tisserand, by M. Stieltjes.—Extension of the problem of Remann to hyper-geometric functions of two variables, by M. Goursat.—On a new integrometer, by M. Abdank-Abkanowicz. Increased accuracy is obtained by means of a disc which rolls on a cylinder without slipping.—On a mode of transformation of figures in space, by M. Vaneeck.—Equilibrium of elasticity of a solid limited by a plane, by M. Boussinesq.—Theoretic interpretation of the calming effect produced by a thin layer of oil spread on the surface of the sea, by M. Van der Mensbrugghe.—On electric motors, by M. Deprez. He describes an experiment proving that the two laws—that of independence of the current's mechanical action, of the state of rest or motion of the ring, and that of proportionality of the electromotive forces to the velocities (supposing, of course, the intensity of the current constant)—hold good within very wide practical limits.—General expressions of the absolute temperature, and of Carnot's function, by M. Lippmann.—Range of sounds in air, by M. Allard. Experiments with different instruments yielded the result that the intensity of sound in air decreases much more rapidly than according to the law of the square of the distance. The second cause of enfeeblement is considered to lie in the non-homogeneous character of the air. A given sound may have, apart from the influence of wind, very different ranges, varying, *e.g.* from two to twenty nautical miles. For small augmentations of range the work required increases very rapidly. The differences of range for different pitches within the octave are little sensible.—On the reform of some processes of analysis used in laboratories of agricultural stations and observatories of chemical meteorology (fourth memoir); volumetric determination of alkalino-earthy carbonates in waters, by M. Houzeau.—Modifications of structure of nerve tubes in passing from the spinal roots into the spinal cord, by M. Ranvier.—On the present flood of the Seine, by MM. Lemoine and de Préaudeau.—Magnetic perturbations from November 11 to 21, 1882, by M. Renou.—A letter from M. Tarry on the aurora showed that while the magnetic currents of earth lines render possible a pre-vision of aurora several hours in advance, those on submarine lines give a pre-vision of *several days* in advance.

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THURSDAY, DECEMBER 14, 1882

ANCIENT SCOTTISH LAKE DWELLINGS

Ancient Scottish Lake Dwellings. By Dr. Munro. (Edinburgh: David Douglas, 1882.)

THE first account of the Irish crannoges, by Sir W. R. Wilde, dates back to the year 1839, and the Lake Dwellings of Switzerland, which have shed so much light on prehistoric archæology, were discovered in the year 1853; yet the first scientific account of any similar dwellings in Scotland was in the paper by Mr. Robertson, read before the Society of Antiquaries of Scotland in the year 1857.

Dr. Munro has now collected together in an interesting and well-illustrated volume the substance of what was previously known, and added to it an account of some interesting investigations of his own, in a general work on the ancient Scottish Lake Dwellings or Crannoges. The number of these more or less artificial islands now known is very considerable. In Wigtownshire we are told that all the lakes were once literally studded with these island habitations.

So far as can be judged at present there is no reason to refer the Scottish Crannoges to so early a period as the earlier Swiss Lake villages. The objects of stone are comparatively few, while those of bone, horn, and of wood are very numerous. None of the animal remains belong to any extinct species. The horns are mostly those of the red-deer; in one case indeed, that of the crannoge at Lochlee, some fragments have been found which may possibly have belonged to the reindeer. This however seems very doubtful. The late Dr. Rolleston, by whom the remains were examined, says of the fragmentary pieces of horn: "I incline to set them down as indicating the presence of the former animal" (the reindeer). "It is usually easy," he says, "to separate even the fragments" (of reindeer's horn), "if the fragment is fresh. Of course the surfaces of the horns in these two horns" (*i.e.* of the reindeer and of the red-deer) "are different, but here the two fragmentary horns have no brow antler left and their surfaces have been macerated so long as to be desquamated." It is obvious therefore that Dr. Rolleston felt considerable doubt on the subject.

The majority of the metallic objects are of iron, but some few gold ornaments have also been discovered, and in one case, viz. at Buston, a single coin which, curiously enough, is a forgery. It consists of two thin plates of gold fastened together by some resinous substance. It belongs to a class which has hitherto been found almost exclusively in England, and is probably Saxon, belonging most likely to the sixth or seventh century. A very similar coin has been found near Dover.

We will now leave Dr. Munro to speak for himself:

"The great and primary object," he justly observes, "of the island builder was the protection afforded by the surrounding lake or morass, the securing of which has continued to be a ruling principle in the erection of defensive works down to the Middle Ages, long after the wooden islands ceased to be constructed. The transition from an island fort to the massive mediæval castle, with its moat and drawbridge, is but another step in the progressive march of civilisation" (p. 243).

The objects discovered in the Scottish Crannoges are in the main of a domestic character:

"Indeed," says Dr. Munro, "amongst the relics military remains are only feebly represented by a few iron daggers and spearheads, one or two doubtful arrow-points, and a quantity of so-called pebbles and so-called sling-stones. On the other hand, a very large percentage of the articles consists of querns, hammer-stones, polishers, flint-flakes, and scrapers, stone and clay spindle-whorls, pins, needles, and bodkins, knife-handles of red-deer horn, together with many other implements of the same material, bowls, ladles, and other vessels of wood, some of which were turned on the lathe; knives, axes, saws, hammers, chisels, and gauges of iron; several crucibles, lumps of iron slag, and other remains of metals, &c. From all these, not to mention the great variety of armaments, there can be no ambiguity as to the testimony they afford of the peaceful prosecution of various arts and industries by the lake-dwellers" (p. 282).

As regards the mode of life of the Scotch Lake-dwellers, we can, he continues:

"From the respective reports of Professors Owen, Rolleston, and Cleland, on a selection of osseous remains taken from the lake dwellings at Dowalton, Lochlee, and Buston (see pp. 50, 139-143, 236-239), we can form a fair idea of the food of the occupiers. The Celtic short-horn (*Bos longifrons*), the so-called goat-horned sheep (*Ovis aries*, var. *brachyura*), and a domestic breed of pigs were largely consumed. The horse was only scantily used. The number of bones and horns of the red-deer and roe-buck showed that venison was by no means a rare addition to the list of their dietary. Among birds only the goose has been identified, but this is no criterion of the extent of their encroachment on the feathered tribe, as only the larger bones were collected and reported upon. To this bill of fare the occupiers of Lochspouts Crannog, being comparatively near the sea, added several kinds of shell-fish. In all the lake dwellings that have come under my own observation, the broken shells of hazel nuts were in profuse abundance'" (p. 283).

It is an interesting fact that the Lake-dwellings as yet discovered are by no means evenly distributed throughout Scotland.

"Though we cannot argue definitely from the present geographical distribution of the Scottish Lake Dwellings, the indications are so clearly suggestive of their having been peculiar to those districts formerly occupied by Celtic races, that the significance of this generalisation cannot be overlooked. Thus, adopting Skene's division of the four kingdoms into which Scotland was ultimately divided by the contending nationalities of Picts, Scots, Angles, and Strathclyde Britons, after the final withdrawal of the Romans, we see that of all the Crannoges proper none have been found within the territories of the Angles; ten and six are respectively within the confines of the Picts and Scots, while no less than twenty-eight are situated in the Scottish portion of the ancient kingdom of Strathclyde. Nor is this generalisation much affected by an extension of the list, so as to include those stony islets so frequently met with in the Highland lakes. On the other hand, that they have not been found in the south-eastern part of Scotland may suggest the theory that these districts had been occupied by the Angles before Celtic civilisation—or rather the warlike necessities of the times—gave birth to the island dwellings. In that case we would suppose that their development dates back to the unsettled events which immediately followed the withdrawal of the Roman soldiers, to whose protection the Romano-British population in the south-west of Scotland had been so long accustomed" (pp. 248 and 249).

In support of this view he also remarks that

"Fragments of Samian ware, bronze dishes (one with Roman letters), harp-shaped fibulæ of peculiar type, together with a large assortment of beads, bronze and bone pins, bone combs, jet ornaments, &c., are so similar to the class of remains found on the excavated sites of Romano-British towns, that there can hardly be any doubt that Roman civilisation had come in contact with the lake-dwellers and partially moulded their habits. The Celtic element is, however, strongly developed, not only in the general character of many of the industrial implements of stone, bone, and iron, but also in the style of art manifested in some of the ornamental objects included in the collection."

We confess that we are disposed to doubt whether the geographical distribution of the Scottish lake dwellings at present known is really connected with that of the ancient Celt, and whether it is not more due to the activity of the Ayrshire and Wigtonshire Archæological Association, of Mr. Cochran Patrick, M.P., and of Dr. Munro himself. Whilst thanking him for what he has already accomplished, we may express a hope that he will continue his researches. JOHN LUBBOCK

OUR BOOK SHELF

The Sportsman's Handbook to Practical Collecting, Preserving, and Artistic Setting up of Trophies and Specimens. To which is added a Synoptical Guide to the Hunting Grounds of the World. By Rowland Ward, F.Z.S. Second Edition. With numerous additional Illustrations. (London: the Author, and Simpkin, Marshall, and Co., 1882).

THIS very useful little book affords all requisite information for the traveller who wishes to preserve specimens of natural history, more especially large animals. The process of skinning quadrupeds and birds is so well explained, and so copiously illustrated by characteristic woodcuts, that the merest tyro would soon learn the art. The best modes of preserving reptiles, fishes, and insects are also given; and then follow instructions for the setting up of trophies, for mounting birds and fishes, and for dressing skins of large animals. A sketch of the chief hunting-fields of the world concludes the book, and in this part much useful information is given as to the more important animals characteristic of each region.

The book is especially valuable in that it does not confuse the reader by a multiplicity of details, or leave him to choose between a variety of methods. The simplest and most effective appliances are alone recommended, and the great experience of the writer in the preservation and mounting of animals renders his advice on these points of the greatest value. The introductory chapter gives good outlines of the bodies and skeletons of the chief types of large mammalia, with the vital spots marked on each, so as to guide the sportsman in killing his game.

We only notice a single point which appears to call for correction in a future edition. The use of the blow-pipe is recommended for killing small birds, and it is described as a tube of metal or wood about 3 feet long and ¾-inch in diameter, through which pellets of clay may be propelled by the breath. Such an instrument would be of very little use, and we doubt whether any ordinary person could propel a ball of clay of this size with sufficient velocity to kill any bird at ten yards off. For using clay pellets, the bore should not exceed ⅝, or at utmost, ½-inch diameter, and the length had better be 6 or 8 feet than 3. The blow-pipes used in South America are usually 8 or 10 feet long, and under ½-inch bore, and with these, light arrows can be propelled so as to kill birds on lofty trees, while with clay pellets, humming-birds are easily killed at more moderate distances.

The book is strongly and tastefully bound, and should be the companion of every sportsman and naturalist about to visit foreign countries. A. R. W.

Diagrams of Insects Injurious to Farm Crops; suitable for Elementary Schools. Prepared by Miss E. A. Ormerod, Honorary Consulting Entomologist to the Royal Agricultural Society of England.

A SERIES of six large diagrams as follows, issued by the Society:—Large White Cabbage Butterfly, Turnip Fly, or Flea (the prospectus writes "Flee") Beetle, Beet Fly, Wire Worm and Click Beetle, Hop Aphis or Green Fly, with Ladybird, Daddy Long-legs or Crane-fly. These diagrams seem admirably adopted for the purpose intended, and are accompanied by short explanations, including remedial prescriptions. In her scientific names Miss Ormerod puts the cart before the horse, by reversing the order of things, and making the lesser include the greater. When she indicates *Agriotes* (*Elater*) *lineatus*, *Phyllotreta* (*Haltica*) *nemorum*, and *Phorodon* (*Aphis*) *humuli*, she means that the parenthetical generic term is the larger and older, and that the preceding one is a later creation by those dreadful specialists; but she does not say so.

Manuel d'Électrometrie Industrielle. Par R. V. Picou (Paris: G. Masson, 1882.)

THIS is one of the many books which owe their appearance to the recent rapid growth of the electrical industries; and may not be inappropriately termed a treatise on electric measurements, only a very small section being however devoted to electro-chemical quantities. The work begins with the ordinary laboratory processes of testing resistance, electromotive force, and strength of currents, &c. The latter half of the book deals with the practical application of such tests to the measurement of the electromotive force, resistance, &c., of batteries and dynamo-electric generators. Under the latter head the methods of MM. Pollard and Cabanellas are expounded. The author does not appear to be acquainted with the recent testing instruments invented by Professors Ayrton and Perry, nor those of Sir W. Thomson, which present many advantages over the instruments described by the author. There are several glaring defects in the work of too important a nature to be passed over. The author gives instructions for making up resistance coils without saying a word about the necessity of winding them so as to avoid self-induction, and as he cautions the reader to use a simple key in testing with Wheatstone's bridge he cannot be aware of the substantial reasons which exist for the use of the British Association key with double-successive contact. As the author professes to follow the British Association in its system of units he ought not to write "dyne = gramme-masse," because that is exactly what the dyne is not. He ought also to know that the statement he makes on p. 132 respecting the efficiency of electromotors, that the useful work is a maximum when the back-electromotive force is equal to half the electromotive force of the generator is not true, and does not refer to maximum efficiency but to maximum rate of using up power. Students will find the books on kindred subjects by Kempe and Day of much more use than the manual of M. Picou.

The Falls of Niagara and other Famous Cataracts. By G. W. Holley. Illustrations. (London: Hodder and Stoughton, 1882.)

THE bulk of this volume is devoted to Niagara, concerning which Mr. Holley has brought together a great deal of information on its history, geology, and local history and incidents, two-thirds of the space being occupied with the last section. The information seems to us in the main correct, though much of the miscellaneous matter included under local history and incidents is of trivial

importance. The space devoted to the other "Cataracts" of the world is small, though most of the important ones are mentioned. The illustrations are good, and on the whole the book is interesting.

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 ensure the appearance even of communications containing interesting and novel facts.*]

Priestley and Lavoisier

IF Mr. Rodwell had anything new to tell us about Lavoisier, there would have been a sufficient motive for his writing; but I do not see what useful purpose is gained by telling us what was already known, namely, that a century ago Lavoisier rendered many important services to science; or, what was not so well known, namely, that chemistry is a French science; or, that Lavoisier was "the most generous of men," "incapable of any meanness." The real question Mr. Rodwell himself asks:—"Upon what authority does Dr. Thomson assert that Dr. Priestley informs us that he prepared the gas in M. Lavoisier's house in Paris, and showed him the method of procuring it in the year 1774?"

Mr. Rodwell quotes from Thomson's notice of Priestley; had he turned to that of Lavoisier (p. 105, vol. ii. 1831, not 1830), he would have found an answer:—"Dr Priestley discovered oxygen in August, 1774, and he informs us in his life [this ought to be "Life," *i.e.* autobiography] that in the autumn of that year he went to Paris and exhibited to Lavoisier, in his own laboratory, the mode of obtaining oxygen gas by heating red oxide of mercury in a gun-barrel, and the properties by which this gas is distinguished; indeed, the very properties which Lavoisier himself enumerates in his paper. [*Mem. Acad.* 1775, pub. 1778.] There can therefore be no doubt that Lavoisier was acquainted with oxygen gas in 1774, and that he owed his knowledge of it to Dr. Priestley."

Dr. Black complained of the publication of Lavoisier's papers without any allusion whatever to what he himself had previously done on the same subject. Cavendish complained of something more than a similar neglect. The facts, as stated in Dr. George Wilson's "Life of Cavendish," are briefly these:—Blagden went to Paris in June, 1783, and informed Lavoisier of the discovery of the composition of water. Lavoisier was incredulous, expressing his opinion that the union of the two gases (O and H) would produce, not water, but an acid. Nevertheless he repeated Cavendish's experiment on a large scale; and in his account of it to the Academy on June 25, stated that the conclusion as to the compound nature of water was drawn by Laplace and himself. The charge brought against Lavoisier by Cavendish, Blagden, and Watt, was summed up by Watt to this effect, that after Lavoisier had had the theory of the composition of water explained to him, "he invented it himself."

Mr. Rodwell "utterly denies" that the acceptance of Lavoisier's doctrine was mainly due to Cavendish's discovery. A strong objection to the oxygen theory was advanced by Berthollet and others, founded on the observation that in the action of dilute acids on metals inflammable air is produced. [The inflammable air of Cavendish, in 1766, was referred not to water, but to the metals]. Whence came this element? The discovery of the composition of water answered the objection, and converted it, as Dr. Whewell remarks, into an argument in favour of the theory.

My statement that "the compound is always equal to the sum of its elements" was already known, was elicited by a remark of Lavoisier's, quoted by Mr. Rodwell:—"I am obliged in this reasoning to suppose that the weight of the bodies employed was the same after the observation as before." My statement is new to Mr. Rodwell, and he calls for references. Many of the old writers on the idea of substance acknowledged the proposition, and its best application was Wenzel's doctrine of definite and reciprocal proportions, although its full significance did not become apparent until the aeriform elements were also taken into account.

But to return to Priestley, I am bound to admit that 1744 is a mistake into which I was misled by Whewell ("His. Ind. Sci., 1857, iii. 110), who gives that date.

Priestley was presented with the Royal Society's Copley medal, as an honourable testimony to his numerous scientific discoveries, which, considering the crude state of chemistry in his time, must be regarded as admirable. He was afterwards driven from the Royal Society and from his country, his house was pillaged, and his library, manuscripts, and apparatus destroyed, and all this persecution was on account of certain opinions which happily are now widely spread. The statue at Birmingham is a less impressive tribute to his memory than the maintenance of respect for his fame; and it is with no unfriendly feeling towards Mr. Rodwell that I express an opinion that this old quarrel between Lavoisier, Priestley, and Cavendish had better be left to repose in the history of science, where it has been discussed with sufficient fulness and fairness by such writers as Thomson, Brande, Whewell, and George Wilson.

Highgate, N., December 4 C. TOMLINSON

The Forth Bridge

IN some remarks made in NATURE, vol. xxvii. p. 101, by Mr. Charles Shaler Smith, the following passage occurs:—"The tests of the last few years show conclusively, that iron exposed to compression within its buckling limit is compacted in texture and strengthened by such use while, if subjected to continuous tension beyond two-thirds of its elastic limit, it is attenuated and weakened." As I think that the words above quoted may perhaps to a certain extent mislead those who have not themselves made experiments on the elasticity of iron and steel, and on the alteration of density which can be produced by compression or extension, I would observe:—

1. That the increase of *density* which can be produced by compressing within the buckling-limit such rods as may be employed in the construction of bridges, would certainly not account for the strengthening of iron exposed to continuous compression. I have examined carefully the alteration of density which can be effected in iron and steel wires by longitudinal extension, &c., and even in cases where the wire was strained to breakage, and the permanent extension exceeded 20 per cent., there was no diminution of density equal to 1 per cent. Of course the words "compacted texture" may not mean that the density is increased, but the idea seems to be not uncommon among engineers, that increase of strength *necessarily* implies increase of density. Though I cannot at this moment lay hands upon it, I remember reading an account of some theories advanced respecting the hardening of steel, from which it was evident that the author of these theories assumed that the hardening is attended with *increase of density*, whereas the density of steel can be more *diminished* by this process than by any mechanical means with which I am acquainted.

2. It is quite true that iron, if subjected to continuous tension beyond two-thirds of its elastic limit, is attenuated, but whether the attenuation is attended with weakening or not depends largely upon the manner in which the tension is applied. If the latter is increased by small amounts at a time, and each amount allowed to act for a few hours before any increase of stress is made, not only is there comparatively small permanent extension, but there may be an actual increase of strength as far as resistance to extension is concerned. The fact is that whether we subject iron and steel to *long-continued* compression or extension, we increase the resistance to compression and extension respectively, mainly for the same reason, namely, that we *give time* for the molecules of the metal to take up such positions as will enable them to offer the maximum resistance. Thus I have proved that the value of "Young's Modulus" is considerably increased in the case of an iron wire which has suffered permanent extension, by allowing the wire to rest for some hours either loaded or unloaded; this increase of elasticity is not attended with any appreciable increase of density.

As I feel that too much precaution cannot be taken in a question of this kind, where life is at stake, I would venture to make the following suggestion:—That bars or rods of steel and iron which run the *slightest* risk of having at any time to undergo a considerable extending or compressing stress should before use be subjected, if possible, to the same kind of stress gradually increased in amount with intervals of some hours between each increase until a stress equal to at least three-fourths of the breaking-stress be reached. Three or four days would suffice to bring the metal to its maximum strength, both as regards resistance to permanent and to temporary strain.

Should any one be interested in the subject, I would refer them to the experiments of Mr. J. T. Bottomley (*Proc. R. Soc.*, No. 197, 1879), of Prof. Ewing (*Proc. R. Soc.*, 1880, June 10), and of myself ("Influence of Stress and Strain on the Action of Physical Forces, *Phil. Trans.*, 1882, second volume).

HERBERT TOMLINSON

King's College, Strand, December 4

Intra-Mercurial Planets—Prof. Stewart's 24·011d. Period, Leverrier's and Gaillot's 24·25d., and Leverrier's 33·0225d. Sidereal Periods Considered

As your regular monthly numbers did not reach our Free Library from September, 1881, until comparatively recently, and I was absent from home when they did arrive, it was only quite lately that I had an opportunity of seeing Prof. Balfour Stewart's very interesting paper "On the Possibility of Intra-Mercurial Planets," read at last year's meeting of the British Association, and published at length in your issue of September 15, 1881. "The possibility" has been almost an admitted fact for over a century, but Prof. Stewart's valuable paper discusses the relation of certain sun-spot periods to a probable sidereal period, approximately at least, of an intra-Mercurial planet of 24·011 days.

On looking through your subsequent numbers, I was rather surprised that so suggestive a paper had not elicited quite a discussion, although it is true that Prof. Stewart remarked that "the test was not yet complete," and many may have waited to see the final results, which have not yet appeared, but perhaps will be forthcoming at the next meeting of the British Association. But the first point that struck me, although not referred to by Prof. Stewart, was the near approximation periods of 24·011 days affords to Leverrier's and Gaillot's period of 24·25 days noticed in your columns of August 22, 1878, which M. Gaillot endeavoured to fit to Prof. Watson's observation, in Wyoming State, of a supposed intra-Mercurial planet at 2° 9′ from the Sun, during *the total eclipse*, July 29, 1878. M. Gaillot's difficulty seemed to be to reconcile Leverrier's formula with Prof. Watson's reasonable belief that he saw the planet in the superior part of the orbit, while Gaillot made the formula and interval require it to be in the inferior part of the orbit July 29, 1878. The only interval that Gaillot referred to was from 1750 (January 1, I presume); it might have been obvious, therefore, that quite a small fractional difference in each of so many revolutions would suffice to make the period accord with either condition that Prof. Watson's observation required; namely, *that the planet was seen at 2° 9′ from superior conjunction*, or 2° 9′ *past inferior conjunction*. For instance, I have obtained these two result for the synodical periods. The same interval for both about 46962½ days, requiring 1808½¼ revolutions of 25·96825104d., each ¼¼ being equal to 11·902115o6d.; that accords very closely with Prof. Watson's belief, while 1808¾¼ revolutions of 25·97423556d. each, and 1·08226d. remainder, meet the condition of its being 2° 9′ past the inferior conjunction. Of course, as a matter of opinion, I presume it would be impossible to see the planet so near its inferior conjunction during any total eclipse of the Sun, the planet's crescent being altogether too fine. These results are simply what the conditions require in relation to approximate 26-day apparent-periods, but we must avoid exactly 26 days, or the interval would put the planet at *its elongation*, perhaps apparently 10° from the Sun, and if we tried the Lescarbault interval, from March 26, 1859, 70651 days, singularly enough it would put the planet *in the other elongation*. Fractional differences are of course very important therefore. And I do not find either that M. Gaillot's figures 24·25d. for the sidereal time, and 14°·8462 for the diurnal motion exactly accord, and neither fills the conditions required by Prof. Watson's observation, if I am approximately correct, which I think I am. For instance, 14°·8462 diurnal motion, gives us 24·24862928d. for the sidereal periods, not 24·25d., and the synodical period would be 25·97299034666d., and the planet's position would be about 46° 12′ in its orbit past inferior conjunction, or apparently about 8° 24′ from the Sun, and 46° 12′ would be about 3¼ days.

The sidereal period of 24·25 days, makes the diurnal motion 14°·8453608247, and puts the planet at about 6°·8 past inferior conjunction, or apparently less than 1°. The synodical revolutions would be 25·97456262d. and fractional remainder ·0188945, or 11h. 46m. 43s., which of course would be too close to the sun. But the sidereal period and the diurnal motion should both agree, instead of producing such a difference as I have here indicated, of nearly 45° in the revolutions. But although I believe we cannot accept the exact published figures, 24·25d., or 14°·8462, still I have shown how near we may make the final results conform to them.

Adopting the same number of synodical revolutions, and practically making the best use of the formula, obtaining 1808½¼ revolutions, and 1808¾¼. The revolution being 25·96825104d., or 25·97423556d., and the remainders 11·902115o6d., or 1·08226. Reduced to clock time they stand as follows: 1808½¼ being equal to 25d. 23h. 14m. 16·9s. each, and 11d. 23h. 39m. 2·7s. remainder, and 1808¾¼ being equal to 25d. 23h. 22m. 54s. each, and 1d. 1h. 58m. 27½s. remainder. *The latter is almost absolutely identical* with the periods that would fit the Fritsch and Stark interval from October 10, 1802, to October 9, 1819, 6208 days, or 239 periods of 25d. 23h. 23m. 51s. And from Stark to Lescarbault makes 14,413 days, which would require 555 periods of 25d. 23h. 15m. 53½s., *which affords almost exact identity* with the general mean, placing Prof. Watson's observation in the superior part of the orbit. Thus, then, we have almost positive assurance that Fritsch, Stark, Lescarbault, and Prof. Watson's planet were identical, and that Prof. Watson was correct about it being 2° 9′ from superior conjunction: these interesting facts, giving a record to Lescarbault's planet of 80 years from Fritsch's observance October 10, 1802, to October next. What other "myths" will stand such satisfactory results? I am afraid that Prof. Proctor and some other astronomers have not given the attention to this question that it deserves. But there are a few exceptions deserving credit: M. de la Baume, in Paris, was engaged last year in a classification of reported observed transits, although he did not then draw any inferences respecting apparent revolutions. He regarded Fritsch, De Cuppe, Lescarbault, and Lummis' transits as the same planets, agreeing relatively with the nodes. While Lichtenburg, November 19, 1762, Hoffman, about May 10, 1764, Scott, June 28, 1847, Ritter and Schmidt, June 11, 1855, and W. G. Wright, of San Bernardino, California, October 24, 1876, whose transit was illustrated in the *Scientific American* of November 18, 1876, he regarded as another larger planet than Lescarbault's.

Adopting the same principle with Prof. Stewart's hypothetical sidereal periods of 24·011d., I first find what results that gives, as applied to the same interval from January 1, 1750, and then take the nearest modification I can to the conditions of Prof. Watson's observation. 360° divided by 24·011d. gives us 14°·99312818 for the planet's diurnal motion, which, multiplied by 46,962½ days, gives us 704114°·78215325, from which, subtracting the earth's motion, 46288°·463941, leaves a residue of 657826°·318213, which, divided by 360° gives us 1827·29533 synodical revolutions; using that to divide the 46962½ days, we obtain the synodical periods of 25·7005536. The fractional revolution ·29533 is equal to 106° 19′ 17″, or 7d. 14h. 10m. Now while that would put the planet in the superior part of the orbit, it would still be nearly 60° from where Prof. Watson observed it. I ought to have explained before that 2° 9′, or 2° 10′ apparently, is about equivalent to 15° from *superior* conjunction, or, 15° past *inferior* conjunction in the planet's orbit; 15° from 180°, therefore, leaves 165° as the required position, instead of 106° 19′ 17″. Perhaps I am only approximately correct, but sufficient for illustration. It is very evident, however, that a very slight modification of Prof. Stewart's inferential sidereal periods, 24·011d., would give us the 60° more required, or exact accord with Prof. Watson's observation, and the evidence would be rather in favour of 1827½¼ revolutions, obtained from such a solar analogy, and may still have an incidental bearing or relation to the Leverrier-Gaillot formula I have construed to require 1808½¼ or 1808¾¼ revolutions. 1827½¼ revolutions would give us 25·6982603342536d. for the synodical periods, and a remainder of 11·77836931986d. Reduced to clock time, that would give us 25d. 16h. 45m. 29·7s. for each apparent revolution, and 11d. 18h. 40m. 51·11s. for the remainder. It must be understood that these definitions, 1808½¼ and 1827½¼, with their results, are intended only to express possible general mean periods of apparent revolutions, and may not exactly apply to any of the intervals between the long list of recorded observations of supposed transits. When Leverrier, October 1876, had strong faith in sidereal periods of 33·0225d., it was probably a general mean from January 1, 1750, to Lescarbault, March 26, 1859, and only approximately fitted Lummis, De Cuppis, Stark, Fritsch, and others, but still in a general sense applied to some of them, while Leverrier was led to predi-

cate a transit, March 22, 1877, which probably did not occur. And yet, viewed in connection with a reported transit, October 24, 1876, seen by Mr. W. G. Wright at San Bernardino, California, and illustrated and fully reported in the *Scientific American* of November 18, 1876, which circumstance Leverrier probably had no knowledge of, was by no means as unsatisfactory as the public imagined; for practically *Wright's transit and Leverrier's hypothetical period mutually confirmed each other.* The *Scientific American* Supplement of August 27, 1881, published some remarks I sent them, which may have reached England. One point I directed attention to was that Leverrier indicated that a conjunction was due September 21, 1876, and I found that there were thirty-three days between that and October 24, 1876, so if Leverrier took 176 synodical periods from Lescarbault to September 21, it was nearly the same thing to take 177 to October 24; but extending the interval to January 1, 1750, there would be much nearer similarity in the synodical periods to accord with Wright's transit, October 24, 1876. I also noticed that the ratio of displacement of the node from Lescarbault and Lummis was 7 days retrograde in 3 years' advance, and on that data, applied to Wright's transit, another transit would be due 11⅛ days earlier in 1881, while Leverrier, in October, 1876, remarked that *for a transit at this node we must wait till about* 1881." My computation made it fall due, therefore, October 12 or 13, 1881, and I was anxious that it might be looked for. The computation made the Hawaiian Islands the most favourable place; but although I believe it was not seen there, nor was it observed from Sacramento or Salt Lake City, where Mr. W. R. Frink looked for it with a 4-inch aperture achromatic telescope, we have no evidence to show whether it might not have occurred in Europe or elsewhere, and been noticed if it had been looked for.

Sacramento, California A. F. GODDARD

[The subject of this communication is a very interesting one, as relating to the possibility of changes on the sun's surface being due in some way to the positions of the various planets of the system. But before this relation can be considered as established, it will be necessary to increase the accuracy of our solar information by collecting our past observations, as well as by securing a set of daily observations for the future.—ED.]

An Extraordinary Meteor

I BEG to send you the following, in case you consider it worth inserting:—At about 1.10 a.m. on the night between November 18 and 19, whilst going in the s.s. *Bokhara* in the Red Sea, about midway from Aden to Suez, the quarter-master on duty called me, saying he had just seen a new comet, or shooting star, which was still visible many minutes after its first appearance. He said that whilst he was looking out ahead, or in a northerly direction, he suddenly noticed the effect of a bright light shining from astern, and on turning round saw a very bright shooting star still moving from left to right, and slightly downwards, in the south, at an altitude of about 40°. The star speedily disappeared, but left a bright train of light behind it, which continued so long (from five to ten minutes he guessed) that he thought I might like to see it. I came on deck a little before a quarter past one by the ship's clock, and found a streak of light which I estimated as 8° or 10° in length, and rather less than half a degree in width, apparently stationary, midway between Sirius and Canopus, and nearly as bright as *the* comet, the head of which must have risen half an hour or more previously. I watched the streak till half-past one o'clock, when it seemed sensibly fainter, though still a conspicuous object, notwithstanding the presence of the moon, the comet, and a number of bright stars. Whilst watching I noticed two small meteors shooting from left to right across the southern sky, which struck me as probably belonging to the same group as the large one whose train I was watching.

At half-past one o'clock I went below, and did not return on deck till 5 o'clock, when the apparition had disappeared. The quarter-master told me afterwards that it had faded away soon after I left the deck, but he believed that from first to last it had remained conspicuously bright for more than half an hour.

Clewer, December 6 B. R. BRANFILL

British Rainfall

I AM just preparing to issue to all the observers of rainfall known to me, blank forms for the entry of their records for the year shortly about to close. This staff now exceeds 2000, but still as they are not unfrequently rather clustered there are many parts of the country where additional records are needed. I have no doubt that records are already kept in many places unknown to me, and I shall be glad if you will allow me to invite communications from any one who has kept an accurate record, and to supply either those already observing or contemplating doing so with a copy of the rules adopted by British observers, and with all necessary blank forms—all, I may perhaps as well add, free of charge, as our greatest requirements are *ample* and *accurate* records. G. J. SYMONS

62, Camden Square, London, N.W.

Swan Lamp Spectrum and the Aurora

IN NATURE, vol. xxv. p. 347, is a description of the spectrum of carbon as found by Professors Liveing and Dewar in a Swan lamp rendered incandescent in the ordinary way. Finding one of these lamps only feebly lighted by ten pint Grove cells, it occurred to me to test it by the secondary current. The coil was nominally a 6-inch spark one, but little battery power was used, and the spark considerably reduced. One wire was connected with the filament holders, the one made into a little coil and laid on the top of the lamp.

The first effect was a fine silver glow filling the lamp, and showing Plücker tube changes when the circuit was reversed. This gave a carbon spectrum of bright lines. Soon, however, the colour of the discharge changed to pink, and the carbon spectrum gave way to a nitrogen banded one. A yellow spark had been noticed where the wire lay on the top of the lamp, and it was evident air had found its way into it.

At one point perforation had taken place by a single spark, while near this the glass was pounded into a sponge-like mass by a series of these.

The sodium lines due to disintegration of the glass were observed in the spark and glow. I was much struck by the rapidity with which, as what was probably only a small quantity of air found its way into the lamp, the nitrogen-spectrum swept away and took the place of the carbon one, a matter which seems to present another difficulty to the favourite theory which makes the aurora, with its bright, sharp unrecognized lines, an electric discharge in rarified air. J. RAND CAPRON

Guildown, November 30

The Aurora

ALREADY we have for the height of the "auroral beam" the varying estimates of 44, 170, 200, and 212 miles, and assuming the correctness of any one of the three last figures, we seem drifting from the improbable to the impossible, for are we not told by Messrs. De la Rue and Müller (NATURE, vol. xxii. p. 24) that while at 81·47 miles' height, the discharge is "pale and faint, at 124·15" *no discharge could pass?* Lest this addition to the aurora's mysteries be for want of definite particulars in the observations, I add mine as nearly as I can—Time 6h. G.M.T. and a few minutes? Altitude of moon above horizon 28°. Distance from moon's centre to centre of beam as it floated *above* 2°, direction east to west (nearly). Lat. 51° 13′ 46″ N., Long. 0° 28′ 47″ W. (observatory).

Guildown, Guildford, December 11 J. RAND CAPRON

Fertilisation of the Speedwell

IF Mr. Stapley, who wrote on this subject in last week's NATURE, can refer to Dr. H. Müller's treatise on the relations between flowers and insects, in the first volume of Shenk's *Handbuch der Botanik* (now publishing as part of Trewendt's *Encyclopædie der Naturwissenschaften*), he will see that his own observations are very similar to those of Dr. Müller. The latter, however, refers to and figures the Germander, not the Common, Speedwell. Is it possible that Mr. Stapley—who speaks of the *Veronica officinalis* as having larger flowers than the *V. hederæfolia*, whereas they have flowers of about the same size—mistakes the *V. chamædrys* for the *V. officinalis?*

The insects which Dr. Müller found bending down the stamens, as Mr. Stapley describes, were small Diptera chiefly of the genera *Ascia* and *Melanostoma*. He mentions this also in *Kosmos*, iii. p. 497, and a few pages earlier (*ib.* p. 493) he gives a large drawing of *V. urticæfolia*.

I have not Darwin's book at hand while I write, but does he not mention the Germander Speedwell?

Bedford, December 9 ARTHUR RANSOM

Shadows after Sunset

FIVE years ago my attention was attracted to the phenomenon now under discussion. I was then at San Fernando, and could perceive almost every evening the rosy and blue or black and white rays converging to a point apparently below the horizon. I was able to trace the rays from west to east many times, and frequently also to trace the black or blue spaces to visible prominences in the cumuli in the western horizon, to whose shadows there is no doubt the rays were due, as they swept the sky with such a rapidity; and they were so persistently traceable to the bright bordered cumuli, that even though there were any hills in the direction of the setting sun (which there were not), the phenomenon could not be attributed to them. Besides, I have observed it when off the coast of Portugal, which leaves the hill shadows out of the question, as the observations were made in the (two consecutive) evenings. Though the sky is too cloudy in this part of Spain, by looking at the right place at the right time I have been able to see it many times. The mock sun described by Mr. Rand Capron in the last number of NATURE (p. 102) was seen once by me, but the phenomenon was but little conspicuous. The rays are seldom equidistant.

Naval School, Ferrol, Spain, December 5 PROF. DIER

Complementary Colours

IN connection with recent correspondence in NATURE it may be worthy of remark that I have often noticed the appearance of strong complementary colours in water from contrast-effects, in the case of a wave, breaking on the shore. If the water is properly illuminated so as to be of a decidedly green tinge, the crest of the wave often appears of a delicate pink, and this even in strong sunlight. The purplish hue of cloud-shadows on the ocean is also a familiar example of the phenomenon under discussion.

CHAS. R. CROSS

Mass. Institute of Technology, Boston, November 23

An Extraordinary Lunar Halo

I PURCHASED a copy of NATURE of November 30 in the hopes of finding some account of a lunar halo observed by myself and several friends on Saturday night, November 18, about 10.30. Instead of which I find that Mr. Barkas has sent you an account of one seen by him on the following Monday. His description tallies almost exactly with the one seen by me, with the exception of date and hour. Can any of your readers give any information respecting them?

S. A. GOOD

751, Wandsworth Road, S.W.

"Lepidoptera of Ceylon"

ALLOW us to correct a slight error in the address of the President of the Royal Society, as reported in NATURE last week. He speaks of the "*completion*" of the "Lepidoptera of Ceylon" having been presented to the Library, whereas it is only the first of the three volumes of that work which is as yet complete. Part vi., being the second part of the second volume, will be ready next week, and the succeeding parts will follow in due course. The error is not very important, but might mislead subscribers and others interested in the work.

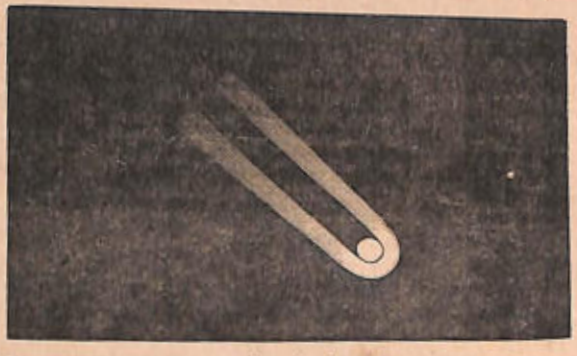
L. REEVE AND CO.

5, Henrietta Street, Covent Garden, London, W.C., December 11

THE COMET

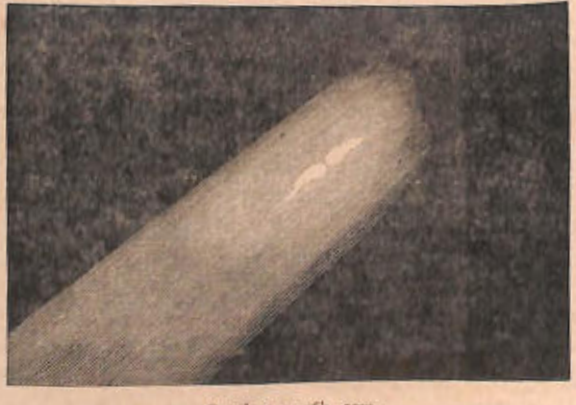
WHEN the comet was first seen on September 16 at 22h. 45m. its appearance was most symmetrical, in colour a most intense white. The sketch shows the appearance on such a scale that the nucleus would have a diameter of about 45", by a comparison made at the time with a sun-spot, the exact size of which has since been kindly furnished by the Astronomer Royal from the Greenwich photographs of the sun. The direction of the comet was to the centre of the sun, as far as could be estimated. On p. 81 of this volume there is a diagram of the sun and the comet; the size of the comet as there given compared with the sun is about as it appeared; and if one imagines the sketch I give, reduced to the length of the sign for the comet on the diagram, and placed some two diameters of the sun to the south-west and *radial*, he will have a good idea of the appearance on the morning of September 17.

The general appearance of the comet has been so fully described that I will confine myself to some points that I have observed with the three-foot reflector, which I did not get to bear, however, till October 29 at 16h. 40m.



September 16, 22h. 45m.

Although the moon was very bright the comet was well seen, the nucleus appearing as an oval bright spot fading into the head gradually (this is called the nucleus in my note-book, but subsequent observations show it ought to be called the bright part of the head). The most noticeable feature of this morning's observation is the peculiar termination to the head; at the n.f. side of head (see sketch for October 30), there was noted an absence of light, while the extension on the south side was particularly noticed, there may have been some extension on the corresponding north side, but I have not recorded it, if so the appearance would then be similar to that in sketch No. 2 (NATURE, vol. xxvii. p. 109). This oblique termination appears in all my sketches made at the telescope. The length of this nucleus or bright part of head was measured as 55". An absence of stripes in the tail was particularly noticed, if there was a difference the south side was a little the brightest.



October 30, 16h. 50m.

On this morning the brightness of the moonlight had a marked effect on the visibility of the broader part of the tail, so much so that it was easier to trace it in the sky with the naked eye, than with either a binocular, a 3-inch achromatic, or a 3-foot reflector.

The following morning, October 30, 16h. 50m., the appearance of the comet was so altered that either a

remarkable change had taken place, or the details had not been properly made out on the previous morning—the head had become brighter, narrower, and longer, with a decided nucleus, situated a little less than half way from the following end; further examination showed a break in the line of light forming the head, a comparatively dark space splitting it in two, the nucleus being on the border of this space, while a brightening of the head near the other side of this space gave an appearance of another nucleus. The sketch for this date shows the position of these brighter parts or nuclei, and the space between.

A careful measurement at 17h. 41m. gives the pos. angle of the line of light forming head as 115° 5′. The distance of the nuclei was 11″·5, and the width of the head 10″. On November 1, 17h. 18m., the pos. angle of head was 117° 5′, the breadth of the head 11″, and the length 100″, the general appearance being as that given for October 30, excepting that on this morning a brightening is recorded as observed at the extremity of the *following* part of the head, giving a tri-nuclear appearance. Subsequent observations made at intervals (on November 5, 8, 9, 10, and 17) show little deviation from the last sketch. Particular attention has not since been given to eye-observations, as the 3-foot has been used on these dates for photography (with doubtful advantage). The brightness of this comet is, as far as can be judged from a comparison of similar exposures, about the same as the great comet of 1881. One minute gives an image faint, but certain, about 25 minutes' exposure gives an intense image of the head and a trace of the tail; but the result is not at present worth the great trouble it causes. One of the November 9 plates shows the dark space in the head, and this is all that can be said for it; longer exposures without a proper means of following the motion of the comet give only a trail. This however I propose to get over by having motions adapted to the plate-holder and an eye-piece attached to the holder for the purpose of running a second image of the comet, taken out of the cone of rays from the speculum by another diagonal mirror properly placed for the purpose. A. AINSLIE COMMON

Ealing, December 4

IN a clear sky at 4.50 a.m. November 26, not a vestige of the comet was to be seen by the naked eye, though its position was known exactly. On applying a telescope to the spot the nucleus appeared as a round nebula, with four small stars near it; as for the comet's tail, I presume it was "left behind," for no trace of it could be discerned, except by the eyes of the imagination. This is singularly corroborative of the statement that has appeared in these columns, viz. that the moonlight obscures the comet, although it seems to be doubted.

Oxford, December 5 FRANK STAPLETON

ILLUSTRATIONS OF NEW OR RARE ANIMALS IN THE ZOOLOGICAL SOCIETY'S LIVING COLLECTION[1]

X.

26. THE MALAYAN TAPIR (*Tapirus indicus*).—In the present condition of zoological life on the world's surface there is no better instance of discontinuous distribution than that of the Tapirs. While Tropical America contains several species of *Tapirus*, and may be regarded as the *focus* of the genus, a single well-marked species—not, however, sufficiently distinct, even in the eyes of those most fond of inventing new names, for generic separation—occurs in Tropical Asia. This is the Malayan or Indian Tapir, *Tapirus indicus* (sive *malayanus*) of systematists.

The discovery of this Tapir in Sumatra, where it was first met with, though claimed by Cuvier for French naturalists, is undoubtedly due to those of our own country. Marsden described the animal in his work on Sumatra as long ago as 1785, and Raffles obtained a knowledge of it in 1805. In 1818 a living example, captured near Bencoolen, was sent to the menagerie at Barrackpore, and was the subject of a drawing, forwarded to Cuvier by Diard and Duvaneel, which first made the great French philosopher acquainted with the existence of this animal.

The first example of the Malayan Tapir sent to Europe likewise came to this country. It was received in September, 1820, from Sir Stamford Raffles, and was the subject of an excellent memoir by the great surgeon and anatomist, Sir Everard Home, which was published in the *Philosophical Transactions* for 1821.

The Zoological Society of London acquired their first living specimen of this animal by purchase of Capt. Miland in September, 1840. This example died on April 17 in the following year. Although one or two specimens of the Indian Tapir passed through this country at subsequent intervals, it was not until the present year that the Society succeeded in obtaining possession of a second specimen. This was a young individual of the male sex, from which our illustration (Fig. 26) was taken by Mr. Smit in August last. It will be observed that although the large white area which covers the hinder quarters like a sheet, and renders the Indian Tapir so readily distinguishable from all its American brethren, is easily distinguishable in this drawing, the stripes and spots, which prevail in the younger dress of all the Tapirs, are still quite distinct. These disappear altogether when the animal is quite adult, leaving the entire body, with exception of the white back, of a glossy brownish black. The Indian Tapir is further distinguishable from all the American species by the absence of the mane, and by the minute structure of the teeth.[1] Unfortunately the Zoological Society's second specimen did not live to exhibit its adult characters, but died in October last in consequence of a disease of the rectum, which seems often to afflict these animals in captivity.

Besides Sumatra, where the Dutch naturalist, Salomon Müller, found it on the west coast up to a height of 2000 feet above the sea-level, the Malayan Tapir inhabits the interior of Borneo and the Malay Peninsula. There is also good evidence that a Tapir of some sort is found in the south-western provinces of China, which is probably of the same species.

In its native state the Indian Tapir is exclusively an inhabitant of the forest, keeping principally to the vicinity of the rivers and treading paths by following the same routes during its excursions from the banks in search of food. In captivity it becomes very tame and familiar. Dr. Cantor gives us the following account of a young female specimen which was captured in Keddah in 1845, and lived many months at his station in Malacca:—

"From the first, although fresh from its native wilds, this young Tapir showed a remarkably gentle disposition. The daytime it spent in sleeping in a dark recess of the portico of my house, though it would rouse itself if noticed. Towards sunset it became lively, would bathe, feed, saunter abroad, and with its lengthened nose examine objects in the way. Within a few days after its arrival it commenced to exhibit a marked partiality to the society of man, not indeed to its keeper in particular, whom it scarcely had discrimination enough to distinguish, but to anybody who happened to notice or caress it. Towards sunset it would follow a servant on the green in front of the house, and punctually imitate his movements, whether standing, walking, or running. If the man suddenly hid himself, the Tapir would hasten to the spot where it had lost sight of its keeper, look about in all directions, and if unsuccessful in discovering him, express its disappointment by a peculiar loud whistling. On the reappearance of the man, it expressed its pleasure

[1] Continued from vol. xxvi. p. 606.

[1] *Cf.* Tomes in *Proc. Zool. Soc.*, 1851, p. 121.

by rubbing its side against his legs, running between them, occasionally giving out a short singular sound, resembling that produced when the larger woodpeckers tap the trees, but more sonorous. When of an evening it heard the voices of people in the verandah above the portico, it exhibited strong marks of impatience till let

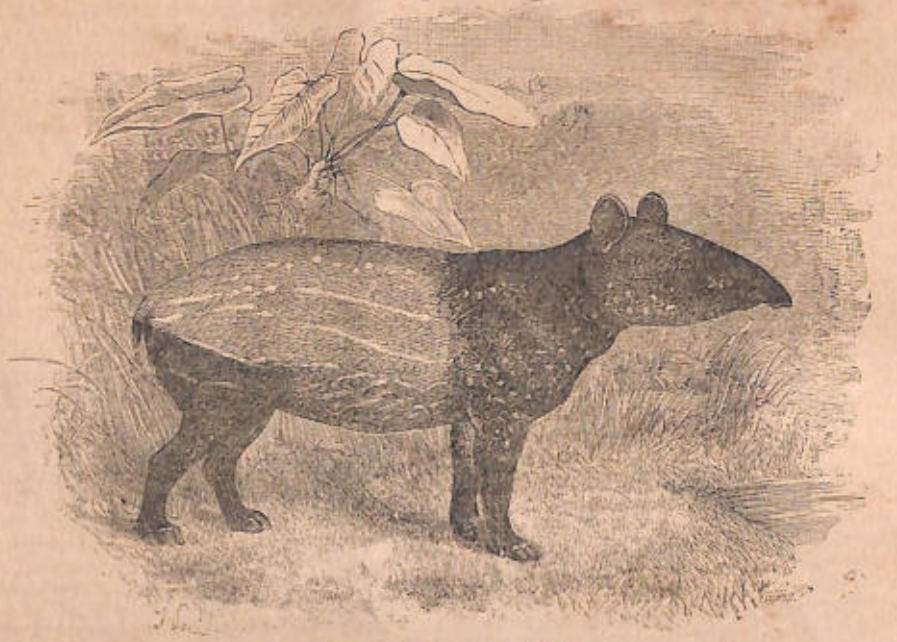


Fig. 26.—The Malayan Tapir.

loose, when of its own accord it would, awkwardly enough, ascend a flight of stairs leading to the verandah. It would then quietly lie down at their feet, and by stretching its limbs and shaking its head, express the

Fig. 27.—The One-wattled Cassowary.

satisfaction it derived from being caressed, and it was only by compulsion that it could be made to leave the company. Its food consisted of plantains, pine-apples mangustins, jambu, leaves of *Ficus pipul*, sugar-cane, and boiled rice, of which latter it was particularly fond, if mixed with a little salt. Its drink was water and also

milk and cocoa-nut oil, which latter taste the Tapir possesses in common with the O'rang-'utan. It delighted in bathing, and was otherwise cleanly.

27. THE ONE-WATTLED CASSOWARY (*Casuarius uniappendiculatus*).—The Cassowaries of the Moluccas and Papuan Islands, together with the Emeu of Australia, constitute a very well-marked division of the Struthiones, or ostrich-like order of birds, and occupy a large area of the Australian region. But while the Emeu (*Dromæus*) is spread over the whole of the Australian continent, the Cassowary is only met with in the northern parts of Queensland and in the peninsula of Cape York, and we must cross Torres Straits into New Guinea and its adjoining islets before we arrive at the true metropolis of the Cassowaries. Here we shall find them scattered over the different islands to the number of nine, as indicated in Count Tommaso Salvadori's recent essay on the group,[1] and but one, or at most two species being ever found exactly within the same area.

A characteristic of the Cassowaries is the large horny casque which covers the head, and is devoid of feathers. In one division of the genus this is much elevated and laterally compressed, in the other the casque is pyramidal in shape, and flattened cross-ways behind. The One-wattled Cassowary belongs to the second division, and is further distinguished by having (in common with its near ally *C. occipitalis*) but a single wattle in the middle of its throat.

This Cassowary was first made known to science in 1860 by Blyth, from an example brought alive to Calcutta, of which the exact origin was uncertain. It has, however, since been ascertained that it inhabits the Island of Salawatty, and adjacent western portions of New Guinea, where the naturalists Bernstein, v. Rosenberg, D'Albertis, and Beccari, who have visited these districts, have obtained specimens. Like other members of the group, it is a forest-hunting bird, living principally on various fruits, but also occasionally indulging in such animal food as lizards, fishes, and insects.

Our figure of this Cassowary (Fig. 27) is taken from a nearly adult individual of this fine species, now living in the Zoological Society's Gardens, which was obtained by purchase in July last.

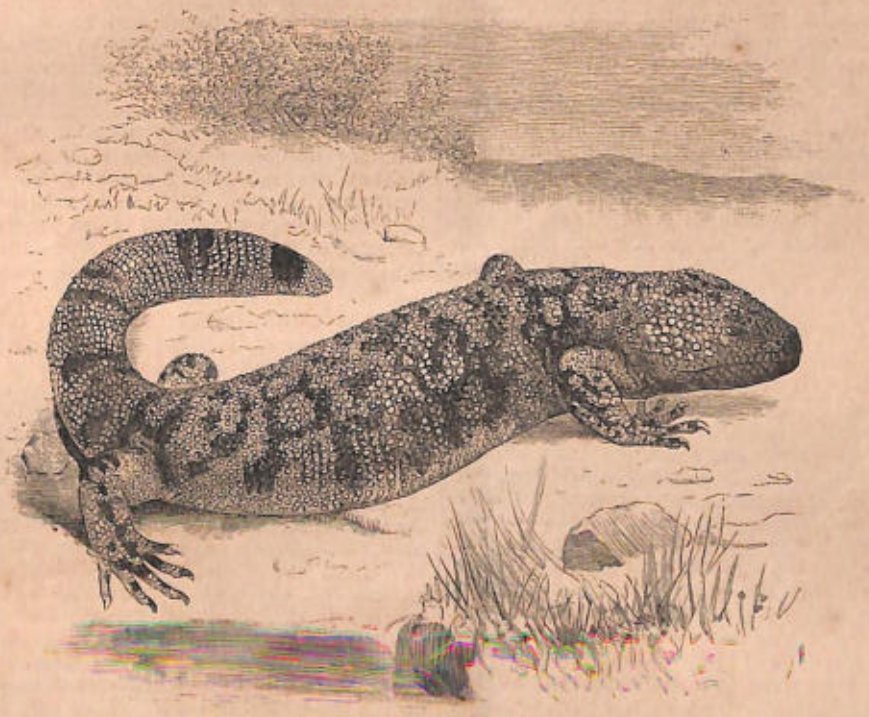


FIG. 28.—The Sonoran Heloderm.

28. THE SONORAN HELODERM (*Heloderma suspectum*).—Lizards, as a general rule, are perfectly harmless animals, whose only object when approached is to get out of sight as fast as possible. In almost every country, it is true, some sorts of lizards have a dreadful reputation amongst the ignorant. The Slowworm, in England, and the Gecko, in India, are alike reputed to be highly venomous, but naturalists well know that there is not the slightest foundation for these fancies, and that both these little creatures are, in fact, quite innocuous. It was, in fact, until within a comparatively recent period, the generally received opinion among the best authorities, that no member of the Lacertilian order was really venomous. It is only within the last few years that the evil reputation which certain lizards of Mexico and the adjoining districts of the United States have long borne among the natives of those countries, has been confirmed by an accurate examination of their teeth, and the conclusion thus forced upon us that at least one form of lizard is endowed with the faculty of producing a poisonous bite. The possesssors of these formidable weapons of defence are the members of the genus *Heloderma* of naturalists, one species of which was long ago described from Mexico under the appropriate name *Heloderma horridum*. It has been shown by MM. Dumeril and Bocourt in France, and Dr. J. G. Fischer in Germany, that this lizard has not only grooved teeth, after the manner of many of the poisonous serpents, but likewise highly developed salivary glands, which issue at the bases of the teeth with the evident purpose of carrying the poisonous saliva into the grooves. It has been likewise shown by the evidence of careful observers that the bite of the *Heloderma horridum* is fatal to small mammals and birds, and highly injurious to man, although not perhaps under ordinary circumstances capable of inflicting a fatal wound.

[1] "Monographia del gen. Casuarius, Briss. Per Tommaso Salvadori," *Mem. R. Acc. Sc. di Torino*). Ser. ii. tom. xxxiv.

The same seems to be nearly the case with a second species of *Heloderma*, *H. suspectum* of Cope,[1] a portrait of which we give (Fig. 28) from a fine specimen recently added to the Zoological Society's collection. Experiments made with this animal have shown that it is sufficiently venomous to kill a small guinea-pig, and, as hereafter shown, there is no doubt that its bite inflicts serious injury upon any one handling it carelessly.

The Sonoran Heloderm, or "Gila Monster," as the inhabitants of Arizona call this reptile, is one of the largest lizards in North America, and is found all through New Mexico, Arizona, and Texas. It inhabits the sandy deserts of that arid land, and is said to be a wonderfully striking object as it darts about the rocks, and shows its brilliant armour of jet black and orange scales. In a recent number of the *American Naturalist*. Dr. Shufeldt gives the following account of his experiences with one of these "monsters":—

On the 18th inst, in company of Prof. Gill, of the Institution, I examined for the first time Dr. Burr's specimens of the Heloderm, then in a cage in the Herpetological Room. It was in capital health, and at first I handled it with great care, holding it in my left hand, examining special parts with my right. At the close of this examination I was about to return the fellow to his temporary quarters when my left hand slipped slightly, and the now highly indignant *Heloderma* made a dart forward, and seized my right thumb in his mouth, inflicting a severe lacerated wound, sinking the teeth in his upper maxilla to the very bone. He loosed his hold immediately, and I replaced him in his cage with far greater haste perhaps than I removed him from it. By suction with my mouth I drew out a little blood from the wound, but the bleeding soon ceased entirely, to be followed in a few moments by very severe shooting pains up my arm and down the corresponding side. The severity of these pains was so unexpected, that added to the nervous shock already experienced, and to a rapid swelling of the parts that now set in, it caused me to become so faint as to fall, and Dr. Gill's study was reached with no little difficulty. The action of the skin was greatly increased and the perspiration flowed profusely. A small quantity of whiskey was administered. This is about a fair statement of the immediate symptoms: the same night the pain allowed of no rest, although the hand was kept in ice and laudanum, but the swelling was confined to this member alone, not passing beyond the wrist. Next morning this was considerably reduced, and further reduction was assisted by the use of a lead water wash. In a few days the wound healed kindly, and in all probability will leave no scar; all other symptoms subsided without treatment beyond the wearing, for about forty-eight hours, so much of a kid glove as covered the parts involved. After the bite our specimen was dull and sluggish, simulating the torpidity of the venomous serpent after it has inflicted its deadly wound, but it soon resumed its usual action and appearance, crawling in rather an awkward manner about its cage."

The specimen of the Sonoran Heloderm in the Zoological Society's Garden's Reptile House was presented to the collection in July last by Sir John Lubbock, Bart., F.Z.S., by whom it was received from Mr. G. A. Treadwell, of the Central Arizona Mining Company, of Vulture, in Arizona territory. There was much difficulty at first experienced in getting the reptile to take food. After articles of diet of various kinds had been presented to it, and successively refused, it was found that small hen's eggs were sufficiently attractive to induce it to break its fast. Since then the Heloderm has grown less dainty, and has actually condescended to take a small rat, though it prefers eggs to any other kind of food. It may be remarked that it is difficult to conjecture of what use venom can be to an egg-eating lizard.

[1] Described in *Proc. Acad Sc. Phil.*, 1869, p 5.

It may be added in conclusion that Dr. Steindachner, the well-known herpetologist of Vienna, has recently described and figured a new form of lizard from Borneo,[1] under the name *Lanthanotus borneensis*, which is nearly allied to *Heloderma*, and has similarly grooved teeth. It would be of great interest to know whether the Bornean lizard has likewise venomous qualities.

THE TRANSIT OF VENUS

A VERY fair amount of success appears from the telegrams to have attended the British expeditions for the observation of the late transit of Venus. In Jamaica Dr. Copeland and his colleague secured all four contacts; at Barbados Mr. Talmage, though he lost the first external contact, observed the other three; we have no intelligence yet from the station at Bermuda, occupied by Mr. Plummer, nor, of course, from the expedition on the west coast of Madagascar. At the Cape the observers were similarly favoured by the weather, and we hear of very successful observations in New Zealand by Colonel Tupman. The only regrettable failure was at Brisbane, whither Capt. Morris, R.E., had proceeded, with Mr. C. E. Peek. It had been at first the intention of the Committee of the Royal Society to send an expedition to the Falkland Islands, but on learning that other countries intended to occupy stations in that part of the globe, Brisbane was substituted with the view to strengthen the Australian stations, and, so to say, assist in counterbalancing the great number of observations that might be expected in the United States. At the Naval Observatory, Washington, all four contacts were observed with the principal instruments, as also at the Observatory of Haverford, near Philadelphia, and in due course we shall doubtless hear of many more American successes.

At the principal observatories in this country little or nothing was seen of the transit. Dr. Ball, so far as we are aware, was most successful at Dublin; though he did not secure either contact at 2h. 37m. Dublin time he was able to commence a series of measures of distance of the outer and inner limb of Venus from the sun's limb, which he continued to 3h. 3m. He found by calculation from the time observations that at 2h. 43m. 30s. Dublin mean time, the limb of Venus nearest to the sun's centre was 188″ from the sun's nearest limb; and also, that at 3h. 0m. 0s. the limb of Venus furthest from the sun's centre was 162″ from the adjacent limb of the sun. The diameter of Venus resulting from these observations is 64 seconds, corresponding exactly with that deduced by Prof. Auwers from his heliometer measures at Luxor, during the transit of 1874.

On comparing the times calculated from the elements of the transit which have been adopted in NATURE when referring to the phenomenon with those telegraphed to the *Times*, as having been noted by two observers at Washington, and one at Haverford, the following differences between calculation and observation are shown:—

		Washington. Frisby.	Washington. Sampson.	Haverford.
		s.	s.	s.
Contact	I. ...	−80 ...	+16	−41
,,	II. ...	+13 ...	+ 3	+33
,,	III. ...	+21 ...	−38	−29
,,	IV. ...	+80 ...	+38	+19

Mr. Neison observed the first external contact at Durban at 3h. 54m. 41s. local mean time; if we assume his longitude to have been 2h. 3m. 30s. east, the difference of the calculated time would be −15s. The view from the observatory there was almost perfect. The conditions were, cloudless sky, but the air was unsteady.

Mr. Marth, writing on November 21, places his

[1] *Denkschr. k. Ak. Wien.*, xxxviii p. 95 (1878).

station at Montagu Road, Cape Colony, in longitude 20° 3′ E., with 33° 20′ south latitude. At the date of his letter he was fearful that one of the whirlwinds of sand and dust of which he had had much experience might at the last moment spoil all. The heat during the day was overpowering, but at night he was in need of his winter overcoat. The transit observations, however, were very successful.

The following telegram from Mr. Talmage, chief of the British party at Barbados, was forwarded to the *Times* by Mr. Stone :—"Internal contact at ingress, and internal and external contacts at egress were well observed." The observers were Mr. Talmage and Lieutenant Thomson, R.A. On this the *Times* remarks :—

"The observations at ingress will combine with those made at the Cape and those at egress with the Australian and New Zealand observations. An official telegram received from Captain Morris, R.E., confirms that from Mr. Peek, announcing a complete failure at Brisbane. Lieutenant Darwin, R.E., who accompanied Captain Morris, will, before returning to England, determine the difference of longitude between Point Darwin and Singapore, thus completing a connection between the Australian and English longitudes. Information has now been received from all the British stations with the exception of Madagascar and Bermuda.

"From the Paris telegram it will be seen that no news is expected from the Patagonian stations for about a week, and it is feared that the Chilian mission has failed. The Russian, Austrian, and Italian Governments have sent no parties out for observation of this transit; but the former have lent two heliometers to MM. Perrotin and Tisserand, and an equatorial to Dr. Pechüle, who has been sent to St. Thomas by the Danish Government. Spain has sent two parties to the Havannah and Porto Rico; these are provided with instruments of the same class as those of the British parties.

"Many observers have noticed the phenomenon known as the 'black drop,' and in some cases a grayish light, probably similar to that seen by Winthrop in observing the transit of 1769 at Cambridge, U.S., the American observers appear to have specially looked for traces of a satellite of the planet but could see none. A very curious phenomenon was seen by Prof. Langley and others observing at the same station. When half the planet was on the sun's disc a small patch of light appeared near the limb outside the sun; it extended for about 30 deg. along the limb, and was totally distinct from the luminous ring seen surrounding the planet by Prof. Langley and several other observers at different places. Spectroscopic observations were taken at several places in the United States; the spectrum showed some strange lines, and a watery vapour was suspected in the atmosphere of the planet. With regard to the observations made by M. Janssen at Oran, no details have been received, but it would appear that they are likely to prove of considerable value, and will add to our knowledge of the physical condition of the planet.

"The phenomenon of the 'black drop' takes place at the contacts of the limb of Venus when the planet last touches the sun's edge at entry on, and first touches when about to pass off, the disc; it has been noticed by some observers at all preceding transits which have been observed, while others have noticed a brown or greyish ligament joining the limbs of the sun and planet. The atmosphere of Venus was remarked by Hirst, who observed the transit of 1761 at Madras, and subsequently by other observers. When part of the planet has entered on or has moved off the sun, a ring of light has been seen surrounding Venus; this arises from the reflection of the solar light on the atmosphere surrounding the planet. This ring of light was noticed during the transit of 1761, and has been seen at all those of 1769, 1874, and on Wednesday. The phenomenon observed by Prof. Langley has not been observed at previous transits, and is probably due to some local causes. This is the only phenomenon mentioned in the accounts received which has not been previously noticed."

Under date December 12, Mr. Stone sends the following to the *Times* :—I have received the following telegram from Mr. Plummer, at Bermuda :—"Ingress well observed. Egress observed amid clouds." The telegram probably indicates that the observations at egress are not of much value. The egress, however, appears to have been better observed than the ingress at some of the American stations, and there will be plenty of observations of accelerated egress to balance the observations which will be available of retarded egress for New Zealand and Australia. Reports have now been received from all the British stations except Madagascar, which is a most important ingress station, and from Captain Wharton, H.M.S. *Sylvia*. Captain Wharton has two good telescopes, and will have established his party somewhere on the South American coast, where he may, if the weather was favourable, have observed both the ingress and egress, but with small factors of parallax. These observations, if secured, would however be very valuable, as a check upon the results obtained from the discussion of the observations at stations where the time is largely affected by parallax. We are not likely to hear any news of the Madagascar expedition for some weeks. The British expeditions have, on the whole, been most successful, and a valuable result is assured.

Up to the present time the following additional details have appeared in the *Times* as to the observation of the transit at home and abroad. At home the meteorological conditions were generally unfavourable :—

At Greenwich Royal Observatory the Astronomer Royal had made considerable preparations for observation, and shortly before two o'clock the whole of the staff were at their instruments, ready to take advantage of even a break in the clouds; but unfortunately the dense stratum of cloud which lay beyond the occasional rapidly passing patches of scud prevented even the sun's position being discerned. Arrangements were made for taking a number of photographs, a photoheliograph having been specially erected to view the sun until it reached the horizon. At the Radcliffe Observatory, Oxford, Mr. E. J. Stone had made considerable preparations for observation, but the sun was only visible for about five seconds, when the planet was seen on the solar disc, well separated from the limb. At Bath the haze which was prevalent during the morning cleared away, and the transit was visible till sunset. In South Wales the sky was clear until shortly before sunset. At Penzance, Plymouth, and Cork the sky was cloudless. Mr. J. Burns, at the Castle, Wemyss Bay, observed the external contact at 2h. 6m. 38s., and internal contact at 2h. 20m. 32s. (Greenwich mean time). The Rev. W. S. Lach-Szyrma, at Penzance, saw the transit from the time of contact to sunset; the black drop was clearly seen.

The astronomers at Potsdam succeeded in taking good photographs of the transit. In France, no observation could be made. At Paris, Bordeaux, Grenoble, Lyons, and Marseilles it was cloudy. MM. Thollon and Gouz, in Portugal, could also take no observations. M. Dumas received telegrams giving the main results of the observations of the transit in Oran, Martinique, and Mexico. In Martinique, M. Tisserand detected the first contact of the planet and the sun, but unfortunately he had scarcely commenced recording his observations when a cloud came over and concealed the rest of the phenomenon. At Puebla, on the other hand, M. Bouquet de la Grye had an unmixed success. The entire transit was visible, and he was able to take observations for deter-

mining the parallax. He will now, of course, work out these calculations, which promise to be amongst the most important of all the observations. At Oran M. Janssen was likewise favoured with sunshine. He was not commissioned by the Academy, but made spectroscopic observations on his own account. In this department he seems to have admirably succeeded, having obtained capital photographs 30 centimetres in size. He telegraphs that he has not only taken excellent photographs, but that he has further been able to observe atmospheric phenomena. As to Col. Perrier, who was posted in Florida, the French Foreign Office have received a telegram reporting full success, but giving no details. No telegrams from the missions in Patagonia, Chili, and Port-au-Prince have as yet been received. In short, of the results thus far known only observations in Mexico and Florida for the calculation of parallax, and those of Oran with the spectroscope seem to have been successful.

The transit was observed at many places in the United States. Special observations were made at the Observatory of the Central High School of Philadelphia by Professors Snyder and Ritter. The weather was favourable, but clouds obscured the sun during part of the time that Venus was crossing the sun's disc. The sky was cloudy all day. All four contacts were observed, and the last two well observed. The weather was not so favourable for the observation of the first two. The planet was seen off the disc at first, and in the fourth with a ring of light frequently visible. While the exact time has not yet been computed, it is known that the first two contacts were in advance of the ephemeris. Prof. Snyder says that just at or before the first contact the planet was projected on the chromosphere. The point where this occurred was verified by a notch of the advancing planet. As Venus approached the second contact a bright luminous horn darted out from the sun round the planet, but not encircling it, being only visible on one side. The same thing was also visible at the third contact. Just before the second contact the edge still off the sun was illuminated by a most beautiful hazy ring of light, seeming to have a sensible breadth. During the second contact the ligament phenomenon was visible, but not so markedly as it was observed in the case of the transit of Mercury in 1878. Just preceding and during the second contact the atmosphere was hazy, but the phenomena were well observed nevertheless. The weather at the third contact was much better, and the ligament phenomenon was not noticed, though a faint obscuration of the luminous line existed just before the geometrical contact, the latter being well observed. After the third contact the horn appearance again came, there being several times noticed evidences of a ring of light. At the last contact, and after the notch had disappeared, the planet seemed to linger off the edge of the sun. The Philadelphia observations of all four contacts are considered to have been successful. A snowstorm prevailed in Canada and the Northern portion of the United States, seriously interfering with the observations elsewhere. But successful views of at least part of the contacts are reported from Ottawa, Albany, Howard University, near Boston; the Naval Observatory, Washington; and the Johns Hopkins University, Baltimore.

Prof. Sharpless, posted at Haverford College Observatory, near Philadelphia, reports the Washington mean time of the contacts as follows:—First contact, 9h. 56m. 5s.; second contact, 9h. 15m. 49s.; third contact, 2h. 39m. 43s.; fourth contact, 2h. 59m. 51s.

At the Washington Naval Observatory the observers slightly differ in the times recorded for the contacts. Prof. Frisby, who had a six-inch equatorial, reports that the first contact occurred at 8h. 56m. 45s.; the second contact at 9h. 16m. 9s.; the third at 2h. 38m. 57s.; the fourth at 2h. 58m. 55s. Prof. Sampson, with a nine-inch equatorial, reports the first contact to have happened at 8h. 55m. 9s.; the second at 9h. 16m. 19s.; the third at 2h. 39m. 56s.; the fourth at 2h. 59m. 37s.; the time of the fourth contact is somewhat uncertain, owing to the prevalence of clouds. Washington mean time was used. Fifty-three photographs were taken during the transit. The professors report that their labours were generally successful, and that if other stations were equally fortunate the result ought to be computed within two years.

Successful observations were made at Yale College, Newhaven, and also by Professor Draper in New York, who got good photographs. The French Astronomical Commission succeeded, at St. Augustine, Florida, in taking 200 photographs. Partially successful results were obtained by the Belgian Commission at San Antonio, in Texas, where 204 photographs were taken of the later phases, the first two contacts being lost. Fully successful observations were made at San Francisco, with 48 photographs; and partly successful ones at Cedar Keys, Florida, where the first contact was lost, while the other three were well observed.

One hundred and eighty photographs were successfully taken by the German Commission at Hartford, Connecticut. They failed to observe the first contact, but afterwards got eight full sets of heliometric observations, which made all they desired, and which they consider very satisfactory. No trace of a satellite was visible. Partly successful results were further obtained by the Germans at Aiken, South Carolina, where they lost the first two contacts, but got three sets of heliometric measurements in the afternoon.

At the Harvard College Observatory spectroscopic observation showed no perceptible absorp-ttion of the sun's light by the planet's atmosphere.

Telegrams announce a complete success in New Zealand, Panama, New Mexico, Jamaica, and some parts of Australia. In New Zealand, England was represented by Colonel Tupman and Lieutenant Coke, R.N., both observers in 1874. The observations of the transit are described as very successful, and Colonel Tupman expected that the observations for determination of the longitude would be complete by Sunday last. The United States party, under Mr. Edwin Smith, observed at Wellington, and were successful in taking two hundred and thirty-six photographs. Of the Australian stations perfectly successful observations were secured at Hobart Town (Tasmania), Wentworth (New South Wales), and in South Australia At Adelaide the transit was slightly obscured by clouds, but no information to hand states whether the contacts were observed or not. In Queensland no success was obtained. Mr. Russell at Sydney arranged to provide about ten observers at lofty stations along the east coast; heavy rain fell in Sydney and Gippsland, but it is probable that observations have been secured by some of the observers, although no success was obtained at the Sydney Observatory. At Melbourne observations were secured, and twenty-three photographs taken. The Government of Victoria provided for two or three stations respecting which no information has been received, but judging from the state of the weather in Melbourne, there is a probability of success.

We have received the following communications on this subject:—

In a communication from the observatory of the Collegio Romano we are informed that the observations of the transit at Rome were quite successful, although the sky a few minutes before contact was cloudy. Signor Tacchini observed the contacts with the grating spectroscope applied to a Merz refractor of 25 c., and M. Milloseisch simply used a Cauchoix refractor of 15 c. in the ordinary way. In the morning, Signor Tacchini,

was able to make his usual spectroscopic observations on the limb of the sun, and he saw that on that part of the limb at which the first contact would take place, the chromosphere was regular, but composed of very active flames, and two protuberances bounded the section (*trait*) of the chromosphere, on which the planet might be looked for before the first external contact. In fact, Signor Tacchini, at 2h. 24m. 33·8s. mean Roman time, saw the edge of the planet on the sharp points of the chromospheric planes He continued to see very clearly the planet advance towards the base of the chromosphere, and he observed the first external contact at 2h. 48m. 54·43s. Afterwards he watched the complete reappearance of the chromosphere, and then he noted the first internal contact at 3h. 9m. 34·79s. The image of the chromosphere was always very well preserved, and the size of the planet projected upon it always very clear. Prof. Milloseisch observed the contacts at the following times:—First external contact, 2h. 49m. 48·14s.; first internal contact, 3h. 9m. 29·34s., for the moment of the appearance of the black drop, and 3h. 10m. 10·14s. for the moment of the disappearance of the drop. Between the times noted by the two observers for the first contact, the difference amounts to 94 seconds, which clearly proves the great advantages of making use of the spectroscope. Shortly after the first contact, Prof. Milloseisch perceived for the first time the presence of the planet's atmosphere, verified by Signor Tacchini and his assistant. Signor Tacchini even observed in the spectroscope the phenomenon of absorption by that atmosphere, as in Bengal in 1874, and even at Palermo something of the same kind has been seen. MM. Tacchini and Milloseisch did not see the entire planet before the first contact. The atmosphere of the planet was more active near the edge of the sun. Prof. Milloseisch estimates the height of the atmosphere of Venus at one-fourteenth of the planet's diameter. Signor Tacchini found the diameter of Venus to be equal to 67″·25.

I HAD the advantage of seeing here yesterday the transit of Venus, under exceptionally favourable circumstances, by means of a very simple and ingenious apparatus fitted up by my cousin, Mr. J. Campbell, of Islay. The image of the sun was thrown from a small telescope, properly focussed, upon a large sheet of cardboard paper, in a dark room. The size of this solar image was a little more than two feet in diameter. Upon this image the solar spots and some brilliant "faculæ" were very distinctly visible. As the time approached, Mr. Campbell expected that we might see the planet whilst yet some little distance from the illuminated edge of the sun, owing to the atmosphere of the planet catching and reflecting some solar light before the apparent contact. I believe Mr. Campbell had seen this on the occasion of the transit, in the clearer atmosphere of Japan. Here, none of the party could detect the planet before its disc began to impinge on the edge of the sun. But when the planet's disc had advanced about one quarter of its own diameter upon the solar image, then a faintly luminous ring was distinctly seen defining the rest of the planet's disc, in the darkness out of which it was moving. For some time I was incredulous as to this appearance; but before one half of the planet's disc had crossed the illuminated edge of the sun, the luminosity of the other side of that disc was too distinct to be doubted, and the appearance was very striking and beautiful. I may mention that the size of the planet's disc was, as nearly as possible, seven-tenths of an inch. The time of contact was exactly 2.28 p.m.

Cannes, December 7 ARGYLL

AT 1h. 48m. 28s. Dunsink mean time, I first saw the sun through an opening in the clouds. Venus was at once seen (in the finder of three inches aperture attached to the south equatorial), and was estimated to be about one-third of the way on the sun. But the snow and clouds again intervening, there was nothing more to be seen until 2h. 37m. 19s., when I was enabled to commence a series of micrometric measures with the large instrument. I used a polarising eye-piece and a power of 177 with the Piston and Martin filar micrometer. The limb of the sun was boiling furiously, and Venus was often of any shape but a circular disk. The measures were consequently by no means easy. I set one wire tangentially on the sun's limb, and the other on that of Venus. Altogether I was able to make sixteen of such sets, nine being made with the limb of Venus nearest the sun's centre and the remainder with the other limb. The following are the results:—

Dunsink mean time.	Far limb of Venus.	Near limb of Venus.
h. m. s.	″	″
2 37 19	171	—
39 24	177	—
40 42	185	—
42 18	187	—
44 13	191	—
45 20	190	—
46 22	198	—
48 17	196	—
52 16	—	142
54 16	—	149
55 36	215	—
58 17	—	161
59 36	—	164
3 0 46	—	161
1 41	—	164
2 51	—	170

These results have not been corrected for refraction.

I conclude from the mean of the first series that at 2h. 43m. 30s. the far limb of Venus was 188″ from the limb of the sun, while at 3h. 0m 0s. I conclude from the second series that the near limb of Venus was 162″ from the sun. By a projection of the results it is easy to see that the diameter of Venus must have been 64″.

My assistant, Mr. Rambant, was observing with the small equatorial, which is 78 metres from where I was observing. He reports as follows: "At 1h. 45m. the clouds, which up to that time had obscured the sun, cleared away, and I saw the planet with about one-half of its disc projected on that of the sun, but a snow-shower coming on almost immediately, I was unable to perceive any trace of light round Venus, or even to follow its outline beyond the limb of the sun. By the time the snow cleared away the internal contact was passed, and Venus appeared at about twice of its own diameter from the sun's limb; the sun's light appeared of great brightness right up to the dark disc of the planet except at the northern limb, where I suspected a dark brown fringe, but the boiling was such that I could not be certain of this.

R. S. BALL,
Astronomer Royal of Ireland

Dunsink Observatory, Dublin

THE transit of Venus was well seen at this observatory owing to the unusually favourable state of the weather. I observed it in the Markree refractor with an aperture reduced to five inches. I did not meet with any difficulties and saw no "black drop," perhaps because I had focussed the eyepiece on double stars the night before. Owing to the boiling of the sun's edge, I did not see Venus till 1h. 27m. 38s., external contact having taken place previous to this. I then measured the distance between the cusps micrometrically, and from a provisional reduction of these observations it appears that Venus was bisected at 1h. 46m. 40s., when a fine line of light appeared at the outer edge of Venus. At 1h. 47m. 58s. the cusps

met for an instant, but did not unite permanently till 1h. 48m. 28s. (Markree mean time). Venus was visible on the sun till sunset. I measured its semi-diameter =29″·07.

W. DOBERCK

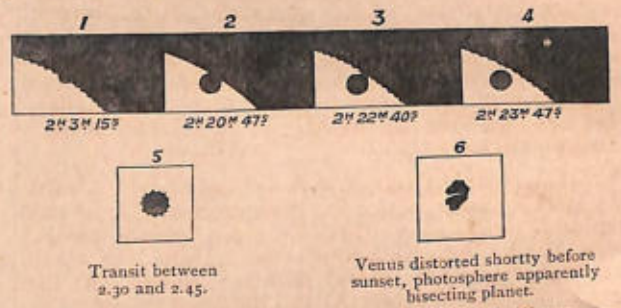
Markree Observatory, December 7

THE ingress of Venus was observed at the Armagh Observatory under very favourable circumstances. I employed the 15-inch reflector in the Newtonian form with an unsilvered flat mirror and a negative eyepiece (power 140) and glass wedge. With an aperture of eleven inches the sun's limb was "boiling" considerably, so that I missed the exact moment of external contact; but having reduced the aperture to seven inches, the internal contact was very well seen. At 1h. 49m. 31s. local M.T. the whole circumference of Venus could be seen; at 1h. 54m. 49s. I saw a faint shade-like object between the cusps, which broke at 1h. 55m. 24s., when a very thin bright line separated Venus from the sky outside; 27s. afterwards the interval was very conspicuous. Rev. Ch. Faris, assistant astronomer, observed with the 4-inch finder attached to the same instrument, and every care was taken to make the two observations independent of one another. He observed external contact at 1h. 35m. 34s., and saw the cusps meeting at 1h. 55m. 10s. without observing any disturbance of the limb. Good determinations of time were obtained on the previous and following evenings.

J. L. E. DREYER

Armagh Observatory, December 9

THE all-important 6th of December, 1882, will long be remembered by us in Lochaber, who had eagerly looked forward to a sight of the transit of Venus. Our hopes were realised to the full, and considering our somewhat high latitude, we were privileged indeed. An account of the meteorological conditions will be of introductory interest. A barometric depression had two days previously travelled down from the vicinity of the Faroe Islands, bringing overcast weather and rain—very discouraging—but the mercury rapidly rose in its rear on the night of the 4th, light north-easterly winds set in, the sky cleared on the 5th, and free radiation, and a hard frost followed with charming winter weather. At 9 a.m. on the 6th the barometer, corrected and reduced to 32° F. and mean sea-level read 29·677, and was steady, dry bulb 27·3, iced bulb 26·1, giving a vapour tension of ·112, relative humidity 76 per cent., and a dew point of 20·9. Light airs were noted from north-east by east, and some pieces of innocent-looking cumulus clouds were observed. Browning's spectroscope, soon after 9 a.m., showed an entire absence of rain-band to the left of the D line, in the solar spectrum, but a broad telluric band stronger than usual was observed on the right of D; this, however, did not much distress me. The meteorological conditions generally continued much the same, the weather being very fine. When the hour for the beginning of the transit drew nigh, I repaired to a field adjacent, entirely open to south-west, with telescope and sketching equipment. Here an uninterrupted view of the sun could be obtained. The instrument employed has a clear aperture of 2¾ inches, object-glass of first quality by Dancer of Manchester, power used 70. A few clouds near the sun about 1.53 caused anxiety, but they soon cleared off, and a perfect and continuous view of the sun was obtained. Two good watches and clock were set to Greenwich mean time, obtained with all possible accuracy from post-office signal in the morning. Considering the sun's low altitude, the thick stratum of atmosphere traversed by the oblique rays, tremors of the air, and effects of atmospheric refraction, the phenomenon of the ingress was well observed in the telescope. The external contact, when the dark body of Venus just indented the sun's limb, south-east by south, took place at 2h. 3m. 15s. Greenwich mean time (see sketch No. 1), by 2h. 13m. 0s. the half of the planet was upon the sun; sketch numbered here 2 (several others not now given were taken) was made just before the internal contact; and at 2h. 22m. 40s. I noted the internal contact. At this time (sketch No. 3) I observed the ligament joining the edges of Venus and the sun, like the thread between two drops of water when about to part, and the planet was much in shape as an apple with the stem joining on to the edge of the solar orb. At 2h. 23m. 47s. (sketch No. 4) Venus was as a round black spot upon the sun, and clear of his edge, and a narrow streak of light intervened. By this time friends had gathered around, and as the chief observations had been made they were enabled to take turn at the instrument and watch the progress of the planet in its course across the sun's disc, until a mass of cumulus cloud at 2.45 put a stop to observation. The outline of Venus against the sun was very irregular (sketch No. 5). Mr. Colin Livingston, of the public schools, also observed the ingress independently, and we agree to the very second that the internal contact took place 19m. 25s. after the external contact. The sun's



The Transit of Venus (Ingress) as observed by Clement L. Wragge.

photosphere by the way was almost wholly free from spots. Just a stippling was observed a little west from the centre, and a small disturbance was noted in perspective near the eastern limb—in marked contrast with the great spot regions well observed here on November 16, and now probably existing in the opposite hemisphere. The sun's edge was very uneven, as I have attempted to show in the sketches. The highest temperature during the day, it is worthy of mention, was only 30·9, and pressure remained fairly steady at a mean of 29·670 at sea-level. Views of the transit were again obtained before sunset, but the intensity of refraction near the horizon so distorted both the sun and Venus—the former being like an egg in shape, and the latter at times as shown in sketch No. 6—that I could but wistfully watch them go down together on a gorgeous sky behind the snow-clad heights of Beinn na Cille, envy our cousins in the west their sight of the egress, and wonder under what strange circumstances the next transit will be observed in the year of our Lord, 2004.

CLEMENT LINDLEY WRAGGE

Fort William, December 10

THIS rare phenomenon was well observed here on the 6th inst. The few clouds which partially hid the sun during the first stages of the transit, only served a useful purpose in moderating the sun's brilliancy. At about 2 p.m. a dark indentation was observed on the south-east margin of the sun's limb, and it was evident the phenomenon had commenced. A few minutes later this indentation had developed into a semicircular notch, and at about 2.21 p.m. the black and now complete circle of Venus had fully entered upon the solar disc. It was very large and conspicuous, and its effect, even as observed in small telescopes, was very striking. The opaque and well-defined globe of the planet was projected with remarkable boldness upon the sun's bright photosphere. Protecting the naked eye with deeply tinted glass, the planet was very plainly seen; indeed, the dark spot was thus clearly distinguishable before it had entered fully

upon the sun, and while it had notched the disc. The planet appeared to be surrounded by an annulus of reddish hue, and over the central parts there was diffused a patch of faint light. The region of the disc just within the margin was very black. These effects may, however, have been purely telescopic. I used a reflector of 4-inch aperture, with which the definition was not all that could be desired. There were very few of the ordinary sun-spots visible. A small irregular group lay slightly to the south-west of the centre, and another with much faculæ, near the eastern limit, but they were of very insignificant character, and not at all comparable to some of the fine spots which have been recently visible on the solar surface. To an observer accustomed to the appearance of these objects, the view of Venus now in transit must have been of extreme interest, and he could not fail to be struck with the marked difference between the black circular disc of the planet, and the more irregular and far less intense forms of the ordinary sun spots. As the transit progressed, the sky continued clear, so that it could be watched until near sunset, but the telescopic view became less effective, owing to increasing atmospheric undulation, which, as usual with objects at low altitudes, greatly impaired the definition. W. F. DENNING

Bristol, December 9

SOME parts of the transit were well seen here. I used a 3¼ Merz refractor, power 60. The external contact was excellently seen. I watched for those peculiar phenomena (black drop, &c.) which have created so much interest, but was able to see nothing of them. At the moment of external contact, I had the point of impact in the centre of my field, and the planet indented the edge of the sun with a black and perfectly circular segment, disturbed only by the "boiling" appearance characteristic of the solar edge. I watched the planet advance upon the sun to within, I guess, a few seconds of internal contact, when unfortunately the sun became obscured by a small cloud. At the time of observation, so near was internal contact, that I could every now and then see the boiling appearance of the solar edge peeping out from behind the black edge of the planet; but no other distortion of the planetary or solar edge was observable, except what arose from the "boiling" appearance referred to. D. TRAILL

Raleigh Lodge, Exmouth, December 7

THE transit of Venus was perfectly seen here yesterday. The sky was overcast quarter of an hour before, but the first and second contacts took place on a clear disk, and the first was almost instantly apparent with a hand glass. The sky remained clear till considerably past three. Considering the total failure in London and Paris, one could wish that some trained observers had selected our south coast. HENRY CECIL

Bregner, Bournemouth, December 7

P.S. As a consequence of popular ideas and anticipations as to celestial phenomena having got "a little mixed" lately, my gardener asked me this morning "*if I saw the star fall into the sun yesterday.*"—H. C.

THE transit was seen here to great advantage, the day being exceptionally fine, the sun shining brightly from about 9·30 till sunset, with the exception of a few passing clouds at noon, and one small cloud obscuring the sun from 2.30 to 2.35 p.m. According to the times and positions of the sun and planet, given in the *Nautical Almanack*, I had made a diagram as correct as I could of the sun with the path of Venus across his disc; but if I had relied entirely upon the diagram I should have missed the place of external contact, as I found afterwards I had drawn the position of Venus considerably too high. To make sure of my object I depressed the telescope so as to keep as much of the sun as possible out of the field of view, and only allowing a portion of his limb to appear, and at 2h. 3m. 11s. I picked up Venus depicted against the sky, and just coming in contact with the sun's limb. Her disc appeared a trifle paler than the background, and was surrounded with a very thin circle of light which appeared a little wider on that side furthest from the sun. It was this light which attracted my attention, and enabled me to identify the planet. At 2h. 3m. 20s. the first *touch* of Venus upon the sun's limb took place. I now watched with much interest to see if it was possible to detect signs of an atmosphere to Venus—changing the eye-pieces. Sometimes I thought there were visible signs of it, but I would not say decidedly that it was so. I noted with some surprise that the planet appeared much smaller upon the sun than it did immediately previous to contact. At 2h. 23m. 31s. internal contact took place. The planet appeared to pass clear off and away from the sun's limb, without showing the least sign of a "black drop," or any appearance of a lingering connection between her limb and that of the sun. The telescope used is an equatorial with driving-clock, silvered glass reflector 8½-inch diameter and 7 feet focal length; eye-pieces ranging from 30 to 170 of magnifying power. I took three photographs between 2h. 35m. and 2.45, but the spring of my instantaneous shutter did not act as it should, and therefore the photographs are not so good as I could wish, but Venus can be readily seen upon the sun's image in the negative.

Silverton, Devon, December 9 R. LANGDON

NOTES

THE following are the probable arrangements for the Friday evening meetings before Easter, 1883, at the Royal Institution:—January 19, R. Bosworth Smith, M.A., The Early Life of Lord Lawrence in India; January 26, George J. Romanes, F.R.S., Recent Work on Starfishes; February 2, Sir William Thomson, F.R.S., The Size of Atoms; February 9, Moncure D. Conway, M.A., Emerson and his Views of Nature; February 16, Prof. William C. Williamson, F.R.S., Some of the Anomalous Forms of Primæval Vegetation; February 23, Walter H. Pollock, M.A., Sir Francis Drake; March 2, C. Vernon Boys, A.R.S.M., Meters for Power and Electricity; March 9, Prof. George D. Liveing, F.R.S., The Ultra-Violet Spectra of the Elements; March 16, Prof. Tyndall, F.R.S.

MR. H. O. FORBES, on his return to Amboina from his first visit to Timor-laut, writes as follows:—"Extended movements were impossible, so that my botanical collections are not very extensive, but the ornithological and anthropological parts are very good. I am now engaged in packing them up for despatch, and hope to send them off soon. My intention is to return to Timor-laut in a few days, if my health will permit, by the Government steamer which leaves for the Tenimber Islands. I shall settle in some more quiet spot than Ritabel. A full report on this interesting country shall be sent by next mail. One of the singular facts I observed is the immense herds of wild buffalo existing on the mainland of the island. They must have, of course been introduced, but by whom, and how long ago, is an interesting question. I was unable to get a specimen unfortunately. My wife, who accompanied me, aided me greatly, so that when I was down with fever (and the fever is of extreme severity) the work was still able to go on." Mr. Forbes' collections will be consigned to the Committee of the British Association for the exploration of Timor-laut, as arranged when the expedition was determined on.

THE Accademia delle Scienze dell' Istituto di Bologna has lately announced that a gold medal of the value of 1000 lire (say 40*l.*) will be presented "to the author of that memoir which, proceeding on sure data either of Chemistry or of Physics, or of Applied Mechanics, will indicate new and efficacious practical systems, or new apparatus for the prevention, or extinction of fires." Memoirs must be written in Italian, Latin, or French,

and sent in (in MS. or printed form, and in the usual anonymous way) before May 30, 1884.

ANOTHER well-known naturalist has passed away. Prof. Andrea Aradas, of Catania, died on November 1 last, after a long and laborious life, which was devoted to the study of marine zoology and palæontology. His publications were very numerous, and extended over nearly forty years. He was a man of great amiability as well as learning.

THE death is announced of Sir Thomas Watson, M.D., F.R.S., the eminent physician, at the age of ninety years.

ON Monday evening the annual dinner of the Professors and Members of the Royal School of Mines was held in the Victoria Room of the Criterion, Piccadilly. Mr. E. L. J. Ridsdale, late of the Royal Mint, presided. It was announced that Major-General Martin was about to retire, owing to ill-health. Prof. Huxley made a long and interesting speech, in the course of which he recalled the personal characteristics of the professors who filled the chairs at the school. Prof. Judd proposed "The Geological Survey," to which Dr. A. Geikie responded.

PROF. KENNEDY has issued invitations for an inspection of the experimental engine and other apparatus just completed at the Engineering Laboratory, University College, London. Prof. Kennedy draws attention to the fact that the laboratory was the first of its kind established in England, and was at the time of its establishment an entirely new departure in technical education in this country. Since that time (1878), its principle has been more or less formally adopted by all the recently-established technical colleges. A very large number of the leading engineers of the country have also formally expressed their approval of the scheme, which, too, came in considerable detail before the present Royal Commission on Technical Education. The additions now just finished to the Laboratory render it already probably the most complete of its kind in Europe.

A RECENT writer in the *China Review* exemplifies the difficulties surrounding interpretation from Chinese into English, or *vice versâ*, by mentioning that the simple question, *Was he (or she) dead?* which occurs so frequently in inquests and other judical proceedings, admits of a positive or negative reply according to whether the European or the Chinese idea as to when death occurs be followed. We believe that a man is dead when he has ceased to breathe, and when his blood no longer circulates; the Chinese consider him still alive whilst a trace of warmth lingers in the body. The two estimates may thus differ by several hours. Hence it was that in inquests in Hongkong the time of death formed a stumbling-block in almost every Chinese case. The medical evidence would show that the deceased must have been dead when brought to the hospital, while the relatives would swear he was alive at the gate. Subsequent inquiry showed that the general view among the Chinese was that a person is considered to be dead when the body is cold, and not before. It does not speak very well for the Chinese scholarship of the officials of Hongkong that it took about forty years to discover this important distinction.

AN aurora was seen in Belgium on October 2, and one feature of it was (according to M. Montigny) the formation of a broad luminous arc extending across the sky from east to west, and passing a little to the south of the zenith. After a little time it broke up and gradually disappeared. M. Montigny observed the stars during this aurora, and found his former conclusions (as to increased scintillation during auroras greater in winter, and in the northern region, and towards the zenith, &c.) confirmed. He notes, however, an interesting new phenomenon of scintillation. For more than a year, when a magnetic perturbation has been observed to occur at Brussels Observatory, he has very often observed a simultaneous sudden increase in the scintillation. No auroral phenomena were reported at those times, as during aurora the increase is more marked for the north and west, and the circular line in the scintillometer becomes irregular. M. Montigny is prosecuting his study of the phenomena.

IN the same *Bulletin* of the Belgian Academy, with M. Montigny's paper (November 9–10) is a full description, by M. Tarby, of the aurora of October 2, as observed at Louvain. Besides the luminous arc referred to above (which moved towards the south), he notes that the aurora had not the pronounced red tint characteristic of large phenomena of this class; white streamers constantly predominated. The successive displacement of the manifestations was from east to west, by north, a direction presented in certain previous auroras (which he specifies); while the opposite direction was observed in others. M. Tarby tabulates several years' observations of aurora in Belgium, and finds striking confirmation of an observation of M. Quetelet's in 1870, that auroras (through some unknown periodic influence) tend to appear at about monthly intervals.

IN the pile-dwellings near Bobenhausen (Zürich), a hatchet made of pure copper has been discovered. Special importance is attached to this discovery by students of prehistoric archæology.

THE fourth edition of the Micrographic Dictionary is now more than two-thirds completed. The book will always be an indispensable work of reference to the student of the lower forms of animal and vegetable life. Very little attempt appears, however, to have been made by the editors to keep pace with the advance of biological science during the eight years that have elapsed since the publication of the last edition; notwithstanding the number of new forms that have been discovered during that period, the work so far occupies rather less space than before. In order to test the extent to which recent knowledge has been incorporated, we turned to two or three of the cryptogamic articles. Under "Fungi," we find it still stated that "the structure of all fungi exhibits a well-defined separation into two parts, namely: (1) a *mycelium* . . . and (2) the *reproductive structure*, or *fruit*"; and this although Schizomycetes are given as one of the groups of fungi; while the classification of "Fungi" into "I. Schizomycetes; II. Phycomycetes; III. Hypodermiæ; IV. Basidiomycetes; V. Ascomycetes; and VI. Myxomycetes" is stated to be "that of Sachs (!) slightly modified." Under "Lichens," the theory of the symbiosis of algæ and fungi is dismissed in a few sentences, without adducing any of the evidence in its favour, as "one of the modern natural-history romances." A new paragraph appears under the head "Gongrosira," which is described as a genus of Chætophoraceæ, without any reference to its genetic connection with *Vaucheria*. These and similar deficiencies suggest the question how far the text can have been revised by the eminent cryptogamist whose name still appears on the title-page.

THE concluding volume of the new edition of "The Imperial Dictionary," edited by Mr. C. Annandale, has been issued with praiseworthy promptitude by Messrs. Blackie and Son. In a supplement Mr. Annandale has added a considerable number of words omitted from their places in the body of the work, including not a few scientific terms. In the Appendix are copious lists of classical, scriptural, and geographical names, foreign words and phrases. In the preface the editor explains his method, which we think rational and judicious, and which has led to an excellent result. The list of authors consulted for quotations contains abou 2,000 names.

THE French official paper publishes an *arrêté* from the Minister of Public Works requiring that all trains be furnished with continuous brakes, and if possible automatic.

THE inundation of the Seine, which had reached a level of about 6¼ metres above the summer season, and has caused many disasters, has terminated abruptly by the cold weather which has set in with the new moon.

AT the last meeting of the St Petersburg Society of Naturalists, M. Beketoff reported that the expedition for the exploration of the Altai sent out during last summer was very successful. MM. Sokoloff, Polenoff, Nikolskiy, and Krasnoff have returned with very rich botanical, zoological, mineralogical, and geological collections. He added also that the appeal of the Society for botanical collections (addressing them to the St. Petersburg University) had been responded to. No less than eighteen very good collections had been received, among which one by the scholars of all *Realschulen* of Western Siberia merits special attention.

IT is worthy of note that snow fell on Sunday in Madrid to the depth of one foot. It is said that no such weather has been experienced in the Spanish capital for twenty years.

THE diaries, pocket-books, cards, and the other useful and beautiful things issued by Messrs. De La Rue for the coming year are in all respects equal to those of which we were able to speak so highly last year. It would be difficult to imagine anything more beautiful of their kind than the cards, and what with Japanese beauties, flowers, birds, and insects, they might be utilised for giving the young ones a liking for natural history. The astronomical and other useful information contained in the diaries is as full and accurate as ever, and adds greatly to their value in our eyes.

AMONG the articles in the *Companion to the British Almanac* for 1883 are "Halley's Comet," by Mr. W. T. Lynn; "Modern Fish Culture" and "Fishery Exhibitions," by Mr. J. G. Bertram; "Insects Injurious to Agriculture," by Mr. W. E. A. Axon; "Electric Lighting," by Mr. L. T. Thorne; "The British Museum," by Mr. Charles Makeson; and a brief sketch of the Science of the Year, by Mr. J. F. Iselin.

HARTLEBEN, of Vienna, has sent us a catalogue of German works, some of which might commend themselves to those who may wish to entice their young friends to the study of German.

A GERMAN translation is announced of Dr. Ingvald Undset's "Study in Comparative Prehistoric Archæology"; Meissner, of Hamburg, is the publisher, and the last number (23) of *Globus* contains an abstract of Dr. Undset's researches into the first appearance of iron in Northern Europe.

THE last number (vol. xvii. part 1) of the *Journal* of the North China Branch of the Royal Asiatic Society contains a short article by Dr. Guppy, R.N., on the Geology of the Neighbourhood of Nagasaki, and a few notes on the South Coast of Saghalin, by Mr. Anderson. The principal paper, occupying 180 pages, is on Annam and its Minor Currency, by M. Toda. Besides the portion devoted to numismatics, the author gives a short historical and geographical account of Annam, which should be valuable at the present time, when public attention is being strongly drawn by political events to these regions. Of the remaining papers, one, by Mr. Giles, discusses Chinese Composition; the other, by Dr. Hirth, describes a manuscript work written at the end of the last century, referring to the manner in which the Customs dues on foreign goods were then levied at Canton. It is called the "Hoppo" book, "Hoppo" being the title popularly given, even now, by foreigners to the principal native chief, or commissioner, of Customs at Canton.

THE additions to the Zoological Society's Gardens during the past week include a Bonnet Monkey (*Macacus radiatus* ♀) from India, presented by Mr. W. Percy Laing; a Black-headed Lemur (*Lemur brunneus* ♂), a Black Lemur (*Lemur macaco* ♀) from Madagascar, presented by the I Company 3rd Battalion King's Royal Rifles; two Leopards (*Felis pardus* ♂ ♀) from India, presented by Lady Brassey; a North African Jackal (*Canis anthus*) from Tunis, presented by Capt. W. F. Wardroper; two Mexican Sousliks (*Spermophilus mexicanus* ♂ ♀) from Mexico, presented by Mrs. Simmonds; a Great Eagle Owl (*Bubo maximus*), European, presented by Mr. R. Leigh Pemberton; a Martinique Waterhen (*Porphyrio martinicus*) from Venezuela, presented by Mr. F. L. Davis; a Common Squirrel (*Sciurus vulgaris*), British, presented by the Hon. L. W. H. Powys; two Raccoon-like Dogs (*Nycterentes procynides*) from North-Eastern Asia, purchased.

OUR ASTRONOMICAL COLUMN

COMET 1882 *b*.—A number of very beautiful photographs of the great comet have been received from Mr. Gill during the past week. Several of them are remarkable for the amount of delicate detail that is brought out. Mr. Gill writes: "These photographs are interesting, not only as pictures of the comet, but they appear to me to show the possibility of making, with very little labour, a photographic *Durchmusterung* of the heavens." One of them taken on November 8 was exposed two hours, and shows all the 8th magnitude stars and the curious envelope extending 4° or 5° beyond the nucleus. This envelope was barely visible either to the naked eye or in the telescope.

Both Mr. Gill and Dr. Elkin had made a careful search for the cometary body seen within a few degrees from the nucleus of the great comet, by Prof. Julius Schmidt at Athens.

We have more than once pointed out that calculations based upon such observations as were available here at the time of writing, indicated sensible disturbance of the comet's motion at the perihelion passage. It is right, therefore, that we should state at once that this inference is hardly countenanced by calculations made by Mr. Finlay and Dr. Elkin at the Cape, who have had the advantage of more numerous, and probably in general more accurate and uniform series of observations. Mr. Gill writes: "The great comet is a puzzle. The whole question of its orbit now turns on which point of its nucleus should be observed. So long as the nucleus was single, *i.e.* from September 8 to September 28, Dr. Elkin has been able to represent its motion by parabolic elements within 3″ of observation. But after September 28 matters change; the head begins to break up. What we took for the principal nucleus is no longer the centre of gravity. Finlay and Elkin's original elements are now nearly 2′ out. Elkin's subsequent elements founded on observations September 8 to 28, give a place corresponding nearly with the end of the elongated nucleus (about 1½′ long) furthest from the head. Now (November 21) the nucleus is getting very ill-defined. We have done the best we can in the matter, and shall continue the best observations we can, as long as the comet is visible."

COMET 1882 *c* (Barnard, September 10).—From an approximate orbit calculated by Mr. Hind, and communicated to Mr. Gill at the Royal Observatory, Cape of Good Hope, which reached him on November 11, this comet was found the same evening, and was observed on the meridian on several days up to November 19. The first position from a lower transit is as follows:—

	R.A.	Decl.
Nov. 11 ...	12h. 53m. 21s.·74 ...	−65° 57′ 28″·3

Mr. Gill's observations will allow of a much better determination of the orbit of this comet, than could have been made from the European observations alone; the comet arrived at perihelion on November 13.

GEOGRAPHICAL NOTES

MR. JOSEPH THOMSON sailed yesterday for Zanzibar as leader of the Geographical Society's Expedition to Mount Kenia and the East Coast of the Victoria Nyanza. Mr. Thomson expects to be away for two years.

THE new number of the *Deutsche Geographische Blätter* continues the interesting account by Dr. Arthur Krause of the researches of himself and his brother in the Chukchi peninsula and Alaska; there is, besides, a separate catalogue of the ethnological collections, and a short paper by Dr. Kuntz of the plants collected. The number contains a useful paper on South New Guinea from the observations of D'Albertis, Moresby, Macfarlane, and others. In the *Zeitschrift* of the Berlin Geographical Society are several papers of interest. Major Lovemann gives the leading results of the new survey of Russia, which is being carried out; Dr. Hann examines the data of Dr. Rholl's for the altitudes in the oasis of Kufra; Herr G. A. Krause gives some account of the Saharan town of Chat, which is followed by an abstract of the census of Bulgaria; and a preliminary account of Prof. Haussnecht's Oriental travels. Dr. W. Götz contributes a valuable paper on a subject which is taking great prominence in Germany—commercial Geography, while Dr. Reiss contributes an analysis of recent researches in some tributaries of the Amazon. In the December number of the *Deutsche Rundschau* for geography and statistics (Vienna, Hartleben), we have the conclusion of Baron von Lehnest's paper on his Land Formations in the Lunda region, the first of a series of pictures from East Africa, by Karl Berghoff; a short paper on the distribution of islands, and a biography of Mr. A. R. Wallace, with a good portrait. The number contains many other short papers and notes.

THE new quarterly number of the *Bulletin* of the Paris Geographical Society reports at length several important papers: Commander Gallieni gives an account of his mission to the Upper Niger and Segou, with a map and several interesting illustrations, some of which show curious formations, suggesting the buttes of some of the North American rivers. M. A. d'Abbadie has a useful paper on the spelling of foreign words; M. Jules Garnier an account of his excursion to the country of the Don Cossacks; M. M. Biollay, a paper on Finland; M. Dutreuil de Rhins, on Père Creuse's journeys to Southern China; M. Romanet du Caillaud, notes on the Ting-King; and M. Theodore Ber the first part of an elaborate paper on the Titicacon valley of Tiahuanaco.

THE December number of *Petermann's Mittheilungen* contains some supplementary information by Dr. Junker on his Welle explorations, in addition to the letters already referred to. Herr R. A. Hehl contributes a geographico-geological sketch of the Brazilian coast-lands between 20° and 23° S. lat. Along with the chief results of the Hungarian Census is an excellent series of statistical maps showing the various aspects of the figures. Signor P. Gialussi contributes an interesting paper on the changes which have resulted from recent geological action in an Istrian valley, while Herr Hehl gives a detailed account of the German colonies in South Brazil.

THE Carpathian Club, which was formed at Hermannstadt (Transylvania) after the pattern of the Alpine Club in 1880, having for its object the study and minute investigation of the mountains of the country, as well as the endeavour to direct the attention of tourists to that region, already numbers no less than 1200 members. It is divided into nine sections. Quite recently the second year-book of the Club appeared, which contains a number of valuable scientific papers, as well as descriptions of tours in the Carpathian Mountains.

SCHWEIGER-LERCHENFELD'S interesting work "Die Adria," has just been completed in twenty-five parts, and published by Hertleben of Vienna. The fact that the eastern coasts of the Adriatic are so little known by the general traveller, renders the book valuable. In an appendix the commerce of the Adriatic, as well as the fisheries, are spoken of, and an excellent map is added to the work.

THE ROYAL SOCIETY[1]

II.

THE subject of the Circumpolar Observations mentioned in my address last year, was since that time brought more formally before our Government by that of Russia. At the request of the Treasury, the President and Council, after consultation with the Meteorological Office, advised as follows:—

"The object of the undertaking is to throw light on the influence of the great inaccessible region surrounding the pole on the meteorology and magnetism of the earth. With this view it is proposed to take simultaneous observations at a chain of circumpolar stations for a full year at least.

"A chain of not less than eight stations will be occupied independently of any co-operation by this country. This chain, however, leaves a gap of 90° in longitude in the northern part of America, the centre of which would be advantageously occupied by a station in the Dominion of Canada. The value of the results will be greatly enhanced by the addition of this link to the chain. Independently of this, such a station would be of great value as being of a continental character, in contrast with the other stations, which are in close proximity to the coast. By choosing for the station one of the forts of the Hudson's Bay Company, no great outlay need be involved in its occupation."

The point first proposed was Fort Good Hope, near the mouth of the Mackenzie River; but it was found too late to erect the necessary huts and to transport the party and its provisions there during the present season. Fort Simpson, on the same river, was next suggested. Guided by considerations of facilities of access and sustentation, the Committee came to the conclusion that either Fort Rae or Fort Providence, on Great Slave Lake, is to be preferred to Fort Simpson, with which the former forts nearly agree in latitude; and accordingly the President and Council recommended one of these.

"In framing an estimate, it was thought well to assume that the expedition might last a year and eight months, so as to allow a sufficient margin for travelling to and from the station, and for possible detention in waiting for the Hudson's Bay Company's brigade. It is calculated that the cost might be safely estimated at 3,000*l.*, which would include salaries of one officer and three men; journey of the party from England and back, including reasonable baggage; rations, allowances, and all other expenses."

To this communication the following reply was received:—

"My Lords have to thank you, and the Committee whom the Council appointed to advise them in the matter, for the valuable information contained in Dr. Michael Foster's letter of the 16th ultimo. Acting upon that information and upon the advice of the Royal Society, Her Majesty's Government have decided that this is an object on which public money may properly be employed and they are prepared to ask Parliament to provide a total sum not exceeding 2,500*l.* for the purpose. My Lords understand that there is good reason to hope that the balance required to make up the total estimated cost of 3,000*l.* will be forthcoming from other sources.

"I am to ask whether the Royal Society would be so good as to take charge of the Expedition under similar conditions to those under which the Transit of Venus Expedition is being conducted; accounts of the expenditure chargeable to the Parliamentary grant being rendered to this Department. The choice of stations, the appointment of observers, and the methods of procedure would be left entirely to the Society, subject to the condition that the total amount chargeable on public funds does not exceed 2,500*l.* My Lords understand that it is expected that not more than 1,500*l.* of this amount would come in course of payment during the present year, and they will present estimates to Parliament for 1,500*l.* and 1,000*l.* at the proper times."

The Canadian Government has since promised a contribution of 4,000 dollars towards the expenses of the expedition.

A committee, consisting of the President, Dr. Rae, Sir George Richards, Mr. R. H. Scott, and Prof. Stokes, was accordingly appointed to superintend the expedition, which, comprising Captain H. P. Dawson, R.A., in command, Sergeants J. English and F. Cookesley as observers, and W. Wedenby, as artificer, left England on May 11, for Quebec, was heard of at Fort Carlton on 27th June, and was about to proceed the next day for Green Lake, on the way to Portage Loche. It was still not quite certain whether it might not be necessary to push on to Fort Simpson, on account of insufficient accommodation, as well as lack of time and materials for building at Fort Rae.

Two parts of *Mittheilungen der Internationalen Polar Commission* have been published, containing full particulars and instructions relating to the whole circumpolar scheme.

The geological, mineralogical, and botanical collections, formerly in the Museum in Bloomsbury, have been properly arranged in the new building in Cromwell Road, and are on exhibition in their respective galleries. A commencement has

[1] Address of the President, William Spottiswoode, D.C.L., LL.D., delivered at the Anniversary Meeting, November 30, 1882. Continued from p. 137.

been made in the transfer of the zoological collections. The osteological specimens, hitherto packed out of sight in an obscure vault in the basement of the old Museum, have been safely removed to the new building, and are now exhibited in a large and well lighted gallery. The collection of shells, which occupied the floor space of the long eastern gallery in Bloomsbury, is now suitably exhibited at South Kensington. Some of the corals have been removed, in order to clear the way for the removal of other specimens; and many of the stuffed quadrupeds and mammalian skins which had been stowed away in the old Museum basement are now in the new repository.

The removal of the general collection of mammalia, of the birds, of the entomological specimens, and those of British zoology, will not be undertaken until after the coming winter. The fittings for the galleries prepared for them are not fully completed. The detached building designed for the specimens preserved in spirit cannot be made ready for their reception before the opening of next spring. It is, however, expected that the whole of the zoological collections will have been transferred to the new Museum by the end of June, 1883.

The subject of Technical Education has continued to be prominently under the notice of the country during the past year. The appointment of a Royal Commission on Technical Instruction, to which I have previously referred, has done much towards awakening the interest of manufacturers, and exciting curiosity in regard to the efforts that are being made abroad to improve the education of artizans. The Commissioners issued in March last their first Report, which dealt exclusively with primary education and apprenticeship schools. The Commissioners expressed an opinion adverse to the establishment of apprenticeship schools in this country; and in this view they are supported by nearly all our large manufacturers, and by the action of the City and Guilds of London Institute for the Advancement of Technical Education. At the request of the Executive Committee, I myself gave evidence before the Commission, explaining generally the objects of the City Guilds and Institute and describing the progress already made towards their attainment. As a member of the Executive Committee of this Institute, I have watched its progress with interest, and have observed with satisfaction that its scheme of Technical Instruction is being gradually matured. The general Examinations in Technology undertaken by this Institute, were held in May last at 147 centres in 37 subjects. Of the 1,972 candidates who presented themselves for examination, 235 passed in Honours, and 987 in the Ordinary Grade. In 1881, 895 candidates passed, showing an increase of 307. The Examinations were held this year for the first time under the revised Regulations, which appear to have worked very satisfactorily. Two points deserve notice with respect to these Examinations. In the first place, the Institute experiences very great difficulty in obtaining properly qualified teachers. The applicants are either practical men working in the factory, or at their trade with no scientific knowledge whatever, or men possessing a very elementary science knowledge, and little or no practical acquaintance with the details of the industry, the technology of which they profess to understand. In order to indicate the kind of qualifications required in an ordinary technical teacher, the Institute has inserted in its programme a paragraph to the effect that persons who are engaged in teaching science under the Science and Art Department, and who at the same time have acquired a practical knowledge of their subject in the factory or workshop, may be registered as teachers of the Institute. The second point calling for consideration is the fact referred to in the Report of the Directors,—that of the 1,220 candidates who, this year, passed the examinations, most of whom are workmen or foremen in various branches of industry, not more than 450 are qualified to receive the full Technological Certificate, by having previously passed the examinations of the Science and Art Department in certain science subjects. This fact clearly indicates that widely beneficial as has been the action of this Department of State, there is still a large field for its influence among the population who are engaged in manufacturing processes, and desire to receive Technical Instruction.

One of the most satisfactory results of the Examinations of the City and Guilds of London Institute is the impulse they have given to the establishment, in different parts of the country, of properly equipped technical schools. At Manchester, Preston, Dewsbury, Hawick, Sheffield, Leicester, and other places, efforts have been made during this year towards organising schools for the technical instruction of artizans and others in the application of science and art to specific industries. At Nottingham, a grant of 500*l.* has been made by the Institute, to be followed by an annual contribution for a limited period of 300*l.*, towards the establishment of technical classes in connection with the University College; and at Manchester a subscription of 200*l.* a year has been promised to assist the funds now being raised for the conversion of the Mechanics' Institution into a Technical School. The attention of the Council has been greatly occupied of late with arrangements for the opening of the Finsbury College. Classes in Electrical Engineering and in Technical Chemistry, have been carried on for nearly three years in temporary rooms belonging to the Cowper Street Schools. The attendance at these classes has been eminently satisfactory, much more so than could have been anticipated. During the past session 960 class tickets were sold at fees varying from 5*s.* to 12*s.* The staff of the College has recently been doubled by the appointment of a Professor of Mechanical Engineering, and a Head Master to the new Department of Applied Art, the establishment of which, as I stated last year, was then under the consideration of the Committee. In January next, it is anticipated that the new building in Tabernacle Row, which is already nearly completed, will be opened for the reception of students. The programme of instruction, prepared by the Director and the Professors of the College, has been for some time under the consideration of the Committee, and it is hoped that in the instruction given in this College will be found the realization of a very important part of the Institute's Scheme of Technical Education.

Grants to the Technical Science Classes at University College and King's College, London, to the Horological Institute, to the School of Art Wood Carving, and other institutions, have been continued during the past year.

The Technical Art School in Kennington Park Road, established and maintained by the Institute, has been satisfactorily attended; and a proposition is to be brought before the Committee for supplementing the teaching of this school by technical science classes, with a view of establishing in the south of London a Technical College for Artizans, similar to the one about to be opened in Finsbury.

The building of the Central Institution or Technical High School in Exhibition Road, the foundation stone of which was laid by H.R.H. the Prince of Wales, President of the Institute, in July, 1882, is rapidly advancing and promises to be completed within a year. It is not expected, however, that this school will be ready for the reception of the students before the commencement of the session 1884-5. Meanwhile, the Council and Committee are fully occupied with the development of other parts of their scheme.

In forwarding the Report of the Meteorological Council to the Treasury in December last, the President and Council took occasion to remind their Lordships that the arrangement for the organisation of the Meteorological Office generally, in May, 1877, would terminate with the then financial year. The Treasury, in reply, asked the advice of the Royal Society. After consultation with the Meteorological Council on various points connected with the subject, the President and Council reported fully to the Treasury, and concluded with the following general recommendation: "The President and Council beg leave to express a hope that the constitution of the Meteorological Council may remain unchanged, and that the same gentlemen who have hitherto performed its duties and administered its funds with such intelligence and judgment may be disposed to continue their labours." To this recommendation the Treasury cordially assented; deciding at the same time that no period should be fixed to the Meteorological Council for their tenure of office, but that it might be terminated by either party at any time on twelve months' notice.

The Meteorological Office has completed during the past year a series of charts of sea-surface temperature, for the three great oceans of the globe, and for the representative months of February, May, August and November. The work, which is now in the course of publication, will consist of twelve large charts, for the Indian, Atlantic, and Pacific Oceans respectively; and of four on a reduced scale, showing, for the four months, the isothermal lines of sea-surface temperature over the entire globe. In the preparation of these charts, all the observations existing in the Log Books of the Meteorological Office, and in the Remark Books of the ships of Her Majesty's Navy, have been employed, as well as the information which has been already rendered accessible in scientific memoirs, and in the narratives of the great scientific voyages. The isotherms agree

substantially with those which have been already given for the months of February and August, in the wind and current charts published by the Hydrographic Department of the Admiralty; but as the present series is founded on a much larger number of observations than have ever before been available for a similar purpose, it may fairly be regarded as a valuable contribution to a not unimportant part of terrestrial physics. Between the limits of 50° north and 50° south latitude, the mean annual surface temperature, so far as it can be deduced from the data now available, appears to be 74°·9 F. for the Indian, 69°·5 F. for the Atlantic, and 68°·6 F. for the Pacific Ocean. The North Atlantic is 4°·6 F. warmer than the South Atlantic Ocean; the corresponding difference in the case of the Pacific Ocean is only 1°·8 F.

Among other contributions to Ocean Meteorology, which the past year has produced, I may mention (1) the Physical Charts of the Atlantic Ocean, published by the Deutsche Seewarte, at Hamburg; (2) the second volume of the narrative of the voyage of H.M.S. *Challenger*, containing the magnetical and meteorological observations; and (3) a report by Captain Toynbee, F.R.A.S., on the Gales of the Ocean District adjacent to the Cape of Good Hope, which completes the discussion by the Meteorological Council of the meteorology of that tempestuous part of the sea.

The meteorology of our own country has been actively studied during the year. The Scottish Meteorological Society have given in their Journal a series of monthly pressure charts for the British Isles, together with a revised edition of the temperature charts already published by them in 1871. The charts now embody the results of observations extending over a period of twenty-four years; the revised edition, as well as the original publication, are due to the indefatigable activity of Mr. Alexander Buchan, F.R.S.E., the Secretary of the Scottish Meteorological Society. An atlas of convenient size, intended for the use of observers in the United Kingdom, and conveying similar information derived from data partly different, and quite independently discussed, has been already prepared by the Meteorological Office, and will immediately appear.

It is a fact now universally recognised that the greater part of the changes of weather which are experienced in the British Isles are occasioned by travelling areas of excessive or defective atmospheric pressure, which arrive at our shores from the Atlantic Ocean. The importance of a systematic study of the weather of the North Atlantic being thus indicated, the Meteorological Council have resolved to undertake the preparation of synoptic weather charts for the thirteen months beginning 1st August, 1882, and ending 31st August, 1883, and have issued a special appeal to the British shipping interest for active co-operation during that period. It is satisfactory to know that this appeal has not been fruitless, and that there is every prospect that the number of observations available for the discussion will exceed 200 per day.

This is, perhaps, the proper place to make mention of some results having an important bearing on meteorology, obtained by Prof. Tyndall in the course of a larger research on the action of radiant heat on gases.

By methods which he has applied to gases and vapours generally, Tyndall has established anew the action of aqueous vapour upon radiant heat, and the sensibly perfect diathermancy of dry atmospheric air. The phenomena of solar and terrestrial radiation are profoundly modified by the presence of aqueous vapour in the earth's atmosphere, the temperature of our planet being thereby rendered very different from what it would otherwise be.

The celebrated experiments of Patrick Wilson, wherein were observed a rapidity of radiation and a refrigeration of the earth's surface previously unknown, are explained by the fact that when they were made, the amount of aqueous vapour in the air was infinitesimal, the unhindered outflow of heat towards space being correspondingly great. The sagacious observation of Six and Wells, that the difference between the surface temperature and that of the air a few feet above the surface, on equally serene nights, is greatest in cold weather, is explained by the fact that, when the temperature is low, the agent which arrests the surface radiation is diminished in quantity. Wells, moreover, found that the heaviest dews were deposited on nights when the difference between air temperature and surface temperature was small; while the greatest difference between the two temperatures was observed on nights when the deposition of dew was scanty. The explanation offered by Tyndall is this:—copious dew indicates abundant vapour; and abundant vapour, by arresting the terrestrial rays, prevents the refrigeration observed in drier air. Strachey's able discussion of observations made at Madras, point distinctly to the action of aqueous vapour on the radiation both of the sun and of the earth; while the experiments of Leslie, Hennessey, Hill, and other distinguished men, which were long considered enigmatical, are readily explained by a reference to the varying quantities of vapour with which the atmosphere is charged, on days of equal optical transparency. The interesting observations of Desains and Branley, made simultaneously on the Rigi and at Lucerne, are well worthy of mention here. The difference of level between the two stations is 4,756 feet, and within this stratum 17·1 per cent. of solar heat was proved to be absorbed. This absorption being due to aqueous vapour, is tantamount to the transmission of the sun's rays through a layer of water of a definite thickness. A sifting of the rays would be the consequence, and on *a priori* grounds we should infer that the percentage transmission through water at Lucerne must be greater than on the summit of the Rigi. This was the exact result established experimentally by Desains and Branley. H. Wild, the distinguished Imperial Astronomer of St. Petersburg, basing his statement on experiments made by himself according to Tyndall's method, has expressed the opinion "that meteorologists may, without hesitation, accept this new fact in their endeavours to explain phenomena which hitherto have remained more or less enigmatical." The correctness of this statement is illustrated by the foregoing examples, to which, if necessary, many more might be added.

At the recommendation of the Committee on Solar Physics of the Science and Art Department, a grant of 350*l.* was made from the Society's Donation Fund to Captain Abney and Mr. Lockyer in aid of their proposed observations of the total eclipse of the sun at Thebes in May last. Unfortunately the state of Captain Abney's health precluded his taking part in the expedition; but Dr. Schuster generously undertook the conduct of his observations, and, notwithstanding the short time remaining for preparation, he carried them out in the most satisfactory manner.

Three photographs of the corona itself were obtained during the eclipse. They show that the corona had the characteristic features observed during the time of the maxima of sun-spots. The long streamers in the plane of the ecliptic seen during sun-spot minima were absent, and the corona showed much disturbance. A bright comet appeared in all the photographs at a distance slightly less than a solar diameter.

A complete photograph of the spectrum of the prominences and the corona was for the first time obtained. The prominences give a spectrum in which the lines of calcium bear a conspicuous part by their intensity. The ultra-violet hydrogen lines, photographed in star spectra by Dr. Huggins, were seen, as well as a number of unknown lines.

The corona gives a very complicated spectrum. Close to the limb of the sun the spectrum was so nearly continuous and so strong as to hide any lines which might have been present. Further away the continuous spectrum fades off, the solar group G appears as an absorption line, and a large number of coronal lines hitherto unobserved appear in the ultra-violet.

In addition to these photographs one was obtained in a camera, in front of whose lens a prism was placed without a collimator. This photograph allows us to study the spectra of different prominences. As the picture was produced on one of Captain Abney's infra-red plates, all the tints of the prominences ranging from the ultra-red to the ultra-violet made their impressions, and some interesting differences in the spectra of different prominences can be noticed.

But, beside taking part in this expedition, Mr. Lockyer has continued with unwearied perseverance his observations on the spectra of solar prominences and spots, and has recently combined with these the results obtained by him during the late eclipse. During this eclipse he made naked eye observations, which he considers to be of a crucial character between the two rival hypotheses regarding the nature of the sun's atmosphere. The results of this investigation have in his opinion considerably strengthened the views which he first put forward in 1873 on the constitution of the solar atmosphere. A statement of these views will be found in a paper by him recently read before the Society.

In the present state of the questions there raised, it must I think be admitted that, after giving all due weight to the facts and reasonings adduced by Mr. Lockyer, additional and varied observations are greatly to be desired; and that no opportunity

reasonably available, for adding to our knowledge of the subject, should be neglected. And, therefore, without committing myself or the Society to the support of any particular proposal or expedition, I think it may be fairly claimed as a *primâ facie* duty on the part of the present generation to obtain as many faithful records of the various phenomena occurring during solar eclipses as possible.

From a discussion of the meridian observations of Mars made during the favourable opposition of 1877, at Washington, Leiden, Melbourne, Sydney, and the Cape, Prof. Eastman has deduced the value 8″·953 for the solar parallax—a value which, though considerably larger than any of those found by other methods, agrees closely with that obtained by Mr. Downing, in 1879, from the meridian observations of Mars at Leiden and Melbourne, as well as with the values found from similar observations in 1862. In this investigation, Prof. Eastman rejects the observations at Cambridge, United States, as they were made in a slightly different manner, and gives (in combination with Melbourne) a very large value for the solar parallax, viz., 9″·138.

The detailed account of the British Observations of the Transit of Venus, 1874, was published at the beginning of the year, and the observations of the transit made at colonial observatories have been recently printed in the Memoirs of the Royal Astronomical Society.

The Transit of Mercury last November was well observed in Australia and other places, and the results are of special interest in connection with the late Transit of Venus. The discordances in the times of internal contact recorded by different observers seem to show that such observations are subject to much uncertainty.

An important memoir on astronomical refraction has been lately published by M. Radau, who, after a discussion and comparison of previous theories, gives formulæ and tables for refraction, in which allowance may be made for difference in the rate of decrease of temperature with the height above the earth's surface at different seasons of the year. M. Radau also discusses the case in which the surfaces of equal temperature in the atmosphere are inclined to the earth's surface.

A new map of the solar spectrum, containing a much larger number of lines than are shown in Angström's classical normal spectrum, has been published by Prof. Vogel in the publications of the new Astrophysical Observatory at Potsdam. In this work Prof. Vogel has bestowed great care on estimates of the breadth and intensity of each line. In the same volumes are given the results of Prof. Spörer's sun-spot observations at Auclam from 1871 to 1879, in continuation of those for the years 1861 to 1870, previously published. From a comparison of the rotation-angles for 78 spots with the formula, Prof. Spörer finds that the larger deviations are always towards the west, indicating that a descending current has brought down with it the larger velocity of the higher regions of the sun's atmosphere. The law previously deduced by Prof. Spörer, that, about the time of minimum, spots commence to break out in high latitudes, and that the zone of disturbance gradually approaches the equator till at the minimum it coincides with it and dies away, to be replaced by a new zone in high latitudes, is confirmed by the recently published Auclam results, comprising (with Carrington's series) two complete spot-cycles.

In astronomical photography an important advance has been made by the successful application of the new processes to the nebulæ as well as to the comets. Prof. Henry Draper and Mr. Common have obtained photographs of the great nebula in Orion, showing considerable detail, and Mr. Huggins and Prof. Henry Draper have succeeded in photographing its spectrum. Mr. Huggins finds in his photograph a very strong bright line in the ultra-violet at wave-length 3730, in addition to the four nebular lines previously discovered by him in the visible portion. Prof. H. Draper's photographs do not show this bright line, though they have faint traces of other lines in the violet, and he thinks that this may be due either to the circumstance that he had placed himself on a different part of the nebula or to his use of a refractor with glass prism, while Mr. Huggins used a reflector and Iceland spar prism. The most striking feature of Prof. Draper's photographs is perhaps the discovery of two condensed portions of the nebula (just preceding the Trapezium) which give a continuous spectrum.

Prof. Schiaparelli has recently called attention to a peculiar feature on the planet Mars. In 1877 he remarked a number of narrow dark lines, which he called "canals," connecting the dark spots or so-called "seas" of the southern and northern hemispheres. He now finds that these lines are each doubled, so that according to his view the equatorial regions of Mars are covered by a network of pairs of parallel straight lines. It is to be remarked that though the appearance of Mars as depicted by Prof. Schiaparelli differs greatly from previous representations, indications of these double "canals" are to be found in the sketches of other observers.

The two bright comets of this year possess more than usual interest. The bright comet discovered at Boston by Wells, on March 18th, was the first comet since the spectroscope was applied to these objects, which presented a spectrum unlike the hydrocarbon type common to all other comets which appeared since 1864. The eye observations, as well as its photographic spectrum (taken by Mr. Huggins), showed an absence of the hydrocarbon spectrum, which was replaced by a brilliant continuous spectrum and bright lines, including those of sodium.

In September, a very brilliant comet appeared near the sun. It seems to have been discovered independently by Eliery, at Melbourne, Finlay at the Cape. Mr. Common in this country, and also by Thollon and Cruls. This great comet has been a brilliant object in the early mornings during the past two months. On September 17th, an observation, apparently unique in the history of astronomy, was made by Mr. Gill at the Cape, who watched the comet right up to the sun's limb. It could not, however, be detected in the sun, and this circumstance of appearing neither bright nor dark when in front of the sun, appears to suggest a very small substantiality, or great separation of the cometary matter. After perihelion it presented a magnificent appearance, having a tail 30° long, and even on October 30th the tail covered a space greater than the mean distance of the earth from the sun.

On October 9th, Prof. Schmidt discovered a nebulous object not far from the great comet, the orbit of which strongly suggests a connection in the past with the great comet. This fact is of more interest when the orbits of the great comet of this year, of Comet I, 1880, and of the well-known comet of 1843 are compared. The very near approach of the great comet to the sun will lead astronomers to watch with great interest for its return to our system, whatever may be its destiny, to fall ultimately into the sun, or to disappear through a process of gradual disintegration. In the *Astronomische Nachrichten*, just published, Prof. Pickering, who has computed the elements of the orbit of this comet, states, "I believe the deviation from a parabola to be real, although the corresponding period may be very long. These differences seem to indicate that the disturbance suffered by the comet in passing through the coronal region could not have been great."

This comet presented a spectrum similar to that of Comet Wells, but while receding from the sun, the bright lines of its spectrum became fainter, and then the usual hydrocarbon spectrum made its appearance. This observation, taken in connection with those of the previous comet, suggests a modified condition of an essentially similar chemical constitution. The phenomena would admit more easily of explanation if the cometary light is supposed to be due to electric discharge as it is well known how preferential is the electric discharge when several substances are present together in the gaseous form.

Before leaving this subject, I venture to quote the following passage from the *Observatory*, which puts in a very clear form the speculations now current, on the relation of the present great comet to that of 1880, 1843, and possibly 1668.

"The physical appearance of the comet, which like that of 1843, and unlike that of 1880, showed at first a decided nucleus, together with the intimation of a period very considerably greater than that of the interval from 1880, January 27, the date of perihelion of the 1880 comet, suggest that perhaps the 1843 comet suffered disintegration when at its nearest approach, and that the 1880 comet was a portion of its less condensed material, whilst the body of the comet with the principal nucleus, suffering less retardation than the separated part, has taken two and a-half years longer to perform a revolution. The remarkable discovery made by Prof. Schmidt, of Athens, on October 8, of a second comet only 4° S. W. of the great comet, and having the same motion, would seem to confirm this view."

The scientific year now concluded has not been so fertile as its predecessor in the initiation of great national and international undertakings, neither have any of those larger enterprises which I took occasion to mention last year, such as the circumpolar observations, or the Transit of Venus Expeditions, as yet been brought to their final issue. Nevertheless, in some of them we

have evidence that good work is already being done, and in the others, of which we have as yet no information, there is no reason to doubt that the same is the case. Nor again, in the border-land betweeen science proper and its applications, have I to record anything so important as the Paris Electrical Exhibition. That Exhibition, however, bore legitimate fruit in the Electric Lighting Exhibition at the Crystal Palace, and in the technical experiments lately carried out on a large scale at Munich. Perhaps the most prominent feature of the Crystal Palace Show was the incandescent light. At Paris that mode of illumination appeared to be little more than a possibility, in London it had become an accomplished fact. The importance attaching to this advance in electric lighting may be measured both by the rapid extension of its use, and also by the fact that not a few of our leading minds consider that the incandescent lamp is the lamp of the future, not merely for domestic, but even for many other public purposes.

But in another way the present year has witnessed the most important step which could have been taken for the promotion of electric lighting in this country. The Legislature has passed the Electric Lighting Bill, and, so far as legislation can effect the object, it has brought electricity to our doors. Up to this time installations of greater or less magnitude had sprung up sporadically in many parts of country, in railway stations, manufacturing works, and occasionally in private houses. But, compared with the lighting of a whole town, or even of separate districts of a large city, even the most important of these must be confessed still to partake of the nature of experiments; experiments, it is true, on a large scale, and, as I believe, conclusive as to the ultimate issue. Indeed, by multiplication of machines it is certainly, even now, possible to increase the lighting power to any required extent; but this can hardly be regarded as the final form of solution of the problem, inasmuch as such a method would be as uneconomical as it would be to use a number of small steam-engines instead of a large one. And when we consider that at the time of the passing of the Act in question, there was but one machine actually constructed which was capable of illuminating even one thousand incandescent lamps (I mean that of Edison), we cannot but feel that much remained to be done before the requirements of the public could be fully met. I do not mean thereby to imply that the Act was passed at all too soon; on the contrary, it has already given just that impetus which was necessary for producing installations on a larger scale. In illustration of this, I cannot help mentioning, as the first fruit of the impetus, a remarkable machine, by our countryman Mr. J. E. H. Gordon, which appears capable of feeding from five to six thousand lamps.

But beside the impulse above described, the Bill will have a scientific influence perhaps not contemplated by its original promoters. Under this Act, for the first time in the history of the world, energy will come under the grasp of the law, will become the subject of commercial contracts, and be bought and sold as a commodity of everyday use. It is, in fact, far from improbable that the public supply of electricity will be reckoned and charged for in terms of energy itself. But whether this be literally the case or not, a measurement of energy must lie at the root of every scale of charge.

And, further, since the Act allows no restriction to be placed upon the use of the electricity so supplied, it follows that it may be used, and undoubtedly will be used, at the pleasure and convenience of the customer, either for lighting, or for heating, or for mechanical, or for chemical purposes. This being so, it is clear that the public must by this process become, practically at least, familiar with the various modes of the transformation of force; and the Act in question might, from this point of view, have been entitled An Act for the better Appreciation of the Transformation of Force.

While offering to the public this new commodity, electricians may, in one respect, especially congratulate themselves, namely, that their article is incapable of adulteration. An electric current of a given strength and given electro-motive force is perfectly defined, and is identically the same whether it comes from a Siemens or a Gramme, from a magneto- or from a dynamo-machine, or as suggested by an eminent counsel before the Select Committee of the House of Commons, from one machine painted red or from another painted blue.

It has been said, and perhaps with truth, that the electric light will be the light of the rich rather than that of the poor. But in more ways than one electricity may now become the poor man's friend. The advantages in avoidance of heat and of vitiated atmosphere in workshops and factories have often been pointed out, and may ultimately become an important factor in the physical growth and prosperity of our population. But besides this, when electricity is literally brought to our doors, it will become possible, by converting it into motive power of limited extent, to revive some of the small industries which during the last half century have been crushed by the great manufacturing establishments of the country. There are operations which are capable of being carried out by the wives and families of workmen; there are works of small extent which can be performed more advantageously in a small establishment than in a large one, and it can hardly fail to be a gain to the community if this new departure should give fresh opportunities for the development of our industry in these directions.

The Copley Medal has been awarded to Prof. Arthur Cayley, F.R.S., for his numerous profound and comprehensive researches in Pure Mathematics.

One Royal Medal has been awarded to Prof. William Henry Flower, F.R.S. During the last thirty years Prof. Flower has been actively engaged in extending our knowledge of Comparative Anatomy and Zoology in general and of the Mammalia in particular.

His Memoirs on the Brain and Dentition of the Marsupialia published in the *Phil. Trans.* for 1865 and 1867, established several very important points in morphology, and finally disposed of sundry long-accepted errors.

His paper "On the Value of the Characters of the Base of the Cranium in the Carnivora" (1869), and numerous memoirs on the Cetacea, are hardly less valuable additions to zoological literature.

Prof. Flower has been for more than twenty years Curator of the Museum of the Royal College of Surgeons, and it is very largely due to his incessant and well-directed labours that the museum at present contains the most complete, the best ordered, and the most accessible collection of materials for the study of vertebrate structure extant.

The publication of the first volume of the new Osteological Catalogue in 1879, affords an opportunity for the recognition of Prof. Flower's services in this direction. It contains carefully verified measurements of between 1300 and 1400 human skulls and renders accessible to every anthropologist a rich mine of craniological data.

The other Royal Medal has been awarded to Lord Rayleigh, M.A., F.R.S.

The researches of Lord Rayleigh have been numerous, and extend over many different subjects; and they are all characterised by a rare combination of experimental skill with mathematical attainments of the highest order.

One class of investigations to which Lord Rayleigh has paid much attention is that of vibrations, both of gases and of elastic solids. The results of most of these researches are now embodied in Lord Rayleigh's important work on the "Theory of Sound," a work which not only presents the labours of others up to the time of writing in a digested and accessible form, but is full of original matter.

The subject of vibration naturally leads on to a mention of other hydro-dynamical researches. Lord Rayleigh has investigated the motion of waves of finite height, and in particular has shown that the "great solitary wave" of our late Fellow, Mr. Scott Russell, has a determinate character; and he has investigated the circumstances of its motion to an order of approximation sufficient to apply to waves of considerable height.

Lord Rayleigh has examined more fully than had previously been done the theory of diffraction gratings, and the effects of irregularities; and also investigated the defining power of optical combinations, and its limitation by diffraction and spherical aberration.

He has lately been engaged in the elaborate re-determination of the B.A. unit of electrical resistance.

The Rumford Medal has been awarded to Capt. W. de W. Abney, R.E., F.R.S. Capt. Abney has contributed largely to the advancement of the theory and practice of photography by numerous investigations. In the Bakerian Lecture for 1880 he has given an account of a method by which photography can be extended to the invisible region below A, which had been hitherto but very imperfectly examined by means of the thermopile.

Making use of plates prepared with silver bromide in a particular molecular condition, Capt. Abney, by means of a diffraction grating containing 17,600 lines to the inch, constructed a detailed map of the infra-red region of the solar spectrum extending from A down to λ 10,650 (Plate XXXI. *Phil. Trans.*,

1880). The lowest limit of this map was fixed by conditions of the diffraction-apparatus, and not by a falling-off of the sensitiveness of the plates at this low point; for, when a prismatic apparatus was used, photographs were obtained which show a continuous spectrum down as far as λ 12,000.

In a subsequent paper (*Phil. Trans.*, 1881, p. 887), Capt. Abney, working with Lieut.-Col. Festing, R.E., applied this new extension of photography to a research on the influence of the atomic grouping in the molecules of the organic bodies on their absorption in the infra-red region of the spectrum. The authors believe that their results indicate, without much doubt, that the complex substances they examined can be grouped according to their absorption spectra, and that such grouping, as far as their experiments go, agrees on the whole with that adopted by chemists. They have more confidence in their results, as they were careful to select such bodies as might be regarded as typical; but, of course, much patient labour of many, for a long period, will be necessary before this new branch of physico-chemical research can be regarded as fully established in any complete form.

Capt. Abney has since carried on his work in this new region of the spectrum at different elevations during a recent visit to Switzerland.

The Davy Medal has been awarded to D. Mendeleeff and Lothar Meyer.

The attention of chemists had for many years past been directed to the relations between the atomic weights of the elements and their respective physical and chemical properties; and a considerable number of remarkable facts had been established by previous workers in this field of inquiry.

The labours of Mendeleeff and Lothar Meyer have generalised and extended our knowledge of those relations, and have laid the foundation of a general system of classification of the elements. They arrange the elements in the empirical order of their atomic weights, beginning with the lightest and proceeding step by step to the heaviest known elementary atom. After hydrogen the first fifteen terms of the series are the following, viz. :—

Lithium	7	Sodium	23
Berylium	9·4	Magnesium ...	24
Boron	11	Aluminium ...	27·4
Carbon	12	Silicon	28
Nitrogen	14	Phosphorus ...	31
Oxygen	16	Sulphur	32
Fluorine	19	Chlorine	35
		Potassium	32

No one who is acquainted with the most fundamental properties of these elements can fail to recognise the marvellous regularity with which the differences of property, distinguishing each of the first seven terms of this series from the next term, are reproduced in the next seven terms.

Such periodic reappearance of analogous properties in the series of elements has been graphically illustrated in a very striking manner with respect to their physical properties, such as melting-points and atomic volumes. In the curve which represents the relations of atomic volumes and atomic weights analogous elements occupy very similar positions, and the same thing holds good in a striking manner with respect to the curve representing the relations of melting-points and atomic weights.

Like every great step in our knowledge of the order of nature, this periodic series not only enables us to see clearly much that we could not see before, it also raises new difficulties, and points to many problems which need investigation. It is certainly a most important extension of the science of chemistry.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—The examiners for the Natural Science Tripos in 1883 are Lord Rayleigh, Mr. Vernon Harcourt (Oxford), Dr. A. M. Marshall (Owens College), Dr. R. D. Roberts, Mr. J. N. Langley, Mr. L. Fletcher (Oxford) of the British Museum, Mr. A. Hill, and Dr. Vines.

The time for the presentation of the report of the Syndicate appointed to frame regulations for the Doctorates of Science and of Letters is extended to the end of next term.

The increased work of the museums and the larger number of departments has caused an excess of expenditure over the ordinary income 3000*l.* allowed by the University, during the past year. The expenditure has included a provision of microscopes for the morphological and physiological laboratories at a cost of nearly 150*l.*, and a Bianchi air-pump for the chemical laboratory, costing 83*l.* The balance which has accrued is 804*l.* which is asked for as a special grant from the chest.

Mr. A. S. Shipley, of Christ's College, has been nominated to study at the Zoological Station at Naples for the first six months of 1883.

A Clothworkers' Exhibition of 52*l.* 10s., tenable for three years, will be awarded by means of the examination of the Oxford and Cambridge Schools Examination Board in July next. The successful candidate must be or become a non-collegiate student at Oxford or Cambridge.

There will be an examination at Gonville and Caius College, beginning on March 9, 1883, for one Shuttleworth Scholarship, value 60*l.* per annum, tenable for three years, open to medical students of the University, who are of at least eight terms' standing. The subjects are Botany and Comparative Anatomy; practical work will be given as part of the examination. The scholarship may be held with any other scholarship at the College, and a candidate may be recommended at the same time for a foundation scholarship. Particulars may be obtained from the Rev. A. W. W. Steel, Tutor of the College.

The following nominations have been made to the Electoral Board of the under-mentioned professorships, with varying tenure of office to secure due rotation:—Plumian of Astronomy: Prof. Stephen Smith (Oxford), the Astronomer Royal, Prof. Adams, Mr. Spottiswoode, P.R.S., Prof. Stokes, the Master of Caius (Dr. Ferrers), Prof. Cayley, and Mr. Todhunter. Mechanism and Applied Mechanics: Sir John Hawkshaw, Lord Rayleigh, Messrs. R. F. Martin, W. Airy, and Coutts Trotter (Trinity), the Master of Emmanuel (Dr. Phear). Mr. W. H. Besant, and Prof. Cayley. Physiology: Prof. Humphry, Prof. Huxley, Mr. J. N. Langley, Prof. Burdon-Sanderson, Dr. Vines, Dr. Pye-Smith, Prof. Paget, Prof. Stokes. Knightbridge of Moral Philosophy, Prof. Caird (Glasgow), Mr. Leslie Stephen, Mr. J. Venn, Prof. Fowler (Oxford), Prof. Hort, Prof. Seeley, Mr. Todhunter, and Dr. Campion. The Boards of Physics and Chemistry and of Biology and Geology hape concurred in recommending that students who have passed in the Mathematical Tripos may be permitted to enter the second part of the Natural Science Tripos without passing in the first part. It is thought desirable to encourage mathematical students thus to take up the practical and experimental work in physics required of the Natural Science students; at present they have not time for studying the elementary parts subjects required of the latter.

SOCIETIES AND ACADEMIES

LONDON

Linnean Society, December 7.—Sir J. Lubbock, Bart., president, in the chair.—The following gentlemen were elected Fellows of the Society:—The Rev. R. Baron, F. O. Bower, T. H. Corry, O. L. Fraser, D. Houston, A. W. Howitt, H. McCallum, E. A. Petherick, S. Rous, and H. C. Stone.—The Rev. R. T. Murray showed specimens of *Althæa hirsuta*, *Vicia Orobus*, and *Phlomis fruticosa*, obtained by him last summer in Somerset.—Mr. W. T. Thiselton Dyer exhibited and explained maps illustrative of the rapid spread of Phylloxera in Spain and Portugal, observing that within the last year quite a wide area of the wine-growing districts therein were affected. He also exhibited photographs and made remarks on the Cinchona cultivation in Ceylon.—Mr. W. B. Espent drew attention to some Kola nuts, and mentioned their remarkable sobering effects after intoxication by spirituous liquors.—Mr. G. Brook read notes on some little known Collembola and the British species of the genus Tomocerus. Tullberg refers to their occurrence in Sweden, but the four species in question have not hitherto been accorded a British habitat.—A paper by J. G. Otto Tepper was read on the discovery of above ninety species of Tasmanian plants near Adelaide, South Australia.—A contribution by Dr. W. Nylander and the Rev. J. M. Crombie was read, viz. on a collection of exotic lichens made in Eastern Asia by the late Dr. A. C. Maingay. Those enumerated were from British Burmah, China, and Japan; some are interesting as illustrative of lichen distribution, and others as new species and varieties.—Remarks on the genera of sub-family Chalcidinæ with synonymic notes and descriptions of new species of Leucospidinæ and Chalcidinæ was a paper by Mr. F. Kirby.—The Rev. R. P. Murray afterwards

made some remarks on cleistogamic flowers of *Hoya carnosa*, producing fertile seed.

Institution of Civil Engineers, December 5.—Sir W. G. Armstrong, C.B., F.R.S., president, in the chair.—The paper read was "On the Sinking of two Shafts at Marsden, for the Whitburn Coal Company," by Mr. John Daglish, M.Inst. C.E.

EDINBURGH

Royal Society, December 4.—The Right Hon. Lord Moncrieff, president, in the chair.—The President, in opening the 100th session of the Society, gave a brief historical statement of its origin.—Obituary notices were read of Mr. Darwin, Prof. Emile Plantamour of Geneva, Mr. Charles D. Bell, Dr. Wm. Robertson, Sir Daniel Macnee, Mr. David Anderson of Morton, Mr. John M'Culloch, Mr. Samuel Rayleigh, and Prof. Spence.—The Rev. Dr. W. R. Smith exhibited specimens of Dr. A. Guébhardt's electro-chemical method of figuring equipotential lines, which had been sent him by the author.—The Astronomer Royal for Scotland communicated a telegram from J. R. Hind, of the *Nautical Almanac*, correcting the time of ingress of Venus upon the sun's disc.

PARIS

Academy of Sciences, December 4.—M. Jamin in the chair.—The President presented to M. Dumas the medal struck in honour of the fiftieth anniversary of his election to the Academy, and M. Dumas spoke in acknowledgment—Presentation of tome iii. of the third part of the "Recueil des Memoires, Rapports et Documents relatifs à l'Observation du Passage de Venus sur le Soleil, en 1874," by M. Dumas.—*Résumé* of measurements of the Daguerrian photographs of the Venus transit in 1874 by the French Commission, by MM. Fizeau and Cornu. About fifty selectep photographs from the four stations were measured by two observers or controlled by an equivalent operation. The 94 results represent 33,840 independent points. In a table are shown the values of the ratio of the distance between the centres to the sum and the radii for all the photographs measured.—Memoir on the vision of material colours in motion of rotation, and on the respective velocities, estimated in figures, of circles, one diametrical half of which is coloured and the other half white; velocities corresponding to three periods of their motion, from the extreme velocity to rest, by M. Chevreul.—On a letter of M. Spœrers relative to a peculiarity of solar mechanics, by M. Faye. If there were surface currents from the solar poles to the equator (as Dr. Siemens' theory requires), the spots should be carried in the same direction. But M. Spœrer's observations for twenty years, and those of Laugier, Carrington, and others, agree in showing displacement of spots in latitudes to be either *nil* or insignificant; and if there is any such tendency in spots far from the equator, it is rather towards than from the poles. The retardation observed in surface rotation towards the poles, M. Faye attributes to ascending and descending movements in the internal mass.—Notice on a new optical apparatus for the study of flexure, by MM. Loewy and Tresca. It consists of three parts (1) at the observer's end a reticule of horizontal wires viewed by a lens, before which is a total reflection prism throwing lateral light along the optic axis; the eyepiece has also movable wires for measurement; (2) at the opposite end, an object holder, with stretched horizontal wires, illuminated; (3) in the middle, a lens with silvered surface, but transparent at the centre, and of such a focus that it reproduces in the plane of the reticule before the eyepiece, either the image of one set of wires by reflection, or that of the other by transparence.—On *rouget* or *mal rouge* of pigs, by M. Pasteur. This disease, called by Dr. Klein (London, 1878) *pneumo-enteritis* of the pig, has destroyed more than 20,000 pigs this year in the Rhone Valley. M. Pasteur considers Dr. Klein quite mistaken as to the nature and properties of the parasite, which is of figure 8 form, and like the microbe of chicken cholera, but finer, less visible, and quite different physiologically. He has found a method of protective inoculation.—Researches on the presence of nitric acid and ammonia in water and snow obtained in Alpine glaciers by M. Civiale, by M. Boussingault.—Order of appearance of first vessels in the leaves of Cruciferæ; demonstration of the distinctly basipetal ramification in these leaves, by M. Trécul.—On the connections (*enchaînements*) of the animal world in primæval times, by M. Gaudry. He gives a sketch of the first part of a projected work on this subject.—Chemical studies on maize (continued), by M. Leplay. This relates to potash and lime-bases in organic combination with vegetal acids or tissues of maize—On the gallicolar Phylloxera, by M. Henneguy.—On the pendulum, by M. Lipschitz.—Formula for determining how many prime numbers there are not exceeding a given number, by M. de Jonquières.—On a mode of transformation of figures in space (continued), by M. Vaneček.—On the transmission of an oblique pressure, from surface to interior, in an isotropic and homogeneous solid in equilibrium, by M. Boussinesq.—On the effect of oil calming the agitation of the sea, by M. Bourgois. Oil affects the breaking of the waves, but not sensibly the undulations themselves.—Method for determination of the ohm, based on the induction by displacement of a magnet, by M. Lippmann.—On the terrestrial induction of planets, and particularly on that of Jupiter, by M. Quet. The planets probably contain iron. With equality of magnetic powers, Jupiter would (next to the sun) exercise the greatest induction on the earth, because of its great volume and rapid rotation; but if its magnetic power were, *e.g.*, ten times that of the sun, variations of the compass might reveal some of the principal periods of that planet. The compass might, within certain limits, show to what point a planet is rich in iron or magnetic substances.—On the currents produced by nitrates in igneous fusion, &c. (second note), by M. Brard. He describes an electrogenerative fuel, which, in any hearth, yields both heat and electricity; and an electrogenerative hearth in which these agents may be generated with any fuel.—On a method of transformation of tricalcic phosphate into chlorinated compounds of phosphorus, by M. Riban.—On a new hydrocarbon, by M. Louise. This is named *benzyleme sitylene*, $C_6H_2(C_7H_7)(CH_3)_3$. It is got by making benzyl act on mesitylene in presence of anhydrous chloride of aluminium.—On an unalterable linseed powder prepared for poultices, by M. Lailles. The oil is eliminated.—On cerebro-spinal ganglions, by M. Ranvier.—On the microsporidia or porospermida of Articulata, by M. Balbiani.—The migrations of the puceron of red galls of the country elm, by M. Lichtenstein.—Researches on digestion in cephalepod molluscs, by M. Bourquelot.—Geological history of the syssidere of Lodran, by M. Meunier.—Reply to a note of M. Musset, concerning the simultaneous existence of flowers and insects on the mountains of Dauphiné, by M. Heckel.

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THURSDAY, DECEMBER 21, 1882

DISEASES OF MEMORY

Diseases of Memory; an Essay in the Positive Psychology. By Th. Ribot. International Scientific Series, Vol. XLIII. (London: Kegan Paul, Trench, and Co., 1882.)

A WORK on such a subject as this from the pen of M. Ribot, cannot fail to be a good work, and although in the one which he has published there is not much originality either in respect of facts or of theories, it is of value as a clearly arranged account of what we know concerning the psychology of memory, united with philosophically wholesome views of interpretation.

It is first shown that the word memory, as ordinarily used, has a triple meaning: "the conservation of certain conditions, their reproduction, and their localisation in the past" (recollection). The third element here, which is most purely a part of consciousness, appears to be an element superadded to the other two. Neglecting it therefore in the first instance, the author seeks to "reduce the problem to its simplest terms, and try to discover how, without the aid of consciousness, a new condition is implanted in the organism, is conserved and reproduced; in other words, how memory is formed independently of all cognition." Here it is well shown that all analogies drawn from inorganic sources are misleading—such as the facts of insolation, photography, &c. "Conservation, the first condition of recollection, is found, but that alone; for in these instances reproduction is so passive, so dependent upon the intervention of a foreign agent, that there is no resemblance to the natural reproduction of the memory. Hence, in studying our subject, it must never be forgotten that we have to do with vital laws, not with physical laws; and that the bases of memory must be looked for in the properties of organic (? organised) matter, and nowhere else."

The first true analogy to be found is that of muscular fibre responding more feebly at first to the excitation transmitted by a motor nerve than it afterwards does when it has frequently been stimulated, allowing natural periods of repose. This is taken to be a true analogy, because in nerve as in muscle, "everywhere we perceive, with an increase of activity and proper intervals of repose, an increased power of organic functions." But even here, we think, the objection might fairly be made that the analogy is scarcely sound, inasmuch as there is no evidence to prove that the increase of power in a muscle due to use, is due to an increase in the power of the individual fibres. We think some better parallels might have been chosen from the region of muscle physiology—such, for instance, as the effect of the constant current in leaving behind it for several minutes after it has ceased to pass through a muscle a change in the excitability of the fibres, so that they are less responsive to a renewal of the current in the same direction, and more so to its passage in the opposite direction. The following paragraph, however, is in our opinion above all criticism, and should be well burnt into the memory of all who write about memory.

"The true type of organic memory—and here we enter the heart of our subject—must be sought in the group of facts to which Hartley has given the appropriate title of secondary automatic actions, as opposed to those automatic functions which are primitive or innate. These secondary automatic actions, or acquired movements, are the very basis of our every-day existence. . . . In a general way it may be said that the limbs and other sensorial organs of the adult act with facility only because of the sum of acquired and co-ordinated movements which forms for such part of the body its special memory, the accumulated capital on which it lives, and through which it acts—just as the mind lives and acts in the medium of past experience. To the same category belong those groups of movements of a more artificial character which constitute the apprenticeship of the manual labourer, and are called into action in games of skill, bodily exercise, &c."

The first requisite to the formation of these automatic movements is association, the original material being provided by primitive reflex actions, which require by frequent repetition or practice to be properly grouped, some combined and others excluded. Such organic memory resembles psychological memory in all but one point—the absence of consciousness. Thus all the following features are common to both: "acquisition, sometimes immediate, sometimes gradual; repetition of the act necessary in some cases, useless in others; an inequality of the organic memory according to individuals—it is rapid with some, slow, or totally refractory with others (awkwardness is the result of a deficient organic memory). With some, associations once formed are permanent; with others, they are easily lost or forgotten. We observe the arrangement of actions in simultaneous or successive series, as if for conscious recollection, and here is a fact worthy of careful notice; each member of the series *suggests* what is to follow."

Touching the changes produced in nerve-tissue, which constitute the objective side of memory, M. Ribot properly observes that it is scarcely safe to speculate, as they are beyond the reach of histology or of histo-chemistry, though facts in abundance prove that some such changes take place, and the probability is, as expressed in a quotation from Maudsley, that "every impression leaves a certain ineffaceable trace; that is to say, molecules once disarranged and forced to vibrate in a different way, cannot return exactly to their primitive state." But over and above this particular modification, which may be supposed to be impressed upon the molecular constitution of the nervous elements concerned in an act of memory, M. Ribot points out that there must be a "second condition, which consists in the establishment of stable associations between different groups of nervous elements." This, we think, is a most important point, and one which, in our author's opinion, has not hitherto received the attention that it deserves. In his own words, "It is of the highest importance that attention should be given to this point, viz. that organic memory supposes not only a modification of nervous elements, *but the formation among them of determinate associations for each particular act*, the establishment of certain *dynamic* affinities, which, by repetition, become as stable as the primitive anatomical connections. In our opinion, the important feature with regard to the basis of memory is not only the modification impressed upon each element,

but the manner in which a number of elements group themselves together and form a complexus." Thus it follows that "a rich and extensive memory is not [merely] a collection of impressions, but [also] an accumulation of dynamical associations, very stable and very responsive to proper stimuli."

The essay then proceeds to consider more especially the case of conscious as distinguished from organic memory:—"The brain is like a laboratory full of movement, where thousands of occupations are going on at once. Unconscious cerebration, not being subject to restrictions of time, operating, so to speak, only in space, may act in several directions at the same moment. Consciousness is the narrow gate through which a very small part of all this work is able to reach us. . . . What has been said of physiological memory applies in a general way to conscious memory; only a single factor has been added." But "dynamical associations have a much more important part to play in conscious memory than in unconscious memory."

These we think are the more important of M. Ribot's preliminary considerations. We have no space to consider others which follow, or to enter into the details of those diseases of memory which constitute the main subject of his work. These diseases are classified under the divisions of General Amnesia, Partial Amnesia, and Exaltations of Memory. Each of these divisions is abundantly illustrated by examples, which, while being adduced in corroboration of philosophical views on the mechanism of memory, furnish in themselves reading of a curiously entertaining kind. We may conclude by rendering, in the words of the author's own summary, the general conclusions which he deems his study of the diseases of memory to have established:—

"1. In cases of general dissolution of the memory, loss of recollections follow an invariable path; recent events, ideas in general, feelings, and acts.

"2. In the best-known case of partial dissolution (forgetfulness of signs), loss of recollection follows an invariable path; proper names, common nouns, adjectives and verbs, interjections, gestures.

"3. In each of these classes the destructive process is identical. It is a regression from the new to the old, from the complex to the simple, from the voluntary to the automatic, from the least organised to the best organised.

"4. The exactitude of the *law of regression* is verified in those rare cases where progressive dissolution of the memory is followed by recovery; recollections return in an inverse order to that in which they disappear.

"5. This law of regression provides us with an explanation for extraordinary revivification of certain recollections when the mind turns backwards to conditions of existence that had apparently disappeared for ever.

"6. We have founded this law upon this physiological principle: Degeneration first affects what has been most recently formed; and upon this psychological principle: the complex disappears before the simple, because it has not been so often repeated in experience.

Finally our pathological study has led us to this general conclusion: Memory consists of a process of registration of variable stages between two extreme limits, the new state, the organic registration."

GEORGE J. ROMANES

EASTERN ASIA

Im Fernen Osten, Reisen des Grafen Bela Szechenyi in den Jahren 1877-1880. Von Gustav Kreitner, Mitglied der Expedition. Two Vols. (Vienna, 1881.)

AFTER rambling for more than three years over a great part of Japan and China, the forerunners of Count Szechenyi's party reached the Irawadi delta in March, 1880, in such a plight that they were actually refused admission to Jordan's Hotel in Rangoon. The expedition was undertaken, not to seek the cradle of the Magyar race in Central Asia, as was given out at the time, but simply to seek distraction from a heavy domestic affliction experienced by the Count in 1876. It was organised with the disregard of economic considerations so characteristic of the open-handed Hungarian nobility, and consisted originally of four members—the Count, Balint de Szent Kotolna, philologist, Ludwig von Loczy, geologist and Gustav Kreitner, geographer. Unfortunately Balint got no further than Shanghai, where his health completely broke down. Hence the linguistic results were *nil*, notwithstanding the sensational story circulated in some American papers regarding a Magyar-speaking nomad tribe said to have been discovered in the Gobi desert. These marauders were stated to have captured and condemned the whole party to death. But on overhearing them casually exchange a few words in Hungarian, the nomad chief, overcome with emotion, fell on his knees, and addressed Count Bela "in the purest Magyar," acknowledging him and his associates as their long-lost brethren, descendants of the warlike hordes, who migrated westwards ages ago, but whose memory was still kept alive in the yurts of their Asiatic kinsmen. This story throws a curious light on the analogous statements long current in popular writings touching the Irish, Welsh, and Basque-speaking Delawares, Algonquins, Guaranis, and other American aborigines. The only difference is that in these critical times such veracious accounts have no longer much chance of surviving their authors.

The expedition has found a competent historian in its geographer, Gustav Kreitner, whose chief fault is perhaps an excessive Teutonic conscientiousness, which omits nothing, and leaves little to the imagination of the reader. Hence these bulky volumes, mostly going over tolerably beaten ground, are apt to grow all the more tedious that the journey was on the whole singularly free from stirring adventures. The camp was broken into and looted during the night by some prowling Tanguts in Mongolian Kansu; a terrific sandstorm nearly overwhelmed the caravan on the skirt of the Gobi; Herr Kreitner on one occasion got entangled in the intricacies of the loess region in North China; an attempt to penetrate into the precincts of a Buddhist monastery at Batang was met by a shower of stones from the doughty but inhospitable llamas; lastly the train conveying the explorers from Prome to Rangoon narrowly escaped the flames of a burning jungle in Pegu. But there was little else to record of an exciting character, beyond the ordinary incidents, mishaps, and hardships of eastern travel.

On the other hand many opportunities were afforded for original observations on the lands and peoples visited by the expedition, which has certainly materially increased

the stock of our information on oriental matters. In Yesso the Ainos were carefully studied by Herr Kreitner, whose independent testimony fully confirms this writer's views regarding the Caucasic affinities of those aborigines. "That the Ainos have nothing in common with the Japanese and Chinese is evident even from a cursory glance. The cranial formation is nobler, the forehead higher and broader, the prominent nose firmer. But it is the horizontal position of their large brown eyes that more especially assimilates them to the Caucasic type" (p. 318). A minute examination of the hair resulted in the curious discovery that its seeming abundance is due rather to its coarse texture than to its denser growth on a given square surface. In this respect it appears to be inferior even to that of the Japanese, at least on the scalp, while the body is on the other hand covered with a fur coat averaging 40 millimetres in length, and in the ratio of about 30 hairs to the square centimetre. The contradictory statements regarding the Aino complexion were shown by a practical experiment to be due to the more or less grimy state of the subjects examined. "The more I rubbed the lighter became the dark colour of the Aino, and the browner grew my hand. How often has the complexion of this race been described as darker than that of the Japanese, by those who forget to apply the test of soap and water!" (p. 296).

In this thoroughly practical spirit many other controversial points, doubts, and mystifications were cleared up. The colour of the "button" on the Mandarin's cap is commonly supposed to indicate official rank. But "such is not the case. It is a mere decoration or order. Very frequently we noticed Mandarins with the red button (first and second mark of distinction) taking his place *after* others decorated with the blue (third) or even with the gold (eighth) button" (p. 190). In the same way by a series of shrewd calculations based on a few given data it is plausibly shown that the population of China has been enormously over-estimated, and that instead of 300 or 400 millions it does not probably exceed 150,000,000, or 100,000,000 less than that of British India! (p. 556). In connection with this point, the opium question raised by over-zealous missionaries and political free-lances, is demonstrated to be a pure bogus. The practice, not always injurious, and in certain fever-stricken districts positively beneficial when kept within moderate bounds, would seem to be indulged in by not more than 850,000-900,000 altogether. The inveterate opium smokers are reduced to about 700,000, or not much more than ½ per cent. of the whole population, taking it even at its lowest estimate.

Archæologists will rejoice to hear that the famous Nestorian monument of Signan-fu, hitherto reported as "lost or missing" since the Panthay rebellion, has been re-discovered by our explorers. For a time neglected and overlooked during those terrible times, it has been recently set up in a place of honour within the precincts of a Buddhist monastery to the west of the city. Three impressions of the well-known inscription were taken, together with a copy of another which has lately been added to the reverse side of the slab, and which runs thus: "A pious Mandarin caused this stone to be restored over twenty years ago, and set up where it now stands." In the same neighbourhood a brick inscribed with the symbol of the Han dynasty was also obtained from a pagoda said to be over 2000 years old.

From Sining-fu an excursion was made to the monastery of Kum-bum, partly for the purpose of testing Huc's extraordinary account of the famous tree of Buddha. The result must be told in the author's words:—

"A few steps brought us to the chief temple. Before it stood, surrounded by a railing, the tree concerning which the Abbé Huc tells us that its leaves bear the natural impress of Buddha's likeness and of the Tibetan alphabet. We sought in vain for such phenomena. Neither image, nor letters, but a waggish smile playing about the corner of the mouth of the elderly priest escorting us. In answer to our inquiries he informed us that *a long time ago*, the tree really produced leaves with Buddha's image, but that at present the miracle was of rare occurrence. A few God-favoured men alone were privileged to discover such leaves. The last so favoured was a pious Mandarin, who visited the monastery seven or eight years ago. Next day Count Szechenyi succeeded in finding a leaf on which a rude likeness of Buddha had been etched, probably with some acid. The llamas allow no one to pluck leaves or blossoms from the tree, and the leaves that fall are carefully collected and sold to the pilgrims as a specific against affections of the larynx. The tree belongs to the Oleaceæ, and I believe it to be Syringa L. (white lilac), which in all probability reached Europe originally from China" (p. 708).

A careful survey was made of the vast region of "yellow earth," to which a total area of at least 360,000 square miles is assigned in the Hoang-ho basin. The origin of this unstratified loess formation is assigned with Richthofen to the weathering of the rocks on the lofty Tibetan plateaux, combined with the prevailing west winds, by which the pulverised particles are wafted eastwards. From a rough calculation of the rate of the deposit, which in Shensi was found to attain a thickness of 1800 feet, a period of at least 260,000 years is supposed to have been needed to remove the detritus from the plateaux to the lowlands.

One of the most cherished objects of Count Szechenyi was to reach Lhassa from the east or north-east. But like Prejevalsky, Gill, Desgodins, and so many other recent explorers, he was baffled all along the Tibeto-Chinese frontier line from Kuku-Nor to Batang. Hence no new territory was anywhere traversed except a small district south of Batang on the road to Tali-fu. Here a fresh route was struck across the Chung-tien plateau, which occupies the extreme west of Se-chuen, within the great bend of the Kinsha-kiang. In this Alpine region several altitudes were taken, some new wild tribes were visited, but no opportunity was afforded of throwing any fresh light on the many interesting hydrographic problems which still await solution in South-East Asia. At Tatsien-lu these problems formed a chief topic of discussion with the Abbé Desgodins, who has probably more practical knowledge of the subject than any living European. The question was again approached during the now familiar route from Tali-fu to Bamo across the narrow, gorge-like valleys of the great Indo-Chinese rivers. The result of these discussions and observations is set forth in the accompanying map of China and East Tibet, which substantially adheres to the lines already laid down on D'Anville's map, prepared in 1735 on data previously collected by the Jesuit missionaries in China. Here the Sanpu appears as the upper course of the

Brahmaputra; the Great and Little Irawadi, forming the two upper branches of the main Burmese artery, are carried through the unexplored Pomi country as far as 32° N.; while the Lu-Kiang (Salwen) and Lantsan-Kiang (Me-Khong) are both traced still higher to 34° N. 92° E. within a short distance of the Murui-ussu (Yangtze-kiang) valley. Thus the basins of five of the great Asiatic streams are crowded at one point into a narrow space of less than 280 miles, where the several water partings are formed merely by a series of lofty ridges following in rapid succession between Sechuen and East Assam. Such a hydrographic disposition is of course elsewhere absolutely unparalleled, and is altogether of such a phenomenal character that it can hardly be finally accepted until the main rivers are actually traced to their respective sources.

The jealousy with which the Tibetan frontier is everywhere guarded Herr Kreitner is disposed to attribute rather to the Lhassa than to the Pekin authorities. The Chinese government is represented as possessing very little practical power in Tibet, which is gradually becoming a sort of fee simple of the Sacerdotal class. The Dalai-lama himself is a mere puppet in the hands of this priestly caste, which has set up no less than 103 living Buddhas altogether, and which now embraces two-thirds of the population of Tibet, grinding the rest to dust, and living in opulence, idleness, and profligacy on the contributions of the countless devotees who periodically visit the vast monastic establishments overshadowing the land. The whole trade of the country is monopolised by the llamas, "who buy in the cheapest and sell in the dearest market," and whose efforts are steadily directed against the intrusion of all foreign competition. These llamas are the greatest curse that ever afflicted an ignorant and superstitious people, plundering and oppressing them in their combined capacity of sorcerers, priests, traders, money-lenders, serf-owners, and landed proprietors. "No Tibetan peasant claims as his own the land he tills, or the house he builds. All is held at the will of the llamas, who eject him whenever he dares to brave their displeasure. And in the power, rapacity, and boundless authority of these priests must be sought the impassable barriers which have hitherto encircled the whole land. By them is Tibet closed to the outer world, and by them will it long remain hermetically sealed" (p. 855).

The work is abundantly illustrated by original woodcuts, which, if not always remarkable for artistic merit, are at least always to the point. It is also unfortunately disfigured by several mis-statements and inaccuracies, some of which are quite unaccountable. Thus the length of the Suez Canal is given at 80 instead of 100 English miles. The Wahhabis are brought to the west of Mecca, where they have never been seen since their overthrow by the Egyptians in 1819. Harakiri and other customs, legally abolished since the Revolution of 1868, would appear to be still practised in Japan. The Shogun is still the "Tykun," while the Mikado, representing the oldest monarchy in the world, is said to have sprung "from the Kubo (Shogun) dynasty, founded in 1603"! Shintoism is described in one place as "a Buddhist sect," and in another, although rightly called the original national religion, it is wrongly said to be now mostly superseded by Buddhism and the Confucian moral system. The upper course of the Yangtze-Kiang, we are told, is called the "Murui-ussu" by the Tibetans, who certainly do not speak Mongolian. The Tibetans themselves are stated to be called "Si-fan" by the Chinese, and at p. 831 the extraordinary statement is made that Tibet "ist leblos auf Thierwelt," the very opposite being notoriously the case.

A. H. KEANE

OUR BOOK SHELF

Die Insekten nach ihren Schaden und Nutzen. Von Prof. Dr. E. Taschenberg. Mit 70 Abbildungen. Pp. 1-300, 8vo. (Leipzig: G. Freytag, 1882.)

THIS forms the fourth volume of a German series of popular works issued under the title "Das Wissen der Gegenwart." It consists of an examination of certain insects injurious, or otherwise, in field, garden, and forest. The author is a man of scientific training, and as a specialist has acquired that practice of accuracy of statement that necessarily results from the education of a specialist. Much of the contents will prove useful to Englishmen who can read German; a portion, however, concerns insects that happily do not occur with us. The figures are mostly very good, many are excellent, a few are indifferent. We recognise most of them as reproductions, or reductions, from varied sources. The "Colorado Beetle" is introduced, and appears somewhat strangely out of place in a work that almost exclusively concerns German insects. Possibly the opportunity for indulging in a little satire (p. 124) may form sufficient excuse. But the author aims his satire at the wrong butt. He alludes to newspaper reports as to Colorado beetles having been sent over by Irish Americans, in order to spite "Englanders," but omits to suggest that the "scare" existed long before these newspaper reports.

Out in the Open. A Budget of Scraps of Natural History gathered in New Zealand. By T. H. Potts, F.L.S. (Christ Church, 1882.)

THIS little volume contains a reprint of a number of interesting papers contributed by the author from time to time to the *New Zealand Country Journal*. These chiefly relate to the ferns and birds of the country, but comprise also an account of a visit in 1878 to Hikurangi, where the Maoris were seen at home. In another paper a good account of the Kia (*Nestor notabilis*) is given. It would seem that it does not do much damage to the flocks of sheep except during periods of severe snow, when the parrots are deprived of their usual food. The work is evidently the result of a good deal of intelligent observation carried on over a number of years.

Catalogue of Mammalia in the Indian Museum, Calcutta. By John Anderson, M.D., F.R.S. Part I. (Calcutta: printed by order of the Trustees, 1881.)

THIS part contains the Primates, Prosimidæ, Chiroptera, and Insectivora of the Indian Museum, Calcutta. Till 1865 this Museum was the property of the Asiatic Society of Bengal, and a catalogue of the mammalia therein was drawn up in 1863 by the late Edward Blyth, so well known to all Indian naturalists of that period. The collection has increased enormously since, from in 1863 150 species of the four orders catalogued by Dr. Anderson to 252 at present existing in the Museum of these same orders. Extensive and important details are given about many of the more remarkable species, especially the Primates. The synonimic lists seem well worked out, and this part will have a value for the working naturalists far beyond that of a mere catalogue. We trust the second part will soon be published, and we congratulate the Trustees on the excellent work done by their superintendent.

The Microscope and some of the Wonders it Reveals. By Rev. W. Houghton, M.A., F.L.S. Fourth Edition. (Cassell, Petter, and Galpin.)

IT seems sufficient to notice the appearance of the fourth edition of this little volume, which, like so many works issued by the same firm, bears no date of its appearance.

The Flora of Essex County, Massachusetts. By John Robinson. (Salem, 1881.)

THIS enumeration of the plants of Essex county embraces, besides the Phanerogams, the Vascular Cryptogams, and the algæ (marine) and lichens among the Thallophytes. Essex County would seem to be an attractive field to the botanist. Besides open country, deep woods and numerous swamps, the Merrimac furnishes a fine fertile valley. The freshwater ponds, over fifty in number, are from four to four hundred acres in extent, and are rich in water-plants. A sub-alpine flora is to be met with, while a long sea-coast affords suitable dwelling-places for a large number of plants peculiar to such quarters. To this well compiled flora an interesting series of sketches of the lives of some of the early botanists of the district—Cutler, Osgood, Oakes, Pickering—is attached.

Catalogue of the Fossil Foraminifera in the British Museum (Natural History). By Prof. T. Rupert Jones, F.R.S. (London: Printed by order of the Trustees, 1881.)

THE Foraminifera which are in a living state to be found widely distributed in the seas of the present day, are also known to enter as fossils into the composition of several of the stratified rocks, forming in some places such vast thickness of limestone, as to command the attention of the Palæontologists. It is found somewhat difficult to draw the line between recent and fossil forms; and it would seem to be equally difficult to be sure what is a foraminiferous form and what is not. In this most useful catalogue, however, all descriptive details and all controversial questions are omitted. Eozoon appears in the list, and so also does Orbitoides. The classification adopted is that of H. B. Brady, and the species are grouped according to their local occurrence and geological age.

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 ensure the appearance even of communications containing interesting and novel facts.*]

The Aurora and its Spectrum

IN the recent correspondence in your columns on the subject of the aurora, no notice has been taken of an old observation by Anjou, in Siberia, that whenever the aurora flashed up past the moon, a halo was formed. This, with numerous other observations, which need not be detailed here, have led me to the conclusion that suspended crystals of ice have most probably something to do with the aurora; and my object in writing is to suggest to some of your readers who are well equipped with suitable apparatus, that if they could contrive to pass a glow or phosphorescent discharge of electricity through fine-falling or loosely-compacted snow, they might very possibly be rewarded by the discovery of the origin of the green and red lines in the aurora spectrum.

Mr. Capron's experiments seem to show conclusively that it is not an air spectrum, and it is also evident that the conditions of discharge in an atmosphere laden with ice crystals are very different from those in the clean vacuum tubes usually employed by experimenters.

While on the subject perhaps I may be permitted to add one small contribution to the question. I have examined most of the auroras recorded by the Meteorological Office during the last four or five years with reference to the synoptic conditions of pressure with which they are associated. The result is, that though the larger number may be grouped round a few types of pressure distribution, it is not easy to see any one constant condition. RALPH ABERCROMBY

21, Chapel Street, London, S.W., December 18

Swan Lamp Spectrum and the Aurora

MR. J. RAND CAPRON'S experiment with the Swan lamp is very interesting; but his inference that the aurora may not be an electric discharge in the upper atmosphere because it does not show nitrogen lines in the spectrum is hardly justified by the experiment. On the contrary, the true significance of that experiment appears to be that there is a certain degree of rarefaction of the air (or vacuum) at which the nitrogen lines disappear. Such a vacuum is given by the Swan, and probably other electric incandescence lamps. According to Mr. Capron's result, when more air got into the bulb and vitiated this fine vacuum, the nitrogen lines appeared. We may say, then, that if the aurora is an electric discharge in the upper air, the rarefaction must be approximately that of a Swan lamp, if there are no nitrogen lines visible in the spectrum of the light. To study this further some one ought to examine the discharge in vacuum tubes containing air at different degrees of density. J. MUNRO

West Croydon, December 18

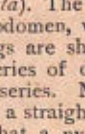
The Meteor of November 17

Mr. CAPRON'S letter (p. 149) gives an interesting confirmation of the meteoric nature of the light seen on November 17; as showing that it is physically impossible that it can be an aurora, according to accepted theories of that light. Setting aside the impossible estimate of forty-four miles, it should be noticed that the heights assigned are in close agreement, 170 miles being merely stated, like other elements in my letter, as a minimum. The oblique direction of the meteor from 10° altitude in due east to horizon in due south-west, as shown by several observations, is another evidence of its extra-terrestrial origin.

Bromley, Kent W. M. F. P.

Invertebrate Casts

THE communication in NATURE, vol. xxvii. p. 46, induces me to state the following fact. Engaged this summer in an economic survey of the North Transcontinental Survey for the North Pacific Railroad in the camp just opposite Umatilla, near the Columbia River, Washington Territory, I observed, on June 26, the nympha of a new species of Ophiogomphus, then very common, emerging out of the water for transformation. The Columbia River had been very high, the water beginning to recede, was still more than 30 feet higher than usual. The country around the camp belonged to the so called sagebrush desert, but near the river was a bank of wet sand, flat and smoothed by the receding water. There were no plants around, and only one willow tree, now about 100 feet distant from the river, for five miles on one side and twelve on the other side. I had observed before on the sand a number of traces like the diagram. In the middle a straight furrow, and on each side two series of equidistant dots. By chance I was able to discover that these tracks are made by the nympha of Ophiogomphus (family *Gomphina* in *Odonata*). The straight furrow is made by the end of the abdomen, which is heavy and slides upon the ground. The forelegs are shorter, and make, with the end of the tibia, the inner series of dots. The other legs are longer, and make the outer series. More remarkable was it that the furrows were made in a straight line from the water to tree, as it is scarcely probable that a nympha so near its transformation can see well at a distance of about 100 feet. Nevertheless I caught the nympha just at the end of the track—which I saw made—in ascending the tree. The two outer series of dots are one inch distant one from the other. I remember having seen an account of similar tracks on fossil slabs, but I have not been able to find the publication. H. A. HAGEN



Cambridge, Mass., November 27

The Scream of the Young Burrowing Owl sounds like the Warning of the Rattlesnake

WHILE working upon the tertiary beds of the plains east of the Rocky Mountains recently, I had numerous opportunities of making observations on the habits of those peculiar creatures the Burrowing Owls (*Speotyto hypogæa*). Among others made at the time is one relating to the extraordinary similarity between the sound of the cry of the young owl when disturbed, and that of the warning of the Rattlesnake (*Crotalus confluentus*), which I do not find to have been noticed by ornithologists. My attention was first called to the peculiar likeness by my friend, Dr. V. T. McGillicuddy, who had in his possession a couple of owlets nearly as large as the adults. The capture of a number of both snakes and birds enabled me by experiment to determine to what extent one might be deceived by the resemblance. At the distance of a few feet the shrill tremulous scream would deceive persons quite familiar with the sound of the rattling of the Crotalus. When not noticing or thinking of the birds, their cry produced on us the same effect as the sudden springing of the rattle by an angry snake. The experiments left no doubt that the cries produced a similar effect on other animals which unwittingly disturbed young owls. And in this way they led to a consideration of the possible benefit of this close resemblance, or, as it might be called by some, mimicry. As you know, the birds are fond of the deserted holes of different burrowing animals, especially so of those of various Spermophiles or Prairie Squirrels. They are common in and about colonies of the so-called "Prairie Dogs" (*Cynomys ludovicianus*), where they take possession of vacant burrows, and sometimes even of those in use, sooner or later dispossessing the rightful owners, as the dogs seem disinclined to bring eyes and noses into contact with the sharp beaks and claws in the passages however familiar they may be with the birds around the mouths of the dwellings. In the same localities the snakes are numerous, and the squirrels form a considerable portion of their prey. Naturally enough the rodents—as also the weasels, foxes, and coyotes (*Canis latrans*)—dread the fangs and venom, and recognise and profit by the warning. May it not be that the peculiar protest or scream of the young owl, by its resemblance to the danger-signal, insures safety by preventing the approach of the mammals, and, possibly, of the dull-eared snakes themselves? The scream of the old bird is rather more hoarse and somewhat less like the shrilling of the serpent. On ordinary occasions, the note of this owl is a cackling or chuckling chatter or laugh, varied with what seem very much like imitations of the barking and squealing of the squirrels. When caught, it gives utterance to the hoarse, long-drawn, rattling scream. The owlets ate greedily of fresh meat, stopping to utter their strange cry of alarm at every attempt to approach them. In behaviour the adults were similar, but much less tractable. One, which had his wing broken, was allowed the freedom of the camp, and usually he stowed himself under the waggon. A halt in a "dog-town" one day brought him near one of the holes, which after a time he discovered. At once his soldierly walk quickened; it became a quick step as he neared the opening. Chuckling to himself, down into the darkness he plunged, and that was the last we saw of him.

S. GARMAN

Cambridge, Mass., U.S.A., December 3

Fertilisation of the Common Speedwell

IF Mr. Ransom will refer again to my letter, he will see that it was written in order to draw attention to the *adaptation* of the flower for cross-fertilisation, and not especially to the *fact* that Diptera in settling upon it, draw down the stamens. This latter, if we consider the close attention paid of late years to the commoner European wild flowers, has in all probability been frequently observed before. As I have not seen Schenck's handbook, I would be glad if Mr. Ransom will quote the passage to which he refers. On looking at my note-book I find that not only *V. officinalis*, but also *V. Chamædrys* and *V. Beccabunga* are shown as fertilised in the same manner. May I suggest that the separation of the stamens, and the difference of inclination between stamens and pistil, have been brought about in order to prevent self-fertilisation? The looseness of the corolla would then, in such a flower as *V. Chamædrys*, bring the anthers to a level with the stigma when an insect alighted upon it, and would thus promote cross-fertilisation. From want of more extended observations, however, I could not say what would happen in the case of a proterogynous species, or of such a flower as *V. spicata*. In reply to Mr. Ransom, I may add that I have nowhere stated *V. officinalis* to possess larger flowers than *V. hederæfolia*, and that Mr. Darwin ("Cross and Self-fertilisation," p. 369), in a brief reference to the genus, simply states that *V. agrestis* is self-fertilising, and mentions species of Syrphidæ as visiting the flowers of *V. hederæfolia* and *V. officinalis*.

A. MACKENZIE STAPLEY

The Owens College, Manchester, December 15

Complementary Colours at the Falls of Niagara

IF Mr. Cross, whose letter on the above subject appears in Nature (vol. xxvii. p. 150), will make what is for him a very short excursion from Boston to Niagara, he will see a very perfect and permanent illustration of contrast-colours. In the American fall, the pure, green, even sheet of water is "trimmed," as it were, at regular intervals by broad bands of foam, which although, of course, really white, appear of a delicate rose-pink hue. I noticed, and "made a note of this" ten years ago, and again this year. The effect heightens the beauty of the beautiful fall, and I am surprised that no poet has made capital out of it. I should like to call attention to the rapidity with which the Canadian fall is deepening its horse-shoe. An immense mass broke off near the middle of the curve in October, 1874 (many windows in the adjacent museum were broken by the concussion), and altogether the fall has receded twenty-four feet in ten years.

H. G. MADAN

Eton College, December 15

M. DUMAS

THE following is a translation of the addresses delivered in the Paris Academy of Sciences on the 4th inst., on occasion of a commemorative medal being presented to M. Dumas:—

The President, M. Jamin, said: Gentlemen and dear Fellow-Members: The Academy considers it a duty to celebrate the golden wedding of those fellow-members who have honoured it during half a century, a duty which is always dear to us, but to-day is dearer than ever; for M. Dumas now completes his fiftieth Academic year. You have had prepared, by an able artist, a medal which happily recalls his features, and must perpetuate them; it bears on the back this inscription:

A M. DUMAS
SES CONFRÈRES, SES ÉLÈVES, SES AMIS,
SES ADMIRATEURS.

I have nothing to add, except that it is not all his admirers, all his friends, all his scholars, but only those who sit here; the Academy has not been willing to share with any stranger the duty of a homage which it has exclusively reserved to itself. I have the honour to offer in your name, with respect, to our illustrious and venerated fellow-member, this token of our affection and of our gratitude.

My dear Teacher: If you will carry back your thoughts to the commencement of your career, you may well be content with your lot and with yourself. When twenty-two years of age, you were at Geneva; you began with Prevost, by discoveries that are still celebrated in physiology, on the urea, on the blood, and on generation. From that moment your name was known, and you acquired confidence in yourself. Then you perceived two things: the first, that physiology must be built upon chemistry, that chemistry was not made, and that it was necessary to make it; the second, that Geneva was not a large enough theatre for your projects. And so you came to Paris, having no other wealth than yourself, than your courage, than a programme resolutely determined, than the will to fulfil it, than confidence, still unconscious of the future that was promised you. Now the time has advanced, your dreams have been realised, your hopes exceeded, and you have reached the highest degree of glory a savant can conceive. Like Franklin, you may

say: If I were to recommence my life, I could not seek anything better.

It is between that departure and this point of arrival that the most brilliant phase of your career is placed. Your discoveries followed one another like improvisations. The composition of ethers was unknown, you analysed them; you enunciated the law of substitutions and of the conservation of chemical types; a constant preoccupation brought you frequently to the atomic theory, that fundamental base of chemistry; and you furnished, for measurement of the density of vapours, a method so simple and so perfect that it is easy to the most unskilful; we know what light it has thrown on the study of organic compounds. But it belongs not to me to speak of your innumerable researches. The scholar may not arrogate to himself, without irreverence, the right of praise or of criticism; in presence of the teacher, he has only the right of respect.

But it is permitted him to remember, and who does not remember, the charm and the marvels of your teaching at the Athénée, at the École Polytechnique, at the Sorbonne, at the École de Médicine, at the Collége de France, at the École Centrale? Everywhere that you have appeared, and you have appeared everywhere, youth and ripe age have been drawn, held, charmed, carried away, to such an extent, that it may be said that you have even rendered more service by the vocations you have decided, than by your own proper works.

Fifty years ago, this Academy opened her gates to you; she has intrusted to you since, and ever congratulates herself for it, the formidable heritage of her illustrious perpetual secretaries. The French Academy has seated you in the chair of Guizot, a professor like yourself; but we have not been therefore jealous. They honoured you, and we did not lose you. Then comes the moment when preoccupations of another order have been imposed by your very renown; you have resigned yourself to those duties which enlarged your *rôle*, because your authority was necessary, because science mixes with all, because chemistry addresses itself to the lighting, sanitation, hygiène, and all the industrial requirements of a large city.

Circumstances have now set you free from manifold cares, and restored you to sciences and to letters. These possess you wholly; and whether it be art or industry, physics or chemistry, electricity or astronomy, it is to you people apply, it is your authority they seek. They find you ever ready for work, ever equal to the most difficult missions. When one recapitulates the work you have accomplished, the services of every kind you have rendered, the discoveries you have made, the lectures you have given in all the chairs, the literary works you have written, the ideas you have sown—all this existence, in fine, which has never known rest, one is astonished that you have not taken more than half a century to fulfil so large a programme; and when one has the happiness of seeing you and hearing you, one marvels that a half-century of labour without truce has still left you so much of youth to expend. It is because, of all human passions, that of study is the most healthy, because it leaves to the organs all their force, to the mind all its serenity—for it is wisdom.

Enjoy, my dear teacher, enjoy these fruits; all the good things that come from God have been given you without stint; genuine happiness, a health which nothing has affected, hearty good will towards all, a mental vision which has not ceased to grow; and all human recompenses have come to be superadded; an authority which makes itself felt and survives all *régimes*, a respect which disconcerts envy, and the affection of your fellow members which has prompted the gift of this medal: it is merely a small fragment of gold, but it will be precious to you, because it is amalgamated with our gratitude.

M. Dumas then spoke as follows:—

Mr. President and my dear Fellow-Members: Since my earliest steps in the way of science, the Academy has been to me the object of a reverence so profound that I cannot receive, without the most lively emotion, the inestimable present with which she honours the close of my career.

As far back as sixty years ago she gave a kindly attention to the work of my youth; half a century ago she received me into her bosom; and since then she has not ceased to accord to me marks of her esteem and of her confidence; nothing had prepared me, however, to think that among my fellow members many should wish even now to call themselves my scholars. Of all the testimonies to which an old teacher might lay claim, the secret has been found of offering that one which is dearest to his heart. Your kindness overwhelms and confounds me!

Ah, my beloved scholars, I go back often enough to these thirty years of an apostolate, which has not been sterile, thanks to the talents of disciples like you; but I believed the remembrance of it to be buried in the tomb of companions in the fight, whom we have lost, or to have passed from the memory of those who survive them. These prelections, then, of another time, of a time so happy, are still not forgotten, since you have wished to recall, in a durable way, on this medal, impressions that are ordinarily apt to be soon attenuated or even extinguished.

You are right! The Professoriate must be honoured, because speech is a power; because from the height of his public chair the professor fulfils a sacred mission. His loyal and penetrating conviction warms hearts, and raises minds towards the disinterested regions of the Ideal. He reflects the present state of science, like a faithful mirror, he prepares the discoveries of the future, he revives the grand traditions of a glorious past. Opening his whole heart and all his thought to his auditors, he teaches them to love the truth, to respect genius, to cherish the fatherland, and to serve it well.

Whoever has found himself surrounded by attentive youth, taking fire at the accents of the teacher, vibrating to his emotions, hastening full of faith towards the conquests indicated to its ardour, that man, believe me, has known the noblest enjoyments of the human soul.

But stay, there is a greater joy still; it is that experienced in seeing oneself outstripped by those to whom one formerly showed the way. This joy you have caused me to taste every day. May you, for the honour of French science, and for the moral greatness of our dear country, you who are of more value than I, have in your turn scholars who surpass you in genius, and equal you in heart.

Mr. President, and all of you my dear Fellow-Members, receive once more the profound expression of my grateful sentiments; the medal which I receive from your hands will be piously preserved by my family as the dearest of souvenirs of my existence, and by my descendants as the most honourable of titles of nobility.

THE METEOROLOGICAL OBSERVATORY ON BEN NEVIS

THE importance of high-level stations in any satisfactory handling of the scientific and practical problems of meteorology which have now come prominently to the front, is everywhere recognised, and accordingly in almost all civilised countries such stations have been established, and their number is steadily increasing. On the continent of Europe, many of the more salient positions available for high-level stations are already occupied in France, Spain, Italy, Switzerland, Austria, Hungary, Germany, and Russia; and as regards other countries, the United States, Mexico, India, and our Australian colonies, have also established stations at great elevations, in an energetic prosecution of this important department

of meteorology. Singularly enough, Great Britain alone stands aloof from participation in the general movement, and notwithstanding the heavy responsibility which her geographical position and vast pecuniary interests and resources impose upon her, none of the mountains that rear their heads in the very tracks of the storms which sweep over Europe from the Atlantic, is yet occupied by either observatory or station for systematic and continuous observation of the weather, the highest station in these islands being Dalnaspidal, which is only 1450 feet above the level of the sea.

At high-level stations near the equator, where temperature varies but little throughout the year, atmospheric pressure, which may be regarded as measuring the mass of air overhead, is subject also to very small variation. Thus at Bogota, in South America, 8727 feet high, where the mean temperatures of January and July are respectively 57°·2 and 56°·2, the normal atmospheric pressure is 22·048 inches and 22·058 inches. Let us look now at the results obtained at Pike's Peak, where a first-class meteorological observatory was established by the United States Government about ten years ago, at a height of 14,151 feet above the sea. Mr. Henry A. Hazen, in a recently published paper on "The Reduction of Air-pressures to Sea-level at Elevated Stations," shows that the normal pressure on Pike's Peak is 0·632 inch less in winter than in summer. The difference is mainly due to the low temperature of winter as compared with that of summer; the reason being that the atmosphere in winter being condensed by the cold, sinks below the summit of the mountain, thus giving a lower pressure there. Now since a lowering of the temperature implies a proportionate condensation, or greater massing of the atmosphere in its lower strata, with a corresponding diminution of pressure in the upper regions, it necessarily follows that at considerable heights in the northern hemisphere the normal pressure is relatively higher in equatorial regions during the winter months, as compared with any other season of the year, than in higher latitudes at the same heights; and that generally the diminution of the normal pressure in the upper regions is in proportion to the lowness of the temperature of the lower strata. From this state of things it results that, during the colder months, the upper atmospheric currents flow northwards in greater volume, velocity, and persistency, bearing with them the higher temperature and humidity of lower latitudes. It is doubtless from the disturbing influences thus called into play, particularly the disturbing influence of the aqueous vapour from the Atlantic, that the notoriously stormy weather of the winters of North-Western Europe is to be traced.

But the fluctuations of pressure at great heights in the atmosphere are not merely seasonal changes following the annual march of temperature through the year; they also follow the changes of temperature which occur from day to day, notably those great and striking changes of temperature which accompany storms. Now it is the investigation of these changes, together with changes in the humidity, cloudiness, and motions of the atmosphere, in their relations to the cyclones and anticyclones of Europe, with the stormy and settled weather that respectively accompanies them, which give to meteorological observations made on Ben Nevis their international significance.

The observations made during the summer of 1881 on the top of Ben Nevis, in connection with the Scottish Meteorological Society, by Mr. Wragge, with an enthusiasm, physical endurance, and undaunted devotion to the work beyond all praise, have now been to some extent discussed, with the result that they amply bear out the strong opinion here advanced of their great value in forecasting weather. The time was sufficiently extended for the determination of the approximate normal differences between observations at the top of the Ben and at Fort William, near sea-level. During the unsettled weather of the summer of 1881, departures from the normal values, and these departures often large, were of frequent occurrence. Now the remarkable and frequent differences from the normals thereby disclosed in the vertical distribution of atmospheric temperature, humidity, and pressure in the aërial stratum between the top of Ben Nevis and sea-level, taken in connection with the weather that followed, give the strongest grounds for the assurance that observations made on the top of Ben Nevis would contribute invaluable aid, if directly wired to London, in framing forecasts of weather for the British Islands and North-West Europe generally. The observations also threw no little light on several controverted points respecting the movements of cirrus clouds, upper currents, and the time when the centres of storms reach higher and lower levels respectively.

The observations were resumed last summer on a more extended scale, the new observations embracing a more complete investigation into the varying states of the atmospheric stratum between the top of the mountain and the sea, by a string of intermediate stations at different heights, and by a very elaborate and carefully worked out system of ozone observations. The weather of 1882 differed materially from that of 1881, and when the observations of 1882 come to be discussed, they will doubtless yield new results in the further extension of our knowledge of weather phenomena. Among the new results may be mentioned the remarkable observations with the hygrometer in the second week of August and at the equinox. The most striking of these were the observations of September 21, when the dry and wet bulbs on the top of the mountain read as follows:—

		Dry	Wet			Dry	Wet
9	a.m.	49°·1	39°·4	10°·30	a.m.	51°·9	39°·0
9°30	,,	49°·5	39°·7	11	,,	51°·1	37°·6
10	,,	49°·4	37°·9	11°·30	,,	53°·7	41°·4

the barometer at Fort William being high at the time and nearly steady. No such relatively warm and dry air was recorded at Fort William where during the time the temperature was only from 1°·9 to 4°·6 higher than that of Ben Nevis, instead of the normal difference 15°·7. It is instructive to note that these hygrometric states of the atmosphere were observed on the top of Ben Nevis, during, or more strictly speaking, towards the termination of a rather protracted and heavy storm from the north, which rolled huge breakers on the beach of the Moray Firth, and poured down deluges of rain on the high northern slopes of the mountain range stretching from near Foyers to Huntly, which flooded the rivers to an unusual height. The unwonted warmth and dryness of the air, and the deluges of rain that fell immediately to the northward, warrant us in classing the singular phenomena recorded by Mr. Wragge on the top of Ben Nevis on the morning of September 21, as quite analogous to the föhn of Switzerland. If the supposition be a correct one, the difference between the two classes of phenomena is, that whilst the föhn of Switzerland has its origin in a saturated atmosphere discharging its superabundant vapour in deluges of rain on the southern slopes of the Alps, and after crossing these mountains, descending the northern steeps of the mountain-range as a dry warm wind, the föhn of Ben Nevis had its origin in the highly saturated air, which, advancing from the North Sea, discharged its vapour on the higher slopes looking down on the Moray Firth, and after ascending to some height, thereafter blew down on Ben Nevis as a descending wind, characterised by a dryness and relative warmth rarely felt at lower levels. The value of these observations from their important bearings on the theory of storms and other atmospheric movements, cannot easily be over-estimated by the meteorologist, and it is important to note that the observations

at none of the lower stations gave indications of the ascensional and descensional movements of the atmosphere to which attention is here directed.

We observe from a circular we have before us, signed by the Duke of Richmond and Gordon, President of the Scottish Meteorological Society, that the Society has obtained from Mrs. Cameron Campbell of Monzie, a suitable site for the proposed observatory on the top of Ben Nevis, that the grounds and buildings are to be invested in the Royal Society of Edinburgh, and that the charge and management of the observatory will be in the Council of the Scottish Meteorological Society, in conjunction with two representatives of the Royal Society of Edinburgh, and one representative of the Royal Society of London, the representatives of the former Society being Prof. Tait and Prof. Chrystal, and that of the latter Sir William Thomson.

It is satisfactory to learn that a good beginning has been made towards raising the 5000*l.* required to establish the observatory, by a number of noblemen and gentlemen, who have intimated handsome subscriptions to the fund. Since, however, a large sum remains yet to be subscribed, we earnestly hope that in the interests of science the remaining balance of the 5000*l.* will soon be subscribed, so that next summer may see the Ben Nevis Observatory an accomplished fact.

NOTES ON THE GEOLOGY OF HONGKONG

WRITING in 1843, Dr. Abel determined the main structure of the island to be of basaltic trap, granite, siliceous and schistose rock. Mr. Kingsmill in 1865, in his excellent papers on the Geology of the Kwangtung Province, was the first to notice the trachytic porphyry of Victoria Peak (1823), the summit of which overlooks the town. This trachytic rock has been apparently forced upwards through the granite after the overflowing and partial hardening of the trap on the west side of the island. It was Mr. Kingsmill also who explained the nature and formation of the pseudo-boulders, with which the island is so plentifully covered. Towards the extreme south-east, near Cape d'Aguilar, these pseudo-boulders assume very large dimensions, and their weather-beaten aspect proves that the chemical action of water and plants, which forced them from the parent rock, occurred a long time ago. Indeed the island must have undergone great changes in course of time; the hill beyond Shekko, for instance, must have been originally nearly or quite as high as Victoria Peak, whereas its present elevation is not more than 500 feet. The rapid action of the heavy rains and rich vegetation is nowhere more apparent than in the high hill (directly back of the peak from which the colony takes its name) known as the Hog's Back, or High West. Its eastern slope is literally covered with pseudo-boulders, rendering the ascent from that side not a little dangerous, and in the rainy season large masses of rock are borne down into the valley beneath.

Now that the population of the island has increased, amateur geologists and mineralogists have become tolerably plentiful, and frequent excursions are made, hammer in hand, to the less known and wilder portions of the island. In this manner traces have been found of not a few minerals and several interesting rocks. Silver has been observed in small quantities, also galena, lead, and iron pyrites; slate near Aberdeen, syenite and dolorite on a cliff overlooking that one-time piratical *rendezvous*, Saiwan, feldspar and grey mica abundant.

One of the most interesting finds is that of molybdenite, near the village of Sau-ki-van. Molybdenite, molybdenum glance MoS_2, was not known hitherto to be among the mineral products of China. Germany, Sweden, and Cornwales are the chief localities for this rare mineral, and it has been found in several parts of the United States. The South China specimens show all the well-known characteristics of European molybdenite—colour, lead-grey, streak the same; thin foliated hexagonal plates, closely resembling graphite; flexible, non-elastic laminæ, H. = 1-2, G. 4. 5. A local chemist corroborated the determination by analysis, and found the composition to be—

Sulphur	= 40·0
Molybdenum	= 60·0
Molybdenum sulphide	= 100·0

It will be seen from this analysis that there is a slight decrease in the quantity of sulphur, compared with European molybdenite. Dana gives the composition of American molybdenum sulphide as follows:—

Sulphur	= 41·0
Molybdenum	= 59·0
	100·0

The mineral was found in small lumps imbedded in the granite.

F. WARRINGTON EASTLAKE

Hongkong, November

TRANSIT OF VENUS, 1882—BRITISH EXPEDITIONS

AN operation which requires for its success the collection of nearly simultaneous astronomical observations over widely separated portions of the earth's surface must always be liable to great risks of failure. These risks may be diminished by a careful selection of stations, and an increase in their number; but they can never be entirely removed.

The telegrams already received show, however, that the British expeditions have been most fortunate; and the success of the work is now assured.

This is not the proper place for a technical discussion of the different methods which may be adopted for the determination of the sun's distance from a discussion of observations of Venus in transit; but it is desirable that some facts should be stated which may enable the reader to form some conception of the strength of the method which has been relied upon in the organisation of the British expeditions, and the probable accuracy of the sun's distance which may be deducible from a careful discussion of the observations which have been collected.

On December 6, 2h. 20m. G.M.T., the sun was distant from the earth about 90,620,000 miles, whilst at the same time Venus was distant only about 24,330,000 miles. The ratio of these two numbers is very accurately known, but the expression of either of these two distances in terms of any unit of length which is directly known to us, as a mile, is a point of great difficulty on account of the small dimensions of our earth, of which the diameter is only about 7912 miles, in comparison with such distances as those of Venus and the sun.

The greatest possible displacement of Venus, as seen projected on the sun's disc from any two places on the earth's surface is only about a twenty-ninth part of the solar diameter. It is from such displacements that the relation between the distances of Venus and the sun and the separation of the observers, which is known in miles, is established; but the maximum displacement is never practically available.

These displacements may be measured in many different ways: we can take photographs of the sun's disc at the different stations, and afterwards measure from the photographs the distances between the centres of the planet and the sun, as seen at the different stations; or the distances between the centres may be directly measured with a heliometer or any equivalent instrument; or we may avoid the difficulties and errors

which arise from the use of all such measuring instruments, use the sun itself as our circle of reference, and infer the displacements by observing the differences in time at which Venus is apparently in contact with the sun's limb, as seen from the opposing stations. The last method is that upon which reliance has been chiefly placed in the organisation of the British expedition. For the success of this method, we have to place observers at two sets of opposed stations, at one of which Venus is thrown, from the effects of perspective, towards the centre of the sun at ingress, whilst at the other set of stations Venus is thrown from the effects of perspective from the centre. The former stations are called stations of accelerated ingress, the latter those of retarded ingress.

The stations of the egress observations are chosen from similar considerations, and divide themselves into stations of accelerated egress and retarded egress. In the selection of stations, the most important points are, that the effects of the apparent displacements on the difference in the times of contact should be considerable, that the climatic conditions should be generally favourable, and that the altitude of the sun should be sufficient to render a good observation possible.

The principal stations selected for the British observations of accelerated ingress were Madagascar and the Cape; but it is hoped that good observations may have been secured by Mr. Meldrum, the director of the observatory at Mauritius, although the altitude of the sun is very low for that station at the time of contact. The observers at Madagascar were the Rev. S. J. Perry and the Rev. W. Sidgreaves, with Mr. Carlisle as an assistant. The instruments provided were excellent 6-inch equatorials. The expedition was placed under the care of Commander Aldrich, of H.M.S. *Fawn*, with instructions to establish the observers near the coast on the south-western part of the island. A telegram has been received, stating that the *Fawn* had returned to Natal, and that the observations had been perfectly successful.

The observations at the Cape have also been successful. At the Observatory there, Mr. Gill reports that seven observations of contact were made. The instruments available at this station were a fine 7-inch telescope by Merz, which belongs to the Observatory, and a new 6-inch equatorial by Grubb, sent out by the Committee for the observation of the transit, and a good Dollond, which was used at the last transit, with an aperture of nearly four inches, and Mr. Gill's heliometer. The goodness of the contact observations with the latter instrument may be open to doubt, from the construction of the instrument with a divided object-glass. Three of the contacts must, I fear, have been made with inferior instruments, but at least three good observations of contacts have been made at this station alone.

Mr. Marth, who is in charge of the station at Montagu Road, on the railway between Cape Town and Beaufort West, reports that two good observations of contact have been secured. The observers at this station were Mr. Marth and Mr. C. M. Stevens, with Corporal Thornton as assistant. The instruments provided were a 6-inch equatorial by Grubb and the fine Dallmeyer instrument which was kindly lent by Dr. Warren de la Rue for the observation of the transit.

At Aberdeen Road, Mr. Finlay, B.A., First Assistant at the Cape Observatory, and Mr. Pett, Third Assistant, were the observers. The instruments were 6-inch equatorials by Simms, provided by the Committee; a marine artilleryman, Gunner Shean, was sent out from England with the instruments, and was attached to the party as an assistant. The observations have been perfectly successful, and the definition is reported to have been fine.

Mr. Neison has also observed the contacts at Durban, Natal, with a fine equatorial provided by the liberality of the colonists for the observations. Therefore we have at least ten first-rate observations of the internal contact at the phase accelerated ingress made upon one uniform plan and with instruments of the same class.

The longitudes of all the Cape stations have been directly connected with that of the Cape Observatory by telegraph, and the longitude of that station has recently been connected by telegraphic determination with Greenwich.

The Greenwich times of the phase of accelerated ingress range from about 2h. 11m. 0s. for Madagascar to 2h. 12m. 8s. for the Cape Observatory. The Greenwich mean time for the general body of observations known to have been secured would not differ greatly from 2h. 11m. 48s.

But the observations made of this phase would have been perfectly useless unless observations for comparison with them had been made at stations of retarded ingress.

The stations selected for the observation of retarded ingress were Jamaica, Barbadoes, and Bermuda. But the Canadian Government also provided three 6-inch telescopes; and one of their observers, Lieut. Gordon, Director of the Observatory at Toronto, came over to England to secure the necessary additions to the instrumental means, and to Oxford to make himself acquainted with the arrangements of the other British stations. It is to be feared that this spirited conduct on the part of the Canadian Government has not been followed by the success which could have been wished; but no official reports have yet been received from the Canadian stations.

The phase of retarded ingress has been successfully observed by all the observers sent out in the British expeditions, and the observations, from the telegrams received, appear to have been perfectly satisfactory.

The observers at Jamaica were Dr. Copeland and Capt. Mackinlay, R.A. Mr. Hall was to have observed the contact at another part of the island away from telegraphic communication, and he has not yet reported.

The observers at Bermuda were Mr. Plummer, Lieut. Neate, R.N., and Capt. Washington, R.E.

The observers at Barbadoes were Mr. Talmage and Lieut. Thomson, R.A.

We have therefore, at these stations alone, seven good observations of retarded ingress.

The Greenwich times of the phase of retarded ingress range from about 2h. 22m. 35s. at Barbadoes, to 2h. 24m. 25s. at Bermuda. The Greenwich mean time for all the observations will not differ greatly from 2h. 23m. 33s., and the available difference between the opposed stations of accelerated and retarded ingress will therefore be about 700s., and an error of five seconds in the determination of the difference of the observers would not give rise to an error of 700,000 miles in the determination of the sun's distance, because 5 seconds is only the 140th part of the available interval. But even if the separate results at a station should occasionally disagree, 10 seconds of time *inter se* there is no reason whatever why the mean difference in time between the opposed stations derived from seven good contacts at one end, and ten at the other, should have an error of three seconds of time. So that from the British observations of ingress alone it should be possible to estimate the sun's distance within 300,000 miles.

The stations at Bermuda, Jamaica, and Barbadoes, which served for retarded ingress, are also available for accelerated egress.

The egress observations at Jamaica and Barbadoes are reported as satisfactory. Those at Bermuda were apparently only picked up through clouds. It is possible, therefore, that the Bermuda observations may not be available, on this account, for combination with the other observations; but with the Jamaica and Barbadoes observations alone we have at least four good contacts.

These accelerated egress contacts were made, roughly, about 7h. 47m. Greenwich mean time.

Corresponding to these, we have for the phase retarded egress the New Zealand observations and the observations by Ellery and his staff at Melbourne. The observers at New Zealand were Lieut.-Col. Tupman, R.M.A., and Lieut. Coke. The internal contacts must have been made about 8h. om. 30s. G.M.T.

Observations of this phase which were secured by Mr. Ellery and his assistants at Melbourne must have been made about 8h. 1m. 30s. G.M.T.

The failure of the Brisbane observations through clouds and the partial failure at least of the Bermuda observations at egress have considerably weakened the weight of the determination of the sun's distance from the egress observations. But the observations secured with the large available difference of time of about 840s. should most certainly give a determination of the sun's distance from the egress observations alone with an error less than 500,000 miles.

Besides the above observations, Capt. Wharton, H.M.S. *Sylvia*, has been provided with two good telescopes; and, if the weather has been favourable, will have secured observations both of the ingress and egress, having established himself at some station on the South American continent, not far from the Falkland Islands.

The Greenwich mean times of internal contact at Capt. Wharton's station may be taken at about 2h. 15m. at ingress, and 7h. 52m. at egress. The computed times for the contacts at Capt. Wharton's station would be but little affected by any error in the assumed mean distance of the sun, but they are influenced as much as the other stations by any error in the assumed distance between the centres of Venus and the sun at which the contacts take place. Observations, therefore, at such a station are of importance as a check upon the results obtained from the comparison of results from stations of greatly accelerated and retarded phase.

The longitudes of stations in Jamaica and Barbadoes have already been connected with Greenwich through Washington by the American observers by means of telegraphy. Lieut. Neate has determined the longitude of Bermuda through Washington, by the conveyance of chronometers between Bermuda and New York, where Washington time is available. Arrangements have been definitely made for Lieut. Darwin, R.E., to connect Port Darwin with Singapore, and thus the telegraphic longitude of the Australian and New Zealand stations, which have already been connected together, will be determined.

The longitude of the Madagascar station has been determined by the conveyance of chronometers between Durban, in Natal, and Madagascar, the sea rate of the chronometers being ascertained by their rates during the voyage between Durban and Cape Town.

It will be seen, therefore, that there will be no difficulty in the discussion of the observations from the want of accurate knowledge of the position of the observing stations.

The observations of the British Expeditions have been made by observers of skill, with excellent instruments, under approximately similar conditions of illumination and with sufficient optical powers. The observers have all been trained to observe the same kind of contact, and that one of so distinctive a character that no doubts about the time record which refers to the kind of contact required for comparison with those made at other stations should be possible. This point is one of the utmost importance. In all attempts to determine the sun's distance from these contact observations we have to assume that the "contacts observed" took place with the *same* angular separation of the centres of Venus and the sun as seen from the observers' position on the earth's surface. There is no reason whatever why this assumption should be true unless the "contacts observed" are contacts of the same class. There is an interval of more than 20m. between the "external contact" at a station and the "internal contact" at the same station. If, therefore, any one should combine the time of external contact at one station with the time of internal contact at another station, without allowing for the motion of the earth and Venus, in the interval of about twenty minutes he would obtain a startling but very erroneous result for the sun's distance. The error thus indicated would, however, differ nothing in kind, but only in degree from those which have, to some extent, unfortunately, brought this method of contact into doubt.

The success of the British observations, particularly at ingress, has, however, been so complete, that the method of contact will now have a fair trial.

I await the result with perfect confidence. Neither the method of contact nor any other known method can, with our present instrumental means, settle the sun's distance to a hundred thousand miles. But the extreme range of possible uncertainty, as shown by the difference between the results obtained from Mr. Gill's heliometer measures of Mars east and west of the meridian at the opposition of 1877, and those obtained from the differences in North Polar distances between Mars and stars on the meridian as observed at our principal northern and southern observatories at the oppositions of 1862 and 1877, is about 1,700,000 miles. All our other recent determinations, which have stood the test of examination, fall within these limits, and do not generally differ much from 92,000,000 miles. The contact observations of the British expedition will, I feel confident, fix the true distance, without any greater error than 300,000 miles, and should settle the question whether either of the extreme values mentioned can be the true distance, or whether their mean is not much nearer the truth than either of them.

E. J. STONE

We have received the following additional communications on the transit:—

THE observation of the transit of Venus here to-day was attended with a remarkable, and I think hitherto unnoticed phenomenon.

When the planet had entered nearly one-half its diameter on the solar disc, its contour was barely traceable outside by the faintly luminous line of light noticed by previous observers. But in addition to this a spot of light extending through nearly 30° of the planet's circumference, and from its periphery *inwards* for about one-fourth of the radius was distinctly seen. The brightness appeared greatest at the outside, and faded toward the centre. This appearance was noted by me through the great equatorial, by the aid of a polarising eye-piece, and a magnifying power of 244. The position-angle of the bright spot was approximately 178°, as estimated by me (for, owing to the fact that the polarising eye-piece has no position-circle, only an estimate was possible).

At the same time an assistant (Mr. J. E. Keeler), observing with a telescope of only 2¼ inches aperture and a power of 70, was able to see the same bright spot quite independently, and estimated its position-angle at 168°. The position-angle of the planet itself on the solar disc was approximately 147°. The bright spot was therefore distinctly on one side of a line passing through the centres of the sun and Venus.

The observation was repeated at intervals through passing clouds for seven or eight minutes, and whatever may be its interpretation, of the fact of observation there can be no question.

There would seem to be no analogy between this very peculiarly disposed and definite bright spot upon the planet's edge, and the small central spots described by

some (and whose existence is denied by others) which have been seen on Mercury and Venus in transit, when they have completely passed on to the disc.

S. P. LANGLEY,
Director of the Observatory
Allegheny Observatory, Allegheny, Pennsylvania,
December 6

THE transit was observed here in a cloudless sky up to sunset, but the low position and great atmospheric disturbance rendered measurements and observations of contact unreliable.

When Venus was half in on the sun, I distinctly perceived a fine curved thread of subdued light on the south-eastern edge outside the sun, and not reaching to the latter, nor extending far on any side. With three-fourths on, the thread of light reached round the remaining fourth outside, and completed the periphery. The segment of light disjoined, as when first observed, would seem to indicate a superior refractive power of the planet's atmosphere in the locality at the time.

A short time before complete ingress, the solar cusps appeared to project out from the disc in double concave forms to join the aureole. The aureole disappeared after complete ingress, but the outer portion of the planet seemed much less dark than the central, which was perfectly black within a dark brown ring of from 5″ to 10″ in breadth. I saw no trace of the black drop or ligament, and, indeed, I should imagine that the aureole crossing the position of the ligament would prevent its appearance. I found nothing like a satellite. I thought the micrometer showed a diameter of the planet rather greater from east to west than from north to south, but the *boiling* of the limbs prevented any measures that could be depended on. I remarked no distortion of the planet as recorded by observers of the previous transit.

JOHN BIRMINGHAM
Millbrook, Tuam, December 8

IN a published letter, dated "Palermo, December 13, 1882," Signor Cacciatore, Director of the Royal Observatory there, writes as follows:—"The observations of the transit of Venus, effected at our Observatory, present results, both as regards the direct observations and the spectroscopic, to which the attention of astronomers and physicists may fairly be invited. Prof. Ricco, with the spectroscope, when the planet was on the sun's disc, and her image entered upon and left the slit, observed near the spectral line B of the more refrangible side, a very weak absorption band, and also near the line C he saw traces of obscuration, but much more weak and uncertain. The same phenomenon, P. Tacchini writes me, was observed by him at Rome. Moreover, my direct observations yielded an indication of the ingress of the atmosphere of Venus upon the sun, as, from those of Prof. Millosevich in Rome, this indication was obtained on the external portion of the planet. The agreement of such observations made in different places is of no little importance for determination of the existence and the constitution of the atmosphere of Venus."

NOTES

M. BERTRAND, perpetual secretary of the Paris Academy of Sciences, intimates that the French Government is anxious to collect any information relating to Fermat, whose statue will be unveiled very shortly at Toulouse. Those who possess any documents relating to Fermat are requested to communicate with the secretary of the Institute.

THE Johns Hopkins University Circulars contain a great amount of important scientific, as well as other information, concerning the work of that institution, which is rapidly developing into one of the most comprehensive and efficient institutions for research and education anywhere. In the number for November, for example, we have notes on the papers read by members of the University at their various societies as well as elsewhere, in mathematics, physics, philology, biology, &c., synopses of recent American scientific journals (mostly issued from the University), besides abstracts of lectures, critical notes on various subjects, and much other information. From the seventh Annual Report moreover, it is evident that the University has taken a strong hold on the American people, and that both in the spirit and the letter it is amply fulfilling the intentions of the founder. The list of the academical staff alone, professors, associates, lecturers, instructors and assistants, fills three pages, while the account of work in the various departments shows that research has become a part of the everyday life of the institution.

PROF. TYNDALL will on Thursday next (December 28), at the Royal Institution, at three o'clock, give the first of a course of six lectures (adapted to a juvenile auditory) on Light and the Eye.

THE death is announced of Dr. Theod. Lud. Wilh. von Bischoff, formerly Professor of Anatomy and Physiology at Munich University, as well as keeper of the Anatomical Institute in that city. He died on December 5 last, aged seventy-five.

ON December 1 the Agricultural Museum of Berlin was opened to the public. The curator, Herr Settegast, has arranged the zootechnical division in a commendable manner. Numerous paintings and sketches illustrate German domestic animals in their agricultural aspect. In the zoological division there are a number of interesting skeletons and skulls, amongst them a human skull from the shell-tombs at Santos (Brazil).

THE French official journal publishes a report on oyster culture, which is in favour of the Portuguese oyster. It appears that 100 grammes of the flesh of this mollusc contains about 1-10th gramme of iodine, bromine, and chlorine, just twice as much as the common oyster.

MESSRS. FOSTER AND MARTIN, of Melbourne, have sent us a graceful photograph of the comet, about which we have had so much correspondence. The photograph was taken with a 3-inch euryscope of 24 inch focus on an ordinary camera, not equatorially mounted, which doubtlessly accounts for the elongation of the nucleus. The photograph is creditable to Messrs. Foster and Martin, though it is not the first time a comet has been photographed; more than a year ago we reproduced the photograph of the comet of the period, taken by Dr. Janssen of Paris.

Acta Mathematica is the name of a new mathematical journal which will appear this month, simultaneously published in Stockholm, Berlin, and Paris. The editor in chief is Prof. J. Mittag-Leffler, of Stockholm, and the publication has been promised the support of the most distinguished mathematicians of Scandinavia, Germany, and France.

LAST week the Crystal Palace Company inaugurated an Exhibition of Electricity and Gas which gives even greater promise of success than that in which electricity was the sole object of attraction. Gas at present occupies the largest display. Exhibitors demonstrate the utilisation of gas, and there are many practical illustrations going on. The South Nave contains a great collection of all the best systems of improved gas lighting, Sugg's stand being distinguished by an immense standard lamp of 1000 candle power and a series of suspended lanterns of tasteful pattern of 600-candle power. There are similar great gas lights by Bray, Siemens, and others, which are submitted as competitors against the electric arc lights. In the North Nave there are numerous stands of electric apparatus and material.

THE annual meeting for the distribution of prizes and certificates in connection with the Institute for the Advancement of Technical Education was held on Thursday night in the hall of the Goldsmiths' Company, Foster Lane. After the presentation of the prizes, Dr. Siemens said that Sir Frederick Bramwell had prevailed upon him to present the prizes on this occasion, and had urged that he was a fit person to do so. The distinction made between ordinary and honour prizes, marking the addition of some scientific knowledge to proficiency in applied science, was worth the attention of all students. It was not sufficient for after-life to be efficient in a craft or calling. Unless the workman also mastered entirely the scientific principles underlying that calling, he might, in consequence of some invention changing the *modus operandi* in an occupation, be left high and dry, whereas with a knowledge of fundamental principles he could adapt himself to changed circumstances. With regard to the school in Cowper Street, he might say, having recently visited it, that the lecture rooms and the laboratory for physical science and chemistry were the most perfect he had seen, and he contrasted them with those in which he had himself received scientific instruction. He remarked upon a deficiency he had noticed in the Finsbury School—the indifferent accommodation and provision for the study of drawing, both artistic and mechanical. He hoped that art and literature would not be neglected in this scheme of education. Dr. Siemens said he hoped that through the dissemination of pure and practical science a higher spirit would take possession of the artisan, and that he would work with the object of attaining higher results and higher ends instead of discussing with his employer questions of hours and wages.

THE American papers have been devoting considerable space to Prof. Henry Draper, whose comparatively early death is regarded as a great loss to American Science. The *Tribune* has a long and interesting biographical article.

MR. A. E. GARROD has published, through Parker and Co., his able and elaborate paper, re-written, on "Nebulæ," which gained the Johnson Memorial Prize (Oxford) in 1879.

ONE of the largest avalanches ever known in Western Switzerland fell a few days ago near Ormons Dessus in Canton Vaud. It carried away several houses, piled up a mass of ice and snow 200 feet thick, and covered three square kilometres of ground. Some of the ice blocks were 18 feet long. The inmates of the houses struck were got out safely.

NEAR Tabiana (Italy) the remains of a fossil elephant have been discovered. Two enormous tusks, two teeth, and several bones from the skull were found. The objects found were submitted to scientific investigation by Prof. Strobel and Dr. Mariotti of Parma. They declared them to belong to *Elephas* (*Loxodon*) *meridionalis*, Falconer. The tusks measure 3·2 metres in length, and 0·28 metres in diameter at the thickest part. The skull bones were so much decayed that they could not be removed. It was resolved, therefore, to cover up the remains with earth until next summer, when it is hoped that warmer weather will be more favourable to further excavations.

DURING a stay near the Suez Canal last winter, Prof. Keller of Zurich made a study of the animal migrations due to the opening of this means of communication. These are very positive, though certain causes quite stop some species, or at least retard their movements, especially (1) the too sandy nature of the ground; (2) the large lakes; (3) the currents; (4) the passage of ships, which derange the ova and larvæ; (5) the too great saltness of the canal water. From the Mediterranean to Suez have passed since 1870, *Solen vulgaris*, *Umbrina cirrhosa*, *Labrax lupus*, *Balanus miser*, *Ascidia intestinalis*. Some Mediterranean species are now on their way through (*Solea vagina*, *Cardium edule*, *Sphæroma*), several fishes (*Pristipoma stridens*, *Crenidens Forskali*, &c.), and some molluscs (*Cerithium scabridum*, *Mactra olorina*, *Mytilus variabilis*) have passed from the Red Sea to the Mediterranean, while quite a numerous "caravan" is now resting in the basins of the great Bitter Lakes. The fauna of the canal is still too poor for large carnivorous species to find a living in it; hence rays, cuttlefishes, &c., do not migrate. Red Sea corals also have not passed into the canal.

THE *Overland China Mail* gives an account, taken from the Manila papers, of the typhoon which visited the Philippine Islands on October 20. The typhoon began at eight o'clock in the morning, and continued with unabated fury until about two o'clock in the afternoon. Not a house in Manila escaped injury. During the storm it was utterly impossible to walk in the streets, owing to the force of the wind, which was rolling carriages along like playthings, and keeping sheets of iron roofing floating in the air like pieces of paper. It is said that during the typhoon several shocks of earthquake were felt. No such destructive typhoon has visited the islands since 1831. The record taken at the Observatory says that the greatest velocity attained by the anemometers reached 144·4 English miles per hour; nothing could resist this force of wind. The vortex was touched at 11·40 a.m., when the minimum barometer reached 727·60 millimetres. The greatest violence of the hurricane could not be indicated, because all the anemometers were rendered useless before the severest gusts came.

THE eleventh annual *soirée* and exhibition of the Lambeth Field Club and Scientific Society will take place on Monday evening, January 1, 1883, at St. Philip's Schools, Kennington Road, S.E.

PROF. GUSTAV VON HAYEK, an eminent Vienna naturalist, is editing a large Atlas of Natural History. Five parts have appeared, and the work will be complete in fifteen. Each part contains eight plates folio size. Moritz Perles, of Vienna and Leipzig, is the publisher.

"MYTHOLOGIE und Civilisation der Nordamerikanischen Indianer" is the title of a little work just completed by Herr Karl Knortz, and published by Paul Frohberg of Leipzig.

A VIOLENT shock of earthquake was felt at Siders (Canton Valais) on December 5 at 3.40 p.m.; the direction of the shock was from east to west.

THE French Lower House has adopted the project of subterranean telegraphic lines, which had elicited some criticism.

ON the 2nd inst. Dr. Finsch, who recently returned to Berlin, after an absence of over three and a half years, reported upon his travels before the Geographical Society of Berlin. He first proceeded to Micronesia in order to study the ethnology of the rapidly disappearing natives of those groups of islands. From Honolulu he proceeded to Oahu, where he visited the old burial-grounds. At Maui he succeeded in obtaining a specimen of a bird that is very nearly extinct, and from the scarlet feathers of which formerly the royal mantles were made. In March 1880 he accompanied the German Consul, Herr Hernheim, to the Caroline group, and saw the ruins of the celebrated colossal edifices there. In July Dr. Finsch proceeded to New Britain. He stayed there for eight months, and then went to visit the Maoris in New Zealand. At the beginning of 1882 he proceeded to New Guinea, in August he left for Batavia and then for Europe, having travelled over 30,000 miles. His collections comprise 4000 ethnological objects from 43 localities, 290 skulls, 200 samples of hair, 200 casts of faces taken from living individuals in 66 different places, 6000 vertebrata, 30,000 invertebrata, 1000 plants, numerous minerals, 400 photographs, and 200 sketches.

THE Russian Geographical Society has addressed to other scientific societies of Russia a proposal to collaborate in the publication of a general description of Siberia. The Geographical Society undertakes for its part the publication of a geographical description and of a general bibliographical index of all works and papers on Siberia.

THE Belgian expedition for the investigation of the Upper Congo has left Antwerp on board the steamer *Harkaway*. The party consists of Dr. van der Heuvel, Herr Schaumann, an Austrian officer, and several mechanics. The expedition takes out large stores of goods, including samples of the seeds of all nutritious vegetables grown in Belgium. They are to proceed as quickly as possible to the furthest of Stanley's stations, and then penetrate further if possible.

THE additions to the Zoological Society's Gardens during the past week include a Chacma Baboon (*Cynocephalus porcarius* ♀) from South Africa, presented by Mr. J. W. Browne; a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Lady Sibyl Tollemache; a Smooth-headed Capuchin (*Cebus monachus*) from South-East Brazil, presented by Mr. A. J. McEwen; a Squirrel Monkey (*Chrysothrix sciurea* ♂) from Guiana, presented by Mr. M. Escaré; a Rhesus Monkey (*Macacus erythræus* ♂) from India, presented by Mr. G. V. Sawyer; two Leadbeater's Cockatoos (*Cacatua leadbeateri*) from Australia, presented by Mr. C. J. Harvey; a Common Barn Owl (*Strix flammea*), British, presented by the Rev. A. Reece; a Ring-hals Snake (*Sepedon hæmachetes*), a Rhomb-marked Snake (*Psammophylax rhombeatus*) from South Africa, presented by Mr. H. Pillans; a Lesser White-nosed Monkey (*Cercopithecus petaurista* ♂) from West Africa, deposited; a Long-eared Owl (*Asio otus*), British, a Marbled Cat (*Felis marmorata*) from Assam, purchased; a Red Kangaroo (*Macropus rufus* ♂) born in the Gardens.

OUR ASTRONOMICAL COLUMN

MEASURES OF DOUBLE STARS.—We receive at about the same time several important series of measures of double stars.

(1) "Results of double star measures made at the Sydney Observatory, N.S.W., 1871 to 1881," under the direction of Mr. H. C. Russell, Government Astronomer for New South Wales. From 1871 to 1874 the instrument employed was a very fine 7¼-inch refractor by Merz; after 1874 the 11½-inch refractor by Schröder was substituted, the same method of observation being followed with both instruments. For the more difficult objects, a power of 330 was applied on the Merz telescope, and one of 800 on the larger refractor. The objects measured include about 746 of Herschel's stars, and it is unnecessary to say more than this, to show the importance and value attaching to the catalogue, no measures of a large number of the stars having been put upon record since the publication of Sir John Herschel's Cape Volume. In addition to these objects, however, Mr. Russell's catalogue includes measures of 350 new double stars detected at Sydney, and he remarks that it would have been easy to double the number if he had adopted the same limit of distance as Sir John Herschel, and without making any very strict examination of the southern heavens, which will be a hint to future workers in this branch of astronomy in the other hemisphere. Some of Herschel's stars, Mr. Russell says, present considerable difficulty, but are probably in motion; thus γ Lupi, an easy double star in 1836, is now single under the highest power on his large equatorial; π Lupi, which Herschel found "excessively difficult," is now quite an easy object with the Sydney refractor; *h* 4854 is another star of the same character; in June, 1872, it was easily divided with power 230; in June, 1874, it could not be divided with any power; and in July, 1880, it presented only a round disc with all powers on the large telescope.

Mr. Russell has made an innovation in the manner of expressing the dates of the separate sets of measures, which appears an unfortunate one: instead of giving them according to the u ual method, as fractions of the different years, he has three columns with "Day of the month," "Month of the year," and "Year in the 19th century," and this inconvenient expression of dates is not remedied without some trouble, by means of the table at p. 68, showing day and fraction of year. The computer of double-star orbits in taking means of sets of measures for an epoch to work upon, will hardly appreciate this innovation.

(2) "Micrometric measurements of double-stars" in vol. xiii. part 1, of "Annals of the Astronomical Observatory of Harvard College." This is a valuable catalogue of measures of about 350 stars in upwards of one thousand sets, made with the 15-inch refractor at Harvard College, chiefly in the years 1866-1872, under the direction of Prof. Winlock, but including a few obtained by the Bonds, and by Mr. Waldo, which have previously appeared in the *Proceedings* of the American Academy of Arts and Sciences, and in the *Astronomische Nachrichten*. The catalogue includes nearly all the more interesting binaries and many difficult objects. In addition, Prof. Pickering publishes a list of 179 double stars discovered at Harvard College Observatory, some of which have been independently detected by Mr. S. W. Burnham; these were found to a considerable extent during an exploration of the southern heavens, occasionally instituted in the intervals of other observations. In the cases of some of the principal revolving doubles as γ Virginis, 70 Ophiuchi, &c., the measures extend to the year 1876.

(3) "Measures of the principal double stars in rapid orbital motion," made in the years 1875-1882, with the Merz refractor of the Observatory of Brera, Milan by Prof. Schiaparelli; an important series of results which will be most welcome to those who are engaged in the investigation of double star orbits, since in most cases, there are measures later than any others available at the present moment. We extract a few of the more recent mean results:—

		Position	Distance
		°	″
ζ Cancri (A : B) ...	1882·247 ...	75·07 ...	0·980
ω Leonis	1882·363 ...	89·99 ...	0·55
ξ Ursæ Majoris ...	1882·386 ...	261·06 ...	1·928
η Coronæ Borealis ...	1882·503 ...	135·37 ...	0.594
μ^2 Bootis	1882·521 ...	120·40 ...	0·795
ζ Herculis	1882·602 ...	101·55 ...	1·473
γ Ophiuchi	1882·600 ...	252·13 ...	1·860
70 Ophiuchi	1882·609 ...	51·83 ...	2·336

No trace of the companion of γ Coronæ Borealis was visible in the years 1875-1881. In 1882 a prominence was once suspected at 120°, but at other times the star was single. In 1875-1879, however, this star was single in the Washington 26-inch refractor.

PHYSICAL NOTES

PROF. W. KOHLRAUSCH gives the following as the results of recent experiments on the electric conductivity of the haloid salts of silver. Chloride, bromide, and iodide of silver at temperatures above their melting-points conduct far better than the best conducting liquids (sulphuric acid, &c.) at ordinary temperatures do. Chloride of silver conducts best, iodide worst of the three. The chloride and the iodide of silver change their resistance very greatly and suddenly on solidifying, the resistance increasing more than a million-fold by cooling through 20°. More remarkable still, iodide of silver undergoes absolutely no change of conductivity at its melting-point (540°), but shows a rapid decrease at the temperature (145°) at which it passes from the amorphous to the crystalline state.

NEW combinations to serve for direct-vision prisms have been suggested recently by several persons. Mr. C. D. Ahrens uses a bisulphide prism cemented between two flint glass prisms, giving a wide dispersion with little loss of light. Herr Fuchs employs a single isosceles glass prism in the position of minimum deviation, a silver-faced mirror being attached to the basal face of the prism to rectify the ray after emergence. Signor A. Ricco has described a similar combination, a total-reflexion prism being substituted for the mirror. He has also constructed the second prism of the combination of a four-sided form, so that it not only rectifies the ray which has been deflected by the first prism, but also augments the dispersion of the first prism by a nearly equal amount.

THE electric resistance of mercury is, according to R. Lenz, affected by pressure. Between the limits of 2 and 60 atmospheres' pressure, the resistance of a quicksilver column 1·2 metres long, inclosed in thermometer tubing, diminished ·02 per cent. for each additional atmosphere.

PROF. MELDE of Marburg proposes to study the force of electric reaction as exhibited in the rotation of Hamilton's well-known "mill," by attaching the "mill" to a torsion fibre, and observing the *torque* produced by the electric reaction. As Tomlinson has shown, the "mill" will work when surrounded by turpentine or other insulating liquid; hence Prof. Melde's suggestion promises to prove of some interest.

DR. H. P. BOWDITCH has recently published in the *Journal of Physiology* a paper on the optical illusions of motion, in which he deals chiefly with the peculiar illusions of rotation, &c., studied a few years ago by Prof. Silvanus P. Thompson. He entirely agrees with the latter experimenter in rejecting the explanation advanced by R. Addams, and more recently by Javal, that these illusions are due to muscular slip, and declares that such an explanation is worthless, being contradicted by the fact that motor after-effects in opposite directions are possible for the same retina at the same time. Dr. Bowditch also thinks that these persistent after-impressions of motion cannot be the product of experience or association, because experience cannot overcome, nor volition control or reverse them. He looks for an explanation in the narrowness of the limits of distinct vision.

M. BERSON has contributed to our knowledge of the magnetic properties of metals by some recent researches on their degree of magnetisation at different temperatures. The experimental method followed consisted in comparing the magnetic moments of different bars by Gauss's method at different temperatures while placed in a magnetic field of constant intensity. The following are the results:—With iron the total and temporary magnetisations both increase up to 260° C., above which the temporary magnetisation falls off rapidly, but the permanent slowly. In steel the total magnetisation is also a maximum at 260° C., but the permanent magnetisation attains its maximum about 240° C. The magnetisation of a steel bar magnetised while cold is diminished by heating, whilst that of a bar magnetised while hot is diminished by cooling. This result appears to be important, as it would follow that a magnet has its permanent maximum power at that temperature at which it was magnetised. With nickel the total magnetisation increases up to 240°, and diminishes above 280° so rapidly as to be zero at 330°. But if magnetised at 280°, the magnetic moment during the subsequent cooling first increases, then diminishes slightly, but still remains greater than at the temperature at which it was magnetised. Cobalt behaves like steel.

M. HESEHUS publishes in the last volume of the *Journal* of the Russian Chemical and Physical Society an interesting paper on his researches on "residual elasticity" (a rather difficult term to translate), the *elastische Nachwirkung* of W. Weber. Without attempting to deal with the immense range of phenomena concerning permanent changes of shape of elastic bodies under the influence of small but continually acting forces, M. Hesehus has studied these changes in a few bodies, especially in lead and caoutchouc, and has made an attempt to bring these changes into connection with other physical phenomena. He comes to the conclusion that residual elasticity depends to a great extent upon the mass of the body, and its surface; that the elastic conductibility depends upon, and increases with, temperature; and that the laws of residual elasticity afford close analogies with those of heating and cooling of solid bodies, as well as with those of phosphorescence and of residual magnetism and electricity.

AT a meeting of the Russian Physical Society, M. Kraevitch made an interesting communication on the results of his researches on the elasticity of air. Rarified air does not obey the Boyle-Mariotte law, that is, in proportion as it becomes more rarified its elasticity diminishes more rapidly than its density, and becomes equal to zero, while the density has still a measurable value. M. Kraevitch observes that it would result from these experiments: (1) that the atmosphere of the earth is limited; and (2) that our weights of gases contain an error, as, however perfect the pneumatic machine, it cannot pump all air from a vessel, if this vessel is lower than the pneumatic machine, or the air is pumped from above. Prof. Mendeleeff, recognising the importance of these researches, advised M. Kraevitch to continue them on heavy gases.

IN a paper relating to recent studies of the Rhone glacier (read at last meeting of the Helvetic Society of Sciences), Prof. Forel formulates these four questions as, in his opinion, the most urgent for a theoretic knowledge of the phenomena of glaciers: (1) How and in what measure does the velocity of flow vary in different layers of the depth of the glacier? (2) How and in what proportion does the surface-velocity vary if the glacier increases or diminishes in thickness? (3) What is the temperature of the internal mass of the glacier? (4) What are the laws of periodic variations of different glaciers? (For this study it is desirable to know, in the case of each glacier, the epochs of commencement of periods of elongation or shortening).

HERR HERTZ has recently measured with special apparatus, the pressure of saturating vapour of mercury at different temperatures, from 0° to 220° (*Wied. Ann.*, No. 10). His numbers are considerably smaller than those of Regnault; and with Herr Hagen's they agree only between 80° and 100° C., being greater below, and smaller above these limits. Between 0° and 40° he finds the elastic force of the vapour of mercury to vary from 0·00019 mm. to 0·0063 mm. It follows that at ordinary atmospheric temperatures it is less than $\frac{1}{10000}$ mm. This result is important in reference to barometers, machines, and Geissler tubes.

SIGNOR MARTINI has studied the sounds produced by outflow of water through a cylindrical hole in a metal disc at the bottom of a long glass tube filled with the liquid (*Atti del. R. Ist. Veneto*, 5 ser. t. viii. 1882). In such a case one does not hear a series of sounds of decreasing pitch, though the liquid charge continually shortens; but a certain number of distinct sounds. The sound is due, as Savart proved, to the vibrations of the liquid vein; and the author verified Savart's law, that the numbers of these are proportional to the liquid charge and inversely as the diameter of the hole. A pure sound of clear tonality is only got if the sound of the vein is one of those the liquid column can yield. The series of sounds from a liquid column of constant length is that of the harmonics of an open pipe. The air column above the liquid strengthens some of the sounds. The sound is quenched if the tube is kept from vibrating. These experiments afford a means of comparing the velocities of sounds in different liquids. One has only to find what lengths the columns must have to yield a particular sound (all air-bubbles must be expelled). The author has tried alcohol, sulphuric ether, and petroleum, and found numbers agreeing with those by other methods.

IT appears from recent experiments by Herr E. Wiedmann (*Wied. Ann.*, No. 12) that a number of water-containing salts, when heated, undergo chemical transposition even before fusion. He has, in this inquiry, found two new modifications of zinc-sulphate and magnesium-sulphate, and determined the changes of volume attending their formation. The general result, he points out, is of interest with reference (1) to determination of tension, inasmuch as it is necessary, first, to ascertain whether a given salt remains unaltered or not within the range of temperature considered; (2) to researches on heat of solution, &c., of a salt partly deprived of water by heating; it should be exactly determined in what form water and anhydride salt are combined.

CHEMICAL NOTES

A RECENT patent by Mr. Morris, of Uddingston, N.B., claims to have solved a problem which has long baffled the skill of technical chemists. By heating an intimate mixture of alumina and charcoal, in a current of carbon dioxide, Mr. Morris says that metallic aluminium is produced; the metal is purified from carbon and aluminium by fusion.

WHAT may perhaps be called the kinetic theory of chemical actions, the theory, namely, that the direction and the amount of any chemical change is conditioned not only by the affinities, but also by the masses of the reacting substances, by the temperature, pressure, and other physical circumstances—is being gradually accepted, and illustrated by experimental results. Thus Hammond (*Monatsheft für Chimie*, 3, 149) concludes, from experiments on the hydration of salts, that when a saline solution is gradually concentrated various hydrates are formed, but that the crystallisation of any one of these from the liquid depends on the relative quantities of the various hydrates, and on the temperature of the solution. Another example of the establishment of a state of equilibrium between antagonistic chemical systems is furnished by the recent observations of L. de Boisbaudran (*Compt. rend.*, 95, 18) on gallium protochloride. When gallium is dissolved in cold concentrated hydrochloric acid a

stable solution of the protochloride is obtained; but when water is added to the solution hydrogen is evolved and gallium perchloride is produced.

HERR SCHWARZ describes (in *Berichte der Deut. Chem. Ges.*, xv. 2505) three lecture experiments illustrative of the action of zinc on sulphur: 2 parts of fine zinc powder are carefully mixed with 1 part of flowers of sulphur, and the mixture is ignited by an ordinary match; combination occurs with evolution of much light. Vapour of carbon di-sulphide is passed over zinc powder, which is gently heated in a piece of glass tubing; zinc sulphide is produced, and a considerable quantity of carbon is separated. Sulphuretted hydrogen is passed through carbon disulphide, and the mixed gases are then conducted over hot zinc powder; zinc sulphide is produced, and a gas, which is passed through potash and collected in a small gas-holder; this gas burns with a slightly luminous flame, and explodes when mixed with air; it is marsh gas.

NILSON has prepared the rare metal thorium in considerable quantity, and determined its atomic weight to be 232·35, specific gravity about 11, and atomic volume about 21 (*Berichte*, xv. 2519).

M. MIKLUKHO-MACLAY ON NEW GUINEA

AMONG the queries that were submitted to M. Milukho-Maclay before his departure from Europe, was one of Karl von Baer, who advised the traveller to visit the Philippine Islands, and to bring home several skulls of the natives, in order to ascertain whether the primitive inhabitants of these islands are brachiocephalic, or not. During a five days' stay of the clipper *Izumrud* at Manila, M. Maclay visited the Mariveles mountains, and discovered there Negritos who lived in their *pondos*, or small huts made out of palm-tree leaves. Numerous measurements (favoured by the custom of the men shaving the back of the head) proved that they really are brachiocephalic, the index being no less than 87·5 to 90. Their size is altogether small; one woman, mother of two children, measured only 1·30 metre. Their faces proved to be very much like those of the Papuans of New Guinea, while their customs are much akin to those of the inhabitants of many Melanesian islands. For instance, when M. Maclay threw some remains of food in the fire, the Negritos immediately extinguished it, and asked him not to do so again. The same prejudice exists with regard to spitting in the fire (a very widely-spread prejudice, we may observe, as it exists also in Russia and Siberia). Another interesting custom of the Negritos is that everybody, before eating, must loudly shout out several times, an invitation to partake of his food, to all those who may be in proximity. This custom is very rigidly observed, and those who do not comply with it are punished, even by death.

In August, 1874, M. Miklukho-Maclay undertook a journey into the interior of the Malay peninsula, in order to settle the question as to the race of its inhabitants—the Orang-Sokays and the Orang-Semongs—about which question there existed a controversy between Messrs. Logan, Newbold, Crawford, and Waitz. M. Maclay went, therefore, from Singapore to Johore. The Maharajah of Johore received him very kindly, and gave him the necessary men for the journey, as well as orders to his subjects to help him in every way during his journey. In exchange, M. Maclay was bound to prepare a map of the dominions of the Maharajah. The Russian traveller crossed the Johore country twice—from west to east and from north to south. The journey was very difficult, on account of the rainy season; the rivers and streams had inundated the country, even the woods, and the party had to walk in water that reached to the knees, and often to the breasts of the oxen. For seventeen consecutive days they were quite wet, as well as their baggage. Reaching thus the mouth of the Moar river, M. Maclay journeyed up this river in a flat boat, passing by Malayan villages, reached its confluence with the Pallon, and went up the last river. At its sources he discovered in the woods the first huts of the so-called "orang-utangs." This name is given by the Malayans, not to the ape, *Pithecus satyrus*—they never call apes by the name of "orang," but to "forest-men." "Orang" signifies "man," and "utang" a forest. Therefore the Malayans say *orang-bukit* (men of the hills), *orang-ulu* (men at the source of a river), *orang-dalah*, *orang-laut* (men of the interior of the sea-shore), and so on. However, the name *orang-utang* could be applied also to a Malay who stays in the woods, but still it is used to designate a tribe of Malays crossed in various degrees with Papuans, as also with Melanesians.

[1] Continued from p. 138.

Though the different tribes M. Maclay met with during his journeys in Johore differ from one another, still none of them are Melanesians. They forget their primitive language, and adopt that of the Malays. M. Maclay presumes that formerly they had several languages, and were divided into several tribes; some difference still remains in their customs. They are at a very low stage of human culture. They wander in the woods, and only occasionally come to stay in their miserable huts. The Malays distinguish two different tribes of orang-outangs: the orang-outang-dina (or tame, who are in intercourse with them), and the orang-outang-liar, quite nomadic. These last use a weapon, *sumpitan*, which deserves to be mentioned. It consists of a hollow bamboo cylinder, two metres long and two or three centimetres wide, through which they blow against their enemies very light poisoned arrows, as large as knitting-needles. The end of these arrows breaks, and remains in the wound. The Malays say that the slightest scratch of such an arrow kills a man in ten or fifteen minutes. M. Maclay purchased quantities of their poison, which proved always to be made of a condensed infusion of the bark of the Javan tree, *Antiaris toxicoria*, or Upas, to which different tribes add other poisons, such as the poison of snakes, of poisonous kinds of strychnis, &c. A small prick of a poisoned arrow kills a dog or a cat, the death being accompanied by tetanus or not, according to the secondary poisons added to the chief one. The Orang-outangs are rapidly disappearing since they were driven by Chinese and Malayans from the sea-shore to the woods of the interior. Besides, the Chinese and Malays purchase their best-looking and healthier girls, leaving them the feeblest, who leave but a weak progeny. The children from the Malays and Orang-outang girls are far more like the former than the latter.

After having crossed the Johore country from the mouth of the Moar River to the entrance of the Indan into the Chinese Sea, that is, from west to east, M. Maclay crossed the same country from north to south, that is from the Indan to the Selat-tebran Strait, which separates Singapore Island from the mainland. He contracted, of course, a strong fever during this journey, fifty days long, and went to Bangkok. There he happened to receive from the King of Siam a letter to his vassals of the Malay peninsula, enjoining them to help M. Maclay during his further travels on the peninsula. Provided with this recommendation, the Russian traveller undertook a most adventurous journey, namely, to walk from Johore to Siam. It was considered by all his acquaintances as quite impossible, but he accomplished it, as the small rulers of the southern part of the Malay peninsula did not venture to stop him on his way, and preferred, each of them, to despatch him to the next ruler. In this way M. Maclay reached Siam, after a journey that lasted for 176 days.

In the mountains at the sources of the Pakkan River, M. Maclay finally met with undoubtedly pure Melanesians, Orang-Sakays, and made on them a few anthropological measurements. They differ as much from the Malayans, as the Malayans differ from the Papuans, and are like the Negritos of Luzon. The height of the men varies between 1·46 and 1·62 metres, and that of the women from 1·35 to 1·48; the skull is nearly brachiocephalic, that is, the widest is between 74 to 82 for men, 75 to 84 for women, and 74 to 81 for children. The diameter of the curls of the hairs is the same as with the Papuans, that is, from 2 to 4 millimetres. The colour of skin is between the numbers 28 to 42, and 21 to 46 of the table of Broca. The *plica semilunaris*, or the so-called *palabra tertia*, is more developed than with other races; its width reaches sometimes 5 and 5·5 millimetres, instead of the 1·5 to 2 millimetres of the Caucasian race. Finally the Orang-sakays have also a fold of the skin at the interior corner of the eye which is known, when pathologically developed, under the name of *Epicanthus*. Like the Orang-utangs they are disappearing; they nomadize in forests, stopping at a few places to mass collections of camphor and caoutchouc tree, of rotang and elephant bone, which they exchange with Malays for tobacco, salt, iron knives, and various rugs which they use for their dress. The dress of the men consists of a girdle, a part of which covers the *perinæum*: the women have also a girdle of rotang, to which two rugs are adjusted. The women are tattooed by lines and round spots. The Orang-sakays, like other Melanesians, put in the partition of the nose the *hayanmsh*, that is, a long stick of bamboo, or a spike of the *Hystria*.

The Orang-sakays are very kind to their women and daughters, who can even inherit the title of *Pateu*. Their wedding customs contain survival of the custom of stealing brides. On a day agreed to before, the bride, in presence of her parents and friends, runs away to the forests, and the bridegroom, who follows her after some time, must find her during a fixed lapse of time. If she does not wish to marry him she can always conceal herself in the woods so as not to be found. They have maintained also the communal marriage, that is, the wife passes from one man to another for a certain time. They are much afraid of death, and if a member of the community becomes seriously ill, they abandon him in the forest with a supply of food, and leave their huts for ever.

In his fourth lecture, M. Miklukho-Maclay gave an account of his cruise among the islands of the Malayan Archipelago, and the islands of Micronesia and Melanesia, as well as of his work in Australia. The anthropological researches in the Malayan archipelago were far more successful than in Melanesia or New Guinea. He had no longer to deal with wild tribes, and the schools, hospitals, and prisons maintained by the Dutch on these islands gave him many opportunities for anthropological studies. M. Maclay thus made very numerous measurements and photographs of Malayans, which will afford the necessary materials for comparing them with other allied races.

In 1876, when going for a second time to the Maclay coast of New Guinea, the indefatigable traveller had an opportunity of visiting the islands of Western Micronesia. He found there that the Micronesian race is very nearly akin to the Polynesian; but still, he thinks it is most probable that it contains a mixture of Melanesian blood, which appears, especially in the more curly hair; in several instances (on the Pelan Islands), the hairs were purely Melanesian, and the darkness of the skin and several distinctive features of the skull showed unmistakable traces of mixture with Melanesians. On the Lub, or Hermit Islands, M. Maclay found a mixture of Melanesians with Micronesians, and on the next group of islands, Escheker, or Eschikie, he discovered the true border-line of the straight-haired Micronesian race. The most important results of this journey were published in the *Sitzungsberichte der Berliner Gesellschaft für Anthropologie*, &c., meeting of March 3, 1878.

In 1879 M. Maclay left Sydney on board an American schooner for a cruise among the islands of Melanesia. He visited New Caledonia, and journeyed in the interior of it, the Loyalty Islands, and many islands of the New Hebrides, making everywhere anthropological measurements and drawings. Many inhabitants of the New Hebrides proved to be brachiocephalic. Thence he proceeded to the Santa Cruz Islands (where Commodore Goodenough, several sailors, and Bishop Paterson were killed by poisoned arrows), and made measurements of those natives who came on board the schooner. Reaching then the Admiralty Islands, he stayed there for two months, and was enabled to complete to a great extent the observations of the *Challenger* expedition. Visiting further the Lub or Hermit islands, which are said to have been peopled by a few natives landed in a canoe from the Admiralty Islands, and where the Melanesians are continually crossed with Micronesians, as the inhabitants bring every year slaves and women from the Ninigo group—M. Maclay proceeded to the Trobrian group of islands which are very rarely visited by Europeans, and thence to the Solomon and the Luisiadea Islands. The journey lasted for 409 days, out of which 237 were spent on shore. The results were as numerous as important, the chief of them being that brachiocephaly is far more usual in Melanesia than it was before; indexes measuring 81, and even 85, being not rare. Further results of this journey were published in the *Izvestia* of the Russian Geographical Society for 1881, and in a letter to Prof. Virchow, which appeared in the *Sitzungsberichte* of the Berlin Society of Anthropology.

M. Miklukho-Maclay concluded his journey by landing at Somerset, on the northern extremity of Australia, and at several places of the eastern coast, in order to make acquaintance with the black Australian race. It is known that several opinions are current as to the origin of this race. Some anthropologists consider them as Papuans, while others consider them as Polynesians, and Prof. Huxley has made of them an independent race of Astraloids. As far as M. Maclay's observations go, he is inclined to consider them, like Huxley, as a race *sui generis*. But he intends to return again to Australia in order further to study this question.

When staying at Brisbane, M. Maclay undertook an excursion into the interior of the country to see if there really exists an "unhaired" race, of which he was told in Europe. Close by Saint George's Town, on the Ballon River, he discovered a few members of one family who really were representatives of the *Atrychia universalis*; they had only a dozen hairs on their eyelids, and said that they were already a third generation of unhaired people. More details of this occurrence of *atrychia*, together with observations on inherited *hypertrichosis* (hairs covering all the body and face) were given by M. Maclay in a letter to Prof. Virchow which appeared in the *Verhandlungen* of the Berlin Anthropological Society for 1881, as well as several other papers on Australians ("Ueber die Mika Operation in Central Australien; Langbeinigkeit der australischen Frauen," &c.).

At Brisbane M. Maclay had at his disposal very rich anthropological material for the study of the comparative anatomy of the brain of the Australian, Melanesian, Malayan, and Mongolian races, as the authorities had given him all facilities for having fresh brains of representatives of all these races who died in the hospitals of the port, or were executed. The Survey Office of Brisbane offered him the use of its excellent photographs, which rendered him very great services. This rich material, left mostly at Sydney, has not yet been worked out by M. Maclay; but he can already state that the brains of different races afford substantial differences in the development of the *corpus callosum*, the *pons varolii*, and the cerebellum, as well as in the relative development of nerves and in the grouping of the sinuosities of the great brain.

Further interesting studies in comparative anatomy were made by M. Maclay on the brains of Marsupials, as well as of the *Ornithorhynchus*, the *Echidna*, and others. The chief occupation of M. Maclay in Australia being thus comparative anatomy, he proposed to the Linnean Society of New South Wales to open a biological station where everybody could "undisturbed and undisturbing" carry on biological and anatomical studies. The success which has met his proposal our readers already know of. The recently-founded "Australian Biological Association" will take care of the new station.

The Geographical Society not having at its disposal the necessary sums for publishing the scientific work which M. Maclay proposes to publish, the Emperor has allowed the sum of 2200*l.* for covering the expenses of the publication.

THE RECENT AND COMING TOTAL SOLAR ECLIPSES[1]

THE following note has been drawn up in anticipation of the detailed accounts of the work done by me in Egypt on the eclipsed sun of 1882, May 17, which I am preparing to lay before the Royal Society, because as the next total eclipse occurs next May, there is no time to be lost if any attempt is to be made to secure observations, and I am of opinion that such observations are most important.

I have prefaced the statement of the work done by a reference to the considerations which led me to undertake it, and I have added a scheme of observations which, in the present state of our knowledge is, I think, most likely to produce results of value.

1. In order to understand the recent change of front in solar research which has followed the introduction of the view of the possible dissociation of elementary bodies at solar temperatures, and suggested the later laboratory, and especially the later eclipse observations with which we are now chiefly concerned, we must first consider what facts we may expect on the two hypotheses. In this way we can see which hypothesis fits the facts best, and whether there are any inquiries possible during eclipses of a nature to throw light on the question.

2. On the old hypothesis the construction of the solar atmosphere was imaged as follows:—

(1.) We have terrestrial elements in the sun's atmosphere.

(2.) They thin out in the order of vapour density, all being represented in the lower strata, since the solar atmosphere at the lower levels is incompetent to dissociate them.

(3.) In the lower strata we have especially those of higher atomic weight, all together forming a so-called "reversing layer" by which chiefly the Fraunhofer spectrum is produced.

3. The new hypothesis necessitates a radical change in the above views. According to it the three main statements made in paragraph 2 require to be changed as follows:—

[1] Paper read at the Royal Society, Nov. 23, by J. Norman Lockyer, F.R.S

(1.) If the terrestrial elements exist at all in the sun's atmosphere they are in process of ultimate formation in the cooler parts of it.

(2.) The sun's atmosphere is not composed of strata which thin out, all substances being represented at the bottom ; but of true strata like the skins of an onion, each different in composition from the one either above or below. Thus, taking the sun in a state of quiescence and dealing only with a *section*, we shall have as shown in (Fig. 1) C say containing neither D nor B, and B containing neither A nor C.

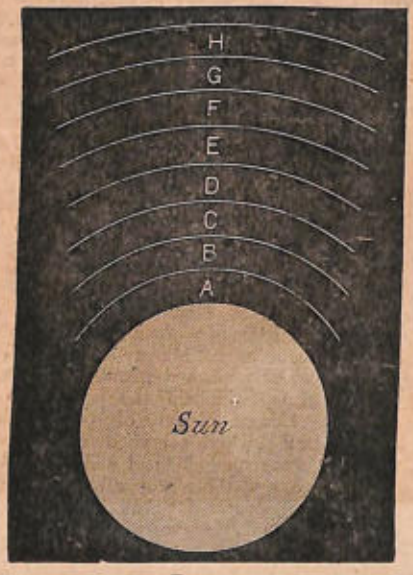


FIG. 1.

(3.) In the lower strata we have not elementary substances of high atomic weight, *but those constituents of all the elementary bodies which can resist the greater heat of these regions.*

4. The conditions under which we observe the phenomena of the sun's atmosphere have not, as a rule, been sufficiently borne in mind, and it is quite possible that the notion of the strata thinning out has, to a certain extent, been based more upon the actual phenomena than upon reasoning upon the phenomena.

5. Take three concentric envelopes of the sun's atmosphere, A, B, C, so that C extends to the base of A, and B also to the base of A, that is, in both cases to the photosphere. Then, whether we deal either with the sphere or a section of it, the lengths of the lines in the spectrum of the strata C, B, A will give the heights to which the strata extend from the sun, and show whether B and A respectively thin out. As the material is by hypothesis continuous down to the sun, the lines will be continuous down to the spectrum of the sun seen below as shown.

6. Now take three concentric envelopes, A, B, C, so that only A rests on the photosphere. The phenomena will *in the main* be the same as in the former case, *i.e.* the line C will still appear to rest on the spectrum of the photosphere, for it will be fed, so to speak, from C' and C", though absent along the line C B A at B and A.

7. Thus much having been premised with regard to the observations as conditioned by the fact that we are observing a sphere, we can now proceed to note *how the two hypotheses deal with the facts.*

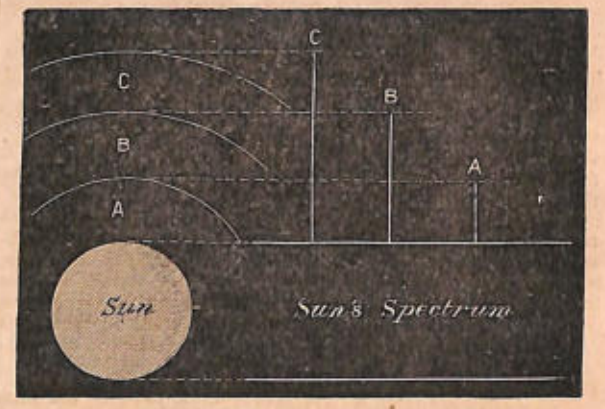


FIG. 2.

Old Hypothesis.	*New Hypothesis.*
1. The spectrum of each element as seen in our laboratories should be exactly represented in the solar spectrum.	The spectra should *not* resemble each other.

FACT.—There is a very wide difference between the spectra.

2. Motion in the iron vapour, *e.g.* in a spot or a prominence, should be indicated by the contortion of all the iron lines equally.	Motion should be unequally indicated because the lines are due to divers constituents which exist in different strata according as they can resist the higher temperatures of the interior regions.

FACT.—The indications show both rest and motion.

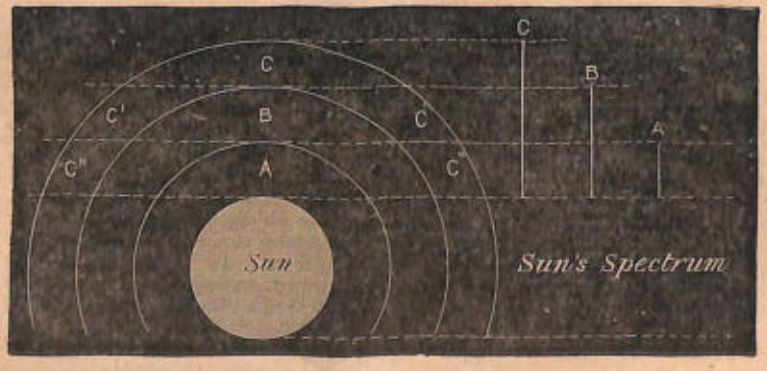


FIG. 3.

3. The spectrum of iron in a prominence should be the same as the spectrum of iron in a sun-spot.	The spectrum of iron in a prominence should be vastly different from the spectrum of iron in a sun-spot, because a spot is cooler than a prominence.

FACT.—The spectra are as dissimilar as those of any two elements.

Old Hypothesis	*New Hypothesis*
4. The spectra of spots and prominences should not vary with the sun-spot period.	The spectra should vary because the sun is hotter at maximum.
FACT.—They do vary.	
5. The spectrum of the base of the solar atmosphere should most resemble the ordinary Fraunhofer spectrum.	The spectrum of the base should least resemble the Fraunhofer spectrum, because at the base we only get those molecules which can resist the highest temperatures.
FACT.—As a rule the lines seen at the base are either faint Fraunhofer lines, or are entirely absent from the ordinary spectrum of the sun.	
6. *Quâ* the same element the lines widest in spots should always be the same	*Quâ* the same element the lines widest in spots should vary enormously, because the absorbing material is likely to originate in and to be carried to different depths.
FACT.—There is immense variation.	
7. The spectra of prominences should consist of lines familiar to us in our laboratories, because solar and terrestrial elements are the same.	The spectra of prominences should be in most cases unfamiliar, because prominences represent outpourings from a body hot enough to prevent the coming together of the atoms of which our chemical elements are composed.
FACT.—When we leave H, Mg, Ca, and Na, most of the lines are either of unknown origin or are feeble lines in the spectra of known elements.	

8. From the above sketch, hasty though it be, it is, I think, easy to gather that the new view includes the facts much better than the old one, and in truth demands phenomena and simply and sufficiently explains them, which were stumbling blocks and paradoxes on the old one.

This being so, then, it is permissible to consider it further.

9. Let us first suppose, to take the simplest case, that the sun when cold will be a solid mass of one pure element, *i.e.* that the evolution brought about by reduction of temperatures shall be along one line only. Let us take iron as the final product.

(3.) We shall rarely, if ever, see the darkest lines affected in spots and prominences.

(4.) The germs of iron are distributed among the various strata according to their heat-resisting properties, the most complex at L, the least complex at A.

(5.) Whatever process of evolution be imagined, as the temperature runs down from A to L, whether A, 2A, 4A; or A+

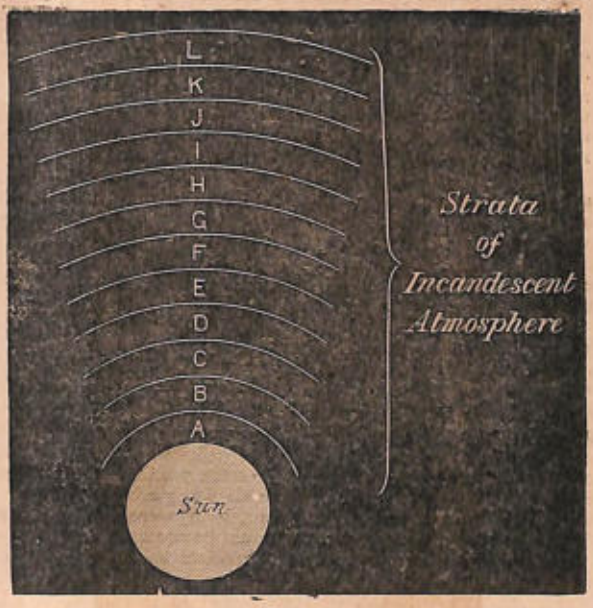


FIG. 4.

B, 2[2(A+B)], or X+Y+Z, the formed material or final product is the work of the successive associations rendered possible by the gradually lowering temperature of the successive strata, and can therefore only exist at L.

10. Now at this point a very important consideration comes in. It was stated (in 6) while discussing the conditions of observation, that whether we were dealing with strata of substances extending down to the sun or limited to certain heights, the spectral lines would always appear to rest on the solar spectrum, and that the phenomena would *in the main* be the same

11. This, however, is true in the main only, there must be a difference, and this supplies us with a test between the rival

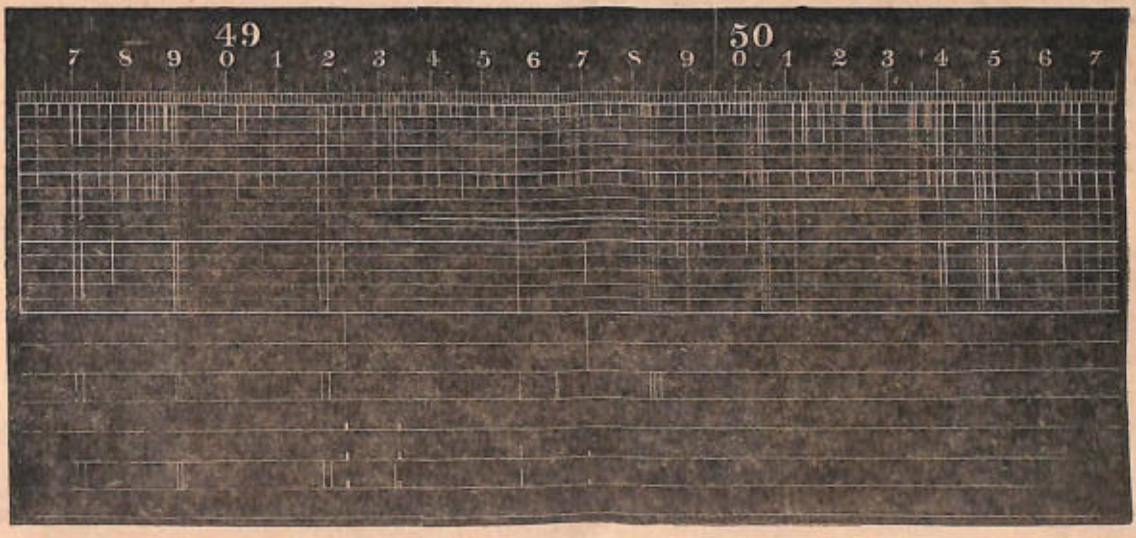


FIG. 5.

Then the sun's atmosphere on the new theory *quâ* this one element may be represented as follows:—

Assume strata A—L. Then—

(1.) The Fraunhofer spectrum will integrate for us the absorption of all strata from A to L.

(2.) The darkest lines of the Fraunhofer spectrum will be those absorbed nearest the outside of the atmosphere.

hypotheses of the greatest stringency. The stratum B, being further removed from the photosphere than the stratum A, will be cooler, its lines therefore will be dimmer, and the lines of C will be dimmer than the lines of B, and so on. So if we could really observe the strata, *the longer a line is, i.e.*, the greater the height at which the stratum which gives rise to it lies, *the dimmer the line will be.*

12. Now our best chance of making such an observation as this is during a total eclipse. We do not see the lines ordinarily in consequence of the illumination of our air. As during an eclipse before totality the intensity of this illumination is rapidly diminishing, the lines first visible should be short and bright, and should remain short while the new lines which become visible as the darkness increases should be of gradually increasing length, so that the spectrum should become richer in the way indicated in Fig. 5.

13. Further, the lines in 1 should be lines seen in prominences, and not in spots, and relatively brighter in the spark than in the arc, while the longer lines added in 2 and 3 should be lines affected in spots, and *not* in prominences.

14. All these phenomena were predicted for the Egyptian eclipse a year before its occurrence, and were verified to the letter for the lines of iron over a purposely limited region.

15. The actual observations of the iron lines made at Sohag are shown in the accompanying map, and these actual observations are contrasted with the lines thickened in spots, the lines observed in the prominences by Tacchini, those intensified on passing from the arc to the spark. The Fraunhofer lines are also given according to Ångström and Vogel, and the iron spectrum of the arc and spark according to Ångström and Thalén. The observations during the eclipse were made 7 minutes, 3 minutes, and 2 minutes before totality as the air was gradually darkened, by which darkening, successive veils, as it were, were lifted so that the more delicate phenomena could be successively seen.

16. We begin with one short and brilliant line constantly seen in prominences, never seen in spots. Next, another line appears, also short and brilliant, constantly seen in prominences, and now, for the first time, a longer and thinner line appears, occasionally noted as widened in spots, while last of all we get very long, very delicate relatively, two lines constantly seen widened in spots, and another line not seen in the spark and never yet recorded as widened in the spots.

17. The procession from the hot to the colder is apparent, and the simplicity of the spectrum as opposed to the Fraunhofer spectrum even yet, is eloquent of the gradual approximation which would be still possible if the darkness could be greater and our attack more complete.

18. It will be noted over what an excessively small range the observations extend. We want similar observations over a wider range during future eclipses, and to do this work properly many observers armed with similar instruments must divide the whole or part of the solar spectrum amongst them, preferably that part between F and D which has been most closely watched in prominences and spots by Tacchini and myself.

19. I next pass to another point on which an observation was made in Egypt.

20. In Fig. 4 we considered the sun's atmosphere, taking the simplest case, that of one element; but evolution and the chemistry of our earth teach us that when the sun cools it will be a very complex mass chemically. If the laws of evolution hold we need not expect that this will largely increase the complexity of the hottest layers A and B, but higher up, say at H—L, the complexity of chemical forms produced by evolution along the fittest lines will be very considerable.

21. These strata H—L may be taken to represent the corona. Its spectrum, therefore, should not be a continuous one, but should consist of an integration of all the radiations and absorptions of these excessively complex layers.

22. The spectrum of the corona, as I saw it in Egypt exactly answered to this description. Instead of the gradual smooth toning seen, say in the spectrum of the limelight, there were maxima and minima producing an appearance of ribbed structure, the lines of hydrogen and 1474 being, of course, over all. This observation, however, requires confirmation, for the look I had at the corona spectrum was instantaneous only.

23. This observation should certainly be repeated during future eclipses with the proper instrumental conditions, *i.e.* small intensely bright image on narrow slit and spectroscope of small dispersion. I believe that, under these conditions, photographs could readily be obtained with the new plates.

24. Now an eclipse occurs next May at a critical time of the sun's activity, for, so far as we can see, we shall be nearly at sun-spot maximum, and I hold that it will be a disgrace to our nineteenth century science, if efficient steps are not taken by those who are regarded as the leaders of science in this and other civilised countries to secure adequate observations.

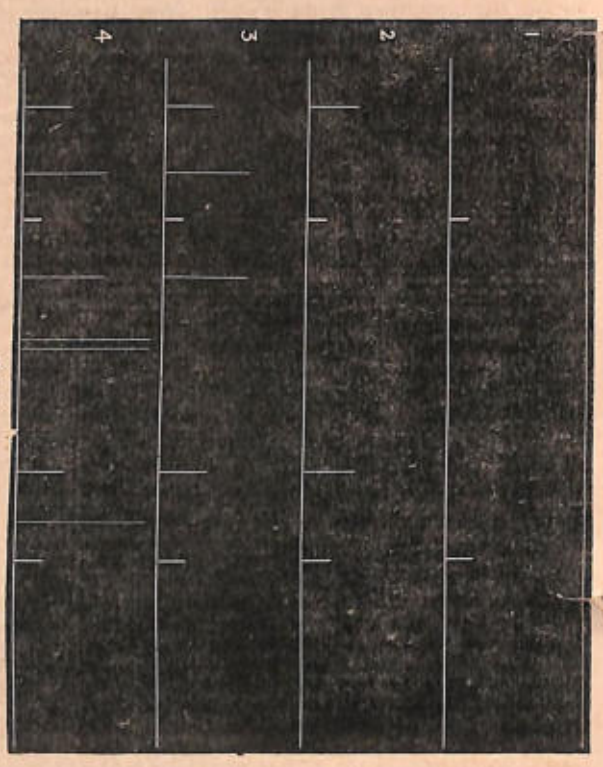


Fig. 6.

25. So far I have only referred to those special observations undertaken this year to discriminate between two rival hypotheses, but both hypotheses may be wrong in many points, so that we must not limit ourselves to such observations, but collect facts over the whole field, as has always been the custom in eclipse expeditions.

26. In my opinion the following scheme shows the observations which, in the present state of our knowledge, it is *most desirable* to secure. The scheme, I am aware, is by no means exhaustive. I give the observations in the order of importance I attach to them, having regard to the present position of solar theory and the conditions of eclipse observations.

(1.) 6-inch equatorial of long focus, perfect clockwork, spectroscope with dispersion of at least five prisms of 60°.

Clamp point of disappearance of sun at base of normal slit, and record phenomena observed from ten minutes before totality to actual totality.

a. Order in which lines appear.

b. Brightness and length when first visible.

The spectrum from λ 4800 to λ 5900 should be distributed among at least nine observers.

Repeat observations after totality on point of reappearance.

(2.) 6-inch photographic lens of 4-feet focus, perfect clock, same dispersion as above.

Clamp point of disappearance of sun on centre of tangential slit and record phenomena observed from ten minutes before totality to actual totality.

a. Order in which lines appear.

b. Brightness and length when first visible.

Repeat observations after totality on point of reappearance. Same part of spectrum, same distribution as in (1).

(3.) 6-inch photographic lens as in (2).

Photographic phenomena before and after totality on slowly ascending or descending or rotating plate, taking care to expose only narrow strip of plate.

(4.) Ditto. Spectroscope of small dispersion, long slit.

Photograph spectrum of corona during totality on both sides of dark moon.

(5.) Prismatic camera. 6-inch photo. lens as in (2), but with grating.

Use first order spectrum on one side and second order on the other.

Commence two minutes before totality. Continue till two minutes after totality on gradually ascending or descending or rotating plate.

(6.) 6-inch photo. lens as in (2), mounted on alt-azimuth. Fine slit. One prism of 60°. To observe spectrum of corona.

(7.) Photographs of corona of short, medium, and very long exposure to determine form and true solar limit of apparent corona due to the illumination of our air, using for the latter purpose the photographic intensity of the image of the moon.

I am aware that because Solar Physics is a new subject, and one so entirely in the domain of pure science, the above scheme may appear ridiculous to many, for if carried out in its completeness its cost would perhaps amount to the sixtieth part of the sum expended on the Transit of Venus in 1874. I have, however, felt myself bound to put it forward as an ideal scheme and one which, if several civilised Governments do each a little, concerted action may help us in part to realise. I am informed that the French and Italian Governments are already making preparations for observations, and my desire is that we may be represented on an occasion which, having regard to the duty which is incumbent upon us to secure observations for the use of those who come after us, is one of high importance.

SCIENTIFIC SERIALS

The American Naturalist, November, 1882, contains:—On the ancient man of Calaveras, by W. O. Ayres.—On the grey rabbit, by S. Lockwood.—On the genus Nebalia and its fossil allies, representing the order Phyllocarida, by A. S. Packard, jun.—American work on recent mollusca, 1881, by W. H. Dall.—Progress of invertebrate palæontology in the United States in 1881, by C. A. White.—On the number of bones at present known in the pectoral and pelvic limbs of birds, by R. W. Shufeldt.—The Editor's table—Recent literature.—General notes.

Zeitschrift fur wissenschaftliche Zoologie, Bd. 37, Heft 3, November 1, 1882, contains:—On the structure and development of *Dinophilus apatris*, by Dr. E. Korschelt (plates 21 and 22). The author would place the forms belonging to this genus in a new family of the Turbellaria.—Studies among the Lampyridæ, by H. Ritter v. Wielowiejski (plates 23 and 24).—On the deposition of bone in the skeleton of bony fishes, by Max Köstler (plate 25).—On the origin and development of the green cells in Hydra, by Dr. Otto Hamann (plate 26); see remarks on this paper by Prof. Lankester, NATURE, vol. xxvii. p. 87.

Bulletin de la Soc. Imp. des Naturalistes de Moscou, 1882, No. 1, contains:—On the geology of the Windimir district, by H. Trautschold.—New lepidoptera of the Amur land, by H. Christoph (conclusion).—On the stone-growth of Sarepta—list of the Staphylinidæ, and on some new plants of Sarepta, by A. Becker.—On the geographical distribution of the hop in ancient times, by Dr. C. O. Cech.—A protest relative to palæontological nomenclature, by H. Trautschold.—Remarks on some anomalies found in the form and colour of the plants in the various countries of the Russian territory, by Dr. A. von Riesenkampff.—Note on an instrument to measure the intensity of gravity, by A. Issel.—On crinoids, addenda and corrigenda, by H. Trautschold.—Materials for a fauna of the Black Sea, fasc. iii. Vermes, by V. Czerniavsky. In Russian, but the diagnoses of new genera and species are in Latin.

Revue internationale des Sciences biologiques, October 15, 1882, contains:—Translation of Prof. Pringsheim's "Researches on Chlorophyll."—M. Roujon, on the faculty of speech in mammals.—Prof. Abel, on the dangerous properties of fine coal dust (translation).—M. Viguier, on orientation and its organs in animals and in man.—*Proceedings* of the Academy of Sciences, Paris.

Rendiconto delle Sessioni dell' Accademia delle Scienze dell' Istituto di Bologna, 1881-82.—We note the following: On the succenturiate spleen of the dog, and on the reproduction of the spleen by pathological processes that have abolished the function of that viscus, by S. Tizzoni.—On adaptation of species to environment; new researches on the genetic history of Trematodes, by S. Ercolani.—On the craniology of lunatics, by S. Peli.—On congenital deviations of the vertebral column in domestic animals, by S. Gotti.—Function of the cœcum and the rest of the large intestine, by S. Vella.—On polydactylia and polymelia in man and vertebrates, by S. Ercolani.—On the variations and the course of the river Po, by S. Predieri.—Meteorology applied to the study of botany, with a description of a new geothermometer, by S. Bertoloni.—On some new electric figures, by S. Villari.—On electric shadows, by S. Righi.—On the minute anatomy of the muscles in insects which move their wings, by S. Ciaccio.—The elevation of the Bolognese Apennines by direct action of gravity and of lateral pressures, by S. Bombieri.—Experimental researches on nerve-stretching, by S. Rossi.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, November 23.—"Monthly Means of the Highest and Lowest Diurnal Temperatures of the Water of the Thames, and Comparison with the corresponding Temperatures of the Air at the Royal Observatory, Greenwich." By Sir George Biddell Airy, K.C.B., F.R.S., late Astronomer Royal.

The observations were instituted at the suggestion of the conductors of the Medical Department in the Office of the Registrar General of Births, Deaths, and Marriages, with the view of supplying some knowledge of an element which may possibly affect the sanitary condition of the metropolis. The plan of observations was arranged at the Royal Observatory of Greenwich; and the instruments were procured and mounted, and repaired when necessary, under the care successively of James Glaisher, Esq., and William Ellis, Esq., superintendents of the Magnetical and Meteorological Department of the Observatory. The self-recording instruments were attached to the hospital ships successively anchored in the Thames, nearly opposite to Greenwich; and their records were read and registered by the medical officers of those ships, and these written registers were transmitted every week to the Royal Observatory.

I have been favoured by Mr. Ellis, who, at my request, has kindly superintended the preparation of the results of observations of thermometers in the water of the Thames, with the following remarks on the nature of the observations and the elements for their reduction.

"The thermometers were inclosed in an upright wooden trunk attached to the side of the ship, its lower portion projecting into the water; the trunk was closed at the bottom; the closing plate, and that portion of the sides which was under water, being perforated with holes, to allow the water easily to flow through. The thermometers were suspended in the trunk, so as to be about two feet below the surface of the water, and one foot above the bottom of the trunk.

"The instruments employed throughout were, one for highest temperature, and one for lowest temperature. For highest temperature two constructions have been successively used: the earlier, in which the mercury, with rising temperature, pushes up a steel index, leaving it detached when the temperature falls; the later, in which the column of mercury becomes divided on fall of temperature, the principal portion of the column being left in the tube. For lowest temperature, a spirit thermometer was employed, its index being contained within the column of spirit. The index-errors of the two thermometers in use were properly determined, and corrections for them were applied when necessary.

"The thermometers were read every morning at 9 a.m.

"The observations of atmospheric temperature at the Royal Observatory were made with the thermometers in ordinary use at the elevation of 4 feet above the ground."

It will be remarked that the indications of the thermometers in the Thames were read only once in each day. I could have wished that a greater number of readings could have been taken, sufficiently numerous to exhibit the dependence of the temperature of the Thames-water upon the phase of the tide. But under the circumstances this was impracticable. To establish a self-registering apparatus was out of question; and if on a few occasions we had gone through the labour of making observations at every hour of day and night, the conclusions deduced from those few instances might have been vitiated by accidents. But I am able to assert positively, as a result from the reductions to be exhibited in the following pages, that nothing has been lost from the restriction of the plan of observation. It will be seen that

the daily change of temperature, produced by the aggregate of strictly diurnal change (depending on the solar hour) and tidal change (depending on the moon's apparent position) is so small that it is impossible to attach with any certainty a sensible value to either of these causes.

I now proceed to describe the principal steps in the reduction of the observations.

In the weekly publication of these observations by the Registrar General, the weekly means of each observed element were also exhibited. In preparation for a detailed publication of the whole, I had the entire series of these weekly means collected, each being accompanied with notes of the principal phases of the moon, the occurrence of remarkable storms, &c., occurring within the week. (This *résumé* exists, and is available for any discussion which might be suggested; I propose to offer it for deposit at the Royal Observatory.) But on general examination of the collected means, I did not perceive that any result could be expected which would justify the labour and expense of printing the whole. For instance, if there were any remarkable dependence on the phase of tide, different values for the "excess of mean temperature of the water above mean temperature of the air" would occur in the weeks which included respectively new moon, first quarter, full moon, third quarter, and these would recur with little alteration for several months. But on general examination, I do not see anything which would justify more technical discussion directed to this point. Finally I decided on exhibiting only the means of deductions as to temperature for each calendar month, and omitting all other phenomena. As the succession of weeks and the succession of entire months do not generally coincide, the rule was established to adopt the first entire week in each calendar month as the first of the weeks to be used, in conjunction with three or four weeks following, to form the monthly mean. Thus, some months contain four weeks, and some contain five weeks. For instance, the month of March, 1846, contains the five weeks, March 1–7, 8–14, 15–21, 21–28, 28–April 4; but the next month contains only the four weeks—April 5–11, 12–18, 19–25, 26–May 2.

By this system, the results, as far as they appear to possess any value, are brought into the compass of five convenient Tables of Double Entry, which, with their columnar and lateral means, appear to give all the information that can be desired. The contents of the several tables are :—

Table I. Monthly Mean Temperature of the Water of the Thames.

Table II. Monthly Mean Atmospheric Temperature at the Royal Observatory.

Table III. Monthly Mean Excess of Thames Temperature above Observatory Atmospheric Temperature.

Table IV. Monthly Mean of Diurnal Range of Temperature of the Water of the Thames.

Table V. Monthly Mean of Diurnal Range of Atmospheric Temperature at the Royal Observatory.

The last line only of each of these tables is given in the present communication to NATURE.

Monthly Means, through a Range of Thirty-five Years, of the Principal Elements of the Temperature of the Water of the Thames

Month.	Temperature of the water of the Thames.	Atmospheric temperature at the Royal Observatory.	Excess of temperature of the Thames above atmospheric temperature.	Diurnal range of temperature of the Thames.	Diurnal range of atmospheric temperature.
	°	°	°	°	°
January	39·4	38·9	+0·5	1·9	9·6
February ...	40·7	40·4	+0·3	2·0	11·5
March	43·6	42·8	+0·8	2·0	15·0
April	50·0	48·7	+1·3	2·3	18·5
May	56·3	54·4	+1·9	2·4	19·9
June	62·6	60·6	+2·0	2·2	20·5
July	65·7	63·9	+1·8	2·1	21·2
August	64·4	62·6	+1·8	2·0	19·6
September ...	59·9	57·9	+2·0	1·9	18·1
October	52·9	50·7	+2·2	2·0	14·3
November ...	44·3	42·3	+2·0	2·1	11·3
December ...	40·4	39·8	+0·6	2·1	9·1

And the following appear to be the legitimate epitomised inferences :—

(1). The mean temperature of the Thames-water is higher than that of the Observatory thermometers by 1°·5. But the locality of the Observatory thermometers is, in hypsometrical elevation, about 160 feet above that of the Thames thermometers. It would seem probable therefore that the mean temperature of the water is higher than the climatic temperature by only a small fraction of a degree.

(2). This difference is not uniform through the year. With some irregularities, the greatest excess of Thames temperature occurs in September, and the least in February. But the autumnal difference exceeds the spring difference by only 1°·6. It seems not improbable that this is the effect of a slight communication with the sea, whose surface-waters have accumulated in autumn the effect of solar radiation through the summer; with contrary effect at the opposite season.

(3). The mean range of temperature through the day is 2°·1. And this expresses the numerical change from the lowest solar temperature, or the lowest temperature in the first tide, or the lowest temperature in the second tide (whichever may be the lowest), to the highest solar temperature, or the highest temperature in the first tide, or the highest temperature in the second tide (whichever may be the highest). It is evident that the change of temperature due to the diurnal change of solar action, and the change of temperature due to each of the tides, must each, individually, be very small.

(4). It appears to me that the fundamental inference must be this: that the material water is very little changed at Greenwich by the tide. Although a vast body of water rushes up at every flow, running with great speed, and sometimes raising the surface by 20 feet, yet nearly the same water runs down at ebb, and is again brought up, with all its contents, at the next flow. These expressions are to be taken as modified by the descent of fresh water from the land; but the amount of that water must be small, in comparison with the mass which it joins in the Thames at London.

(5). I do not imagine that the tidal action has any beneficial effect on the climate of London, except that probably the agitation of the water produces mechanical agitation of the air, and thus destroys injurious stagnation.

Mathematical Society, December 14.—Prof. Henrici, F.R.S., president, in the chair.—Messrs. T. Woodcock, Hugh Fraser, Major Allan Cunningham, R.E., and Capt. P. A. Macmahon, R.A., were elected members.—The chairman announced that in consequence of ill-health Mr. C. W. Merrifield, F.R.S., had been obliged to resign the office of treasurer, and that the council had elected Mr. A. B. Kempe, F.R.S., to undertake the duties of the office. Dr. Hirst spoke in feeling terms of the work Mr. Merrifield had done for the Society, and in accordance with his suggestion a vote of thanks for his services in the past, and of condolence with him on account of the reasons which had led him to sever his official connection with the Society was carried.—The following communications were made :—On the vibrations of a spherical shell, by Prof. H. Lamb.—On the absolutely least periods of the elliptic functions, by Prof. H. Smith, F.R.S.—On certain relations between volumes of loci of connected points, by Mr. E. B. Elliott.—Geometrical proof of Griffiths' extension of Graves' theorem, by Mr. J. J. Walker.—On polygons circumscribed about a tricuspidal quartic, by Mr. R. A. Roberts.—Note on an exceptional case in which the fundamental postulate of Prof. Sylvester's theory of Tamisage fails, by Mr. J. Hammond.—On certain quartic curves, which have a cusp at infinity, whereat the line at infinity is a tangent, by Mr. H. M. Jeffery, F.R.S.

Zoological Society, November 28.—Prof. W. H. Flower, F.R.S., president, in the chair.—Mr. W. B. Tegetmeier exhibited and made remarks upon the skull of a rhinoceros from Borneo; also the horns of a buffalo and deer from the same country.—Mr. J. E. Harting exhibited a specimen of the South African Eagle-Owl (*Bubo maculosus*), said to have been obtained many years ago near Waterford in Ireland.—Mr. R. Bowdler Sharpe exhibited and made remarks on some specimens of Swifts from the Congo. Mr. Sharpe also exhibited a specimen of *Macherhamphus alcinus* which had been obtained in Borneo by Mr. Everett.—A communication was read from Prof. Owen, C.B., on the sternum of *Notornis* and on sternal characters.—A communication was read from Dr. A. B. Meyer, C.M.Z.S., in relation to the adoption by naturalists of an international

colour-scale in describing the colours of natural objects.—A communication was read from Dr. W. Blasius, of Brunswick, containing a description of a small collection of Birds made by Dr. Platen in the island of Ceram. The collection contained 49 specimens referable to 21 different species, one of which was new to the fauna of Ceram.—A communication was read from Mr. E. P. Ramsay containing the description of a new species of *Monarcha* from the Solomon Islands, proposed to be called *Mo...rcha* (*Piezorhynchus*) *browni*.—Mr. W. Bancroft Espeut read a paper on the acclimatisation of the Indian Mungoos (*Herpestes griseus*) in Jamaica. The author explained that the object in introducing the Mungoos into Jamaica was the destruction of the rats, which had committed serious ravages among the sugar and coffee crops. The first Mungooses were introduced in 1871, and so beneficial was the effect produced, that the saving to the sugar and coffee planters now was estimated at least at 100,000*l.* a year.—Lieut.-Col. Godwin-Austen read a paper describing specimens (male and female) of *Phasianus humiæ*, Hume, which had been obtained by Mr. Ogle on the peak of Shiroifurar in North-East Munipur, upon the Naja Hills.—A communication was read from Mr. A. Thomson containing the results of some observations made by him during the rearing of a species of Stick-insect (*Bacillus patellifer*) in the Society's Insect-house.

Chemical Society, December 7.—Dr. Gilbert, president, in the chair.—The following papers were read:—On the condensation products of oenanthol, by W. H. Perkin, jun. The author has endeavoured to obtain evidence as to the constitution of these bodies. By the action of dilute alcoholic potash on oenanthol, an acid, $C_{14}H_{26}O_2$, was formed, boiling at 270°-298°, and two aldehydes, $C_{14}H_{26}O$, boiling 277°-279°, and $C_{28}H_{50}O$, boiling 330°-340°. Zinc chloride forms with oenanthol principally $C_{14}H_{26}O$; nascent hydrogen converts this last substance first into an alcohol, $C_{14}H_{28}O$, and finally into the alcohol, $C_{14}H_{30}O$. Alcoholic potash converts $C_{14}H_{26}O$ into heptylic acid and an acid, $C_{14}H_{26}O_2$. The author concludes that the substance $C_{14}H_{26}O$ is hexylpentylacrylic aldehyd.—On the condensation products of isobutyl aldehyd, by W. H. Perkin, jun. Fossek has also recently worked on this subject, but has used aqueous potash, the action of which seems to be very different from that of alcoholic potash. Thus the latter forms an acid, $C_{12}H_{22}O_3$, not solidifying at − 10°. Fossek obtained with aqueous potash an acid, $C_8H_{16}O_3$, melting at 75°. The author prepared an aldehyd, $C_{12}H_{22}O_2$, and from this, by nascent hydrogen, an alcohol. By the action of stronger potash upon isobutyl-aldehyde, higher condensation products were obtained.—On a condensation product of phenanthraquinone with ethylic acetoacetate, by F. R. Japp and F. W. Streatfield. This substance has the formula $C_{29}H_{16}O_4$, and crystallises from benzene in white silky needles, fusing at 185°; it is ethylicphenanthroxyleneacetoacetate; by treatment with hydriodic acid it forms ethylicphenanthroxylenisocrotonate, fusing at 124°. A new acid and a new compound, which the authors believe to be the desoxybenzoin of phenanthrene, have also been obtained.—On the constitution of lophin, by Dr. Armstrong. The author considers that the symmetrical formula proposed by Radziszewski is to be preferred to that proposed by Dr. Japp.—On the constitution of basic ferric sulphate, by S. U. Pickering. By the determination of its molecular weight, this salt has the formula $Fe_2(SO_4)_3$, $5Fe_2O_3$.—On the chemistry of Hay and "Ensilage," by F. W. Toms.—On certain brominated carbon compounds obtained in the manufacture of bromine, by S. Dyson. In a bye product the author has detected carbon tetrabromide, bromoform, and chlorobromoformi—Note on the preparation of diphenylenketone ether, by W. H. Perkin.

Anthropological Institute, November 28.—General Pitt-Rivers, F.R.S., president, in the chair.—Dr. W. G. Parker read a paper on the language and people of Madagascar. The language belongs to the Malayo-Polynesian group, being most nearly allied to the Malay proper. The various dialects, numbering more than sixteen, are essentially only one language. It is soft, musical, phonetic, and easily learned by Europeans. Until the early part of the present century it was a spoken language only, but the English missionaries reduced it to its present form, our own English alphabet being adopted, with the exception of the letters *c*, *q*, *u*, *w*, *x*, which have no equivalent sounds in Malagasy. The vowels are four in number, and the consonants sixteen, pronounced as in English, with the exception of *g*, which is always hard (as in *gate*), and *j*, which has the sound of *dz* (as in *adze*). There are only two real diphthongs. In pronunciation every vowel or diphthong must be clearly sounded, and the accents properly placed, because often the alteration of one vowel, or of the place of the accent, is the only means of distinguishing similar sounding words. The author then gave the six chief rules of syntax, and explained the grammatical structure of the language. In the second part of the paper the peculiar geographical position of Madagascar was first noticed. Its estimated population (from four to four and a half millions), and its chief structural features, with a special notice of the central plateau. There are a great many tribes in Madagascar, but all are divisible into two distinct classes, according to their race-origin, Malay and African. Their forms of government are (1) petty absolute monarchies over the greater part of the island; (2) among the Hovas tribe it is nominally an absolute monarchy, really an oligarchy, the head of which has almost regal power. The office of *Prime Minister* is not peculiar to the Hovas, tribes on the north and west coasts also possessing the same institution; but only among the Hovas is the Prime Minister not only the factotum, but also the "ex-officio husband to the queen." A short sketch of the new code of Hova laws was next given, this being the only tribe which possesses a code of laws. An outline of the history of Madagascar was given, showing the origin of the present form of government among the Hovas, the tribe which seeks to possess the entire island. Lastly, reference was made to the French claims against Madagascar, now being put forward, and their effect upon British interests. These claims are: (1) the demand that French subjects should be allowed to buy, sell, and own land in Madagascar; (2) the claims of private individuals; (3) the establishment of a French Protectorate over a large part of the island. The French are now acting in accordance with a preconcerted (and published) plan for invading and conquering the whole of the island. As affecting the interests of the British Empire, the possession of Madagascar by France will enable that Power, if at war with us, to endanger or even stop our lines of communication with our Indian, Australian, and other colonies, by the Red Sea and the Cape of Good Hope route. In the discussion that followed the Rev. James Sibree, the Rev. W. C. Pickersgill, Prof. Gustav Oppert, Mr. A. H. Keane, and others took part.

BERLIN

Physiological Society, November 24.—Prof. Du Bois-Reymond in the chair.—Dr. A. Fraenkel read a paper upon the further results of experiments which he had made in conjunction with Dr. Geppert to determine the influence of a rarefied atmosphere upon the animal organism. Some of the results of these investigations had been brought before the last meeting of the Society by Dr. Geppert (*antea*, p. 120). Besides the general phenomena and the behaviour of the gases of the blood in animals which breathe in a rarefied atmosphere, investigations were made as to the influence of rarefaction upon blood-pressure. The blood-pressure was read off upon a manometer which was outside the box in which the animal, the subject of experiment, was kept exposed to various degrees of rarefaction. One arm of the manometer communicated through the side of the box with an artery of the animal, while the other arm was in communication with the general cavity of the box. When the atmospheric pressure sank to half the normal amount, the blood-pressure showed no change; when the pressure sank to a third of an atmosphere, a small rise took place in the blood-pressure. This rise, however, passed away during the sleep that occurred under the influence of this amount of rarefaction, and the pressure became normal again. When the air was still further rarefied till the pressure was as low as one quarter of an atmosphere or less, the pulse became weak and small, the blood pressure went down, and then if normal quantities of oxygen were not quickly restored, the heart stopped. The chief aim of the whole investigation was the definite determination of the influence of a rarefied atmosphere upon metastasis (Stoffwechsel), upon which question, up to the present, only few, and even these contradictory, data were existent. The authors agreed in general with M. Paul Bert, in regarding the effect of a rarefied atmosphere as inducing a chemical change which was brought about by a diminished supply of oxygen. The amount of urea secreted in the twenty-four hours was taken as the measure of metastasis. During a lengthened period of observation on those days in which the animals thus experimented on had the same amount of food, the quantity of urea secreted in the twenty-four hours remained constant. Nor was there any alteration in the amount of urea when they were exposed to variations of pressure down to half an atmosphere.

On the diminution of the pressure to one third of an atmosphere, at and under which pressure the amount of oxygen contained in the blood is markedly diminished, and the animal falls into a deep sleep, there was, after this degree of rarefaction had lasted several hours, a very remarkable increase in the amount of urea. This increase did not occur till the next day in the case of animals which had been fed, whereas it occurred on the day of the experiment in the case of those animals which were kept hungry, but it in all cases lasted over a couple of days after the experiment. Dr. Fraenkel's belief is that the rarefaction influences the metastasis by depriving the blood and the tissues of some of their necessary oxygen, and that this want of oxygen entails an excessive destruction of albumen, the constituents of which are in part deposited as fat, and in part are changed into urinary products. Besides the increased elimination of urea, fatty degeneration of tissues (*e.g.* of the heart) is observed when the system is in want of oxygen.

PARIS

Academy of Sciences, December 11.—M. Jamin in the chair.—M. Faye presented the *Connaissance des Temps* for 1883, and noted some improvements.—Observation of the transit of Venus in the Argentine Republic, by M. Mouchez. Good observations were made at the two stations, by MM. Beuf and Perrin.—M. Mouchez stated that the weather prevented observations on the Pic du Midi.—Installation and preliminary operations of the mission for observation of the transit of Venus, at Fort-de-France, by M. Tisserand.—Observations of the transit at Marseilles Observatory, by M. Stephan. There were five observers. The phenomenon was seen through a veil of vapours, and M. Stephan does not think this unfavourable; perhaps, indeed, it is the best condition possible (the solar intensity being weakened), if the observer do not lose his *sang-froid*, through fearing too great obscuration. The black drop was not seen. (Data for the first two contacts are furnished.)—New facts concerning rabies, by M. Pasteur, with MM. Chamberland, Roux and Thuillier. All forms of rabies come from the same virus. Death after inoculation with rabid saliva may be either from a microbe found in the saliva, from formation of much pus, or from rabies. The virus of rabies is found not only in the *medulla oblongata*, but in the brain and spinal cord. Rabies may be produced certainly and quickly, either by trepanation and inoculation, or by intravenous injection. The symptoms are different in the two cases. Animals sometimes recover after the first symptoms of rabies, never after the acute symptosm. The authors have now four dogs which cannot take rabies, however inoculated. Whether this is from having had a mild form of it and recovered, or from being naturally refractory, he cannot at present say.—Separation of gallium, by M. Lecoq de Boisbaudran.—New studies tending to establish the true nature of *glairine* or *barégine*, and the mode of its formation in the thermal and sulphurous waters of the Pyrenees, by M. Joly. The concrete glairine of chemists, found in all those waters, consists essentially of detritus of a host of animals and plants, with some inorganic substances (crystals of sulphur, sulphate of iron, silica, &c.), and very often *Sulphuraria*, a true *Oscillator*.—On the conservation of solar energy; reply to Dr. Siemens, by M. Hirn.—Examples of black seen as orange red, by M. Trécul. A lady's black veil, in full sunlight, seemed orange red at the nodes of the tissue, while the internal parts remained black. The dye in this case was a very dark blue; and the orange-red is complementary.—Effects of lightning on the top of the Puy-de-Dôme, by M. Alluard. The anemometer cups (of red copper) at the top of an iron mast (6 m. high, and having a ladder and stand largely iron; also connected with earth plates), all show traces of fusion in their upper parts, and the fused matter is raised as a cone. (St. Elmo's fire often appears at the salient points of the mast, &c.)—Observations made during the viticolar campaign 1881–82, by M. Boiteau.—Factitious purulent ophthalmia produced by the liquorice Iana, or jequirity, by M. Moura-Brazil.—M. de Lesseps presented a note on M. Wiener's explorations in the regions of the Amazon.—The Secretary read telegrams from Brazil, Washington, Oran, Nice, Bordeaux, &c., regarding the transit of Venus.—Observation of the transit at Châtsandun, by M. Lescarbault. He describes a greyish yellow luminous fringe seen all round the planet when this was three-fourths on the sun; it persisted till entrance was completed.—Observations of the transit at the Roman College, by P. Tacchini. He observed the contacts successfully with the spectroscope applied to a Merz refractor; while Prof. Millosevich observed in the ordinary way. He verified the absorption by the Venus atmosphere, found the planet's diameter 67″·25, &c.—Observations of solar spots and faculæ during the third quarter of 1882, by the same. The spots show a diminution, with well-marked secondary minimum in August. The faculæ had nearly the same extension as in the preceding quarter. While their size diminishes, that of the spots increases.—On the great solar spot of November, 1882, and the magnetic perturbations that accompanied its appearance, by the same. It showed maximum activity at the middle of the disc, and afforded the rare opportunity of distinguishing solar protuberances in the disc as easily as on the limb.—Observations of the great Southern Comet, by M. Jacquet. A sketch is furnished, taken on board the *Niger*, at the mouth of the Rio de la Plata.—On Fourier's series, by M. Halphen.—On solids of equal resistance, by M. Léauté.—On a communication of M. Deprez, relative to the transport of force, by M. Lévy.—Displacements and deformations of sparks by electrostatic actions, by M. Righi.—On the atomic weight of yttrium, by M. Cléve. He obtains 89·02 and 88·9, with different values for O and S.—On a fish at great depths in the Atlantic, the *Eurypharynx pelecanoides*, by M. Vaillant. This was brought up from a depth of 2300 m. off the coast of Morocco, during a cruise of the *Travailleur*. It is about a foot and a half long, quite black, and remarkable for its enormous and disproportionate mouth (like a pelican's). It has no swimming-bladder and few fins, peculiar branchiæ, &c. The genus *Malacosteus* seems the nearest.—On a new fossil insect of the order of Orthoptera, from the coal-mines of Commentry (Allier), by M. Brongniart. It is of remarkable size, and is named *Titanophasma Fayoli*. The author canot say whether it was winged or not.—On the meteorological fauna of the Varangerfjörd, by MM. Pouchet and de Guerne.—The Suctociliates, a new group of Infusoria, intermediate between the Ciliates and the Acinetians, by de Merejkowsky.—Influence of excitability of muscle on its mechanical work, by M. Mendelssohn. For a certain tension the mechanical work of a single contraction of a more excitable muscle is greater than that of a muscle of normal excitability. But the number of successive works the former can do till exhaustion, and their sum total, is less; and the length of time it can perform a series of works with a given load, till exhaustion, is less.—Vegetation of wheat by M. Risler.—Conditions of production of Epinastia in leaves, by M. Mer.

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THURSDAY, DECEMBER 28, 1882

MATHEMATICS IN AMERICA

American Journal of Mathematics, Pure and Applied. Published under the Auspices of the Johns Hopkins University. Vols. III. and IV. (Baltimore: Isaac Friedenwald.) And other Mathematical Journals.

THE *American Journal of Mathematics* was established in 1878 under the auspices of the Johns Hopkins University at Baltimore, and four handsome quarto volumes of 400 pages each have now been published. Prof. Sylvester was editor-in-chief of the first three volumes, being assisted by Mr. Story as editor-in-charge, but the last volume bears Sylvester's name alone as editor.

A notice of the first two volumes of the Journal appeared in NATURE, vol. xxii. p. 73, and the hope was there expressed that it might have as great a future before it as awaited Crelle's Journal half a century before. A careful examination of the last two volumes shows that the promise of the earlier volumes has been so far maintained, and that the Journal has already acquired a distinctive character of its own. It almost invariably happens that mathematical journals exhibit marked characteristics, and that certain branches of the subject occupy a pre-eminent position. One paper leads to another relating to the same questions, and the original bias of a journal is generally due, both directly and indirectly, to its editor, as authors naturally prefer to send contributions where they are more likely to be understood and appreciated. That this is especially the case with the American Journal is what we should expect, as besides being the principal contributor, the editor is professor in the institution with which it is connected, and many of the papers are by his former pupils and colleagues. Although a very distinct tendency is thus evident in the direction of the large group of subjects (and more particularly Higher Algebra and Higher Arithmetic) with which the name of Prof. Sylvester is associated, it is not to be supposed that the Journal has become narrow in its scope. On the contrary, the whole range of mathematical subjects is very fairly represented, as will appear from the following paragraphs, which contain a list of the papers in vols. iii. and iv., an attempt being made to group them to some extent according to subjects.

The arithmological papers are numerous. Prof. Sylvester gives closer limits for a quantity which occurs in Tchebycheff's well-known investigation of the number of primes inferior to any given prime; he contributes also a note on the trisection and quartisection of the roots of unity, and an instantaneous proof of a theorem of Lagrange's on the divisors of a certain quadratic form. In a paper on a point in the theory of vulgar fractions he gives a method of developing any vulgar fraction as a sum of certain special fractions, each having unity as its numerator. This development he terms a sorites, and he remarks that it was suggested to him by the chapter in Cantor's *Geschichte der Mathematik*, which gives an account of the singular method in use among the ancient Egyptians for working with fractions: it was their curious custom to resolve every fraction into a sum of simple fractions according to a certain traditional method, which however only leads in a few simple cases to a sorites. There are two papers by Mr. O. H. Mitchell, both relating to the theory of congruences: one of them contains a generalisation of Fermat's and Wilson's theorems. There is also a short note by Prof. Newcomb on the relative frequency of the occurrence of the digits as leading figures in logarithmic tables.

The contributions to the higher algebra occupy a very conspicuous place. The important tables of the generating functions and ground forms of binary quantics which have been calculated by Prof. Sylvester and Mr. F. Franklin, with the aid of a grant from the British Association, are continued. Mr. Franklin is also the author of a separate paper, in which he gives a consecutive account of the methods, due to Cayley and Sylvester, of calculating the generating functions for binary quantics and thence determining the number of fundamental invariants and covariants of any order and degree. Prof. Sylvester gives a determination of the impossibility of the binary octavic possessing any ground form of degree 10 and order 4. There is a paper on the 34 concomitants of the ternary cubic by Prof. Cayley, who also gives a specimen of a literal table for binary quantics and certain tables for the binary sextic; and there are some notes on Modern Algebra by M. Faà de Bruno, of Turin. Mr. Mitchell and Mr. T. Muir, of Glasgow, give theorems relating to determinants.

Prof. Wm. Woolsey Johnson is the author of a paper on strophoids. The term strophoid has been applied by French writers to a cubic curve, the symmetrical form of which Dr. Booth discussed under the name of the Logocyclic curve. The author gives to the term a more extended signification, and defines a strophoid as the locus of the intersection of two straight lines which rotate uniformly about two fixed points in a plane. Dr. Booth's curve is included as a particular case of the class of curves which Prof. Johnson terms right strophoids. Prof. Sylvester considers the theory of rational derivation on a cubic, and Mr. Story is thus led to discuss the subject more fully in a separate memoir: the points on the curve which are considered are those whose coordinates can be expressed as rational functions of an arbitrary initial point on the curve. Mr. Samuel Roberts contributes a paper on the generalisation of local theorems, in which the generating point divides a variable linear segment in a constant ratio; and there is a note by Miss Christine Ladd on segments made on lines by curves.

There are three papers on solid geometry, all by Mr. T. Craig: they relate to the orthomorphic projection of an ellipsoid upon a sphere, to certain metrical properties of surfaces (in n dimensions as well as in three dimensions), and to the counter-pedal surface of an ellipsoid. The surface which the author designates the counter-pedal is the locus of the intersections of central planes parallel to the tangent planes of the ellipsoid with the normals at the corresponding points of contact; its equation is worked out, and is found to be of the tenth order. Mr. E. W. Hyde contributes a note on the centre of gravity of a solid of revolution, and there is a discussion by Prof. Stringham on the regular figures in n-dimensional space.

Prof. Cayley gives a note on the analytical forms or

ramifications which he has termed trees. This is a subject which has applications to the theory of chemical combinations, and it is one to which Prof. Cayley has already devoted attention, a long memoir of his upon it having appeared in the Report of the British Association for 1875. Prof. Cayley also is the author of a short paper on certain imaginaries connected with the product of two sums of eight squares. Among papers on general analysis should also be mentioned a determination by Prof. Stringham, of the number of possible finite groups of quaternions, a group being defined as in the theory of substitutions; and a note by Mr. Story on non-Euclidean geometry.

A number of papers relate to the differential calculus. There are two by Prof. Sylvester on the solution of classes of difference and differential equations. No less than four relate to development in series by Taylor's and other expansion theorems and the forms of the remainder: these are by Mr. J. C. Glashan of Ottawa, Mr. McClintock, and Mr. A. W. Whitcom. Prof. Crofton gives some remarkable theorems involving symbols of operation, and Mr. J. Hammond considers the theory of general differentiation, a subject that received attention from Liouville, Peacock, and others half a century ago, but which has attracted but little notice in recent times. Mr. Franklin contributes a short note on Newton's method of approximating to the roots of equations, and Mr. Glashan gives certain formulæ relating to the change of the independent variable in differentiations.

More than one whole number is devoted to a reprint of the late Prof. Benjamin Peirce's valuable memoir on Linear Associative Algebra, of which only a small number of copies in lithograph were made in the author's lifetime for circulation among his friends. This well-known paper was read before the National Academy of Sciences at Washington in 1870: it is here reproduced with notes and addenda by Mr. C. S. Peirce, the son of the author, and occupies 133 pages. Mr. C. S. Peirce himself, who is known not only by his logical writings but by his stellar photometric researches, is also the author of two papers, the one on the algebra of logic and the other on the logic of number. In connection with this subject a paper by Miss Ladd on De Morgan's extension of the algebraical processes should be noticed.

There is a short bibliographical paper relating to Alhazen's problem by Mr. Marcus Baker. The problem is from two points in the plane of a circle to draw lines meeting at a point on the circumference, and making equal angles with the tangent at that point. The author also gives an extension of the problem to the sphere.

Only three papers belong to mathematical physics. One, by Prof. H. A. Rowland, relates to the general equations of electromagnetic action, with application to a new theory of magnetic attractions and to the theory of the magnetic relation of the plane of polarisation of light. The other two are on hydrodynamics, they are by Prof. Rowland and Mr. Craig, and relate respectively to the motion of a perfect incompressible fluid and to certain possible cases of steady motion in a viscous fluid. There are some notes on moving axes by Prof. Loudon of Toronto; and Prof. Sylvester considers the theory of mechanical involution, which is the name he has given to the relation between six lines in space so situated that forces may be made to act along them whose statical sum is zero. Linkages form the subject of a paper by Mr. F. T. Freeland.

Astronomy is represented by two papers: one by Prof. Newcomb, on a method of developing the perturbative function of planetary motion; and the other by Mr. G. W. Hill, on Hansen's general formulæ for perturbations. The object of the former paper is to exhibit a method of effecting the development in powers of the eccentricities. The author remarks that in consequence of the complex character of the series this development has been but little used even in the cases of nearly circular orbits, when its application would be most convenient, but that, as the disturbing force is given as an explicit function of all the elements, it is of more interest to the mathematician than any other. In his method of development Prof. Newcomb directs especial attention to the expression of the coefficient of each power of the eccentricity in terms of the coefficients of lower powers, and to the expression of the coefficient in each term involving the perihelia of two planets as the symbolic product of coefficients involving the perihelion of one only. Mr. Hill's paper contains a transformed form of Hansen's expression for the perturbation of the mean anomaly, which is more simple and more convenient for computation. There is also a short note by Mr. Ormond Stone relating to formulæ in elliptic motion.

The titles of the papers speak for themselves, and but little comment is needed. It will be seen that the two volumes represent a considerable amount of mathematical work, a fair proportion of which may have real influence on the advancement of the science. Some of the papers, as must evidently be the case, are needlessly pretentious in form, and the new matter they contain might be advantageously stated in less space. The effect of Professor Cayley's visit to Baltimore is apparent in the papers which occur in the last number issued, and we believe that the lectures which he gave at the Johns Hopkins University will shortly appear in a future number.

The dates which the numbers of the Journal bear are the dates when they ought to have appeared, assuming it to be published quarterly in March, June, September, and December, and not the dates when they did actually appear. Thus the last number issued bears date December, 1881, but in the case of this number the inconvenience attending so great a discrepancy between the nominal date and the date of publication is partially remedied by the words "Issued July 18, 1882," at the foot of the last page. It seems a pity to retain the nominal dates on the wrappers, as they may be misleading. It will be difficult to regain the lost time, and there is but little advantage in stating the time when the number should have appeared. The volume and number and date of publication are all that need to be given.

On the wrappers of the numbers of vol. iv. appears an announcement in which a prize of 1500 francs and a perpetual free subscription to the journal from its commencement are offered to the first person who, before January 1, 1883, discovers and transmits to the Editor a valid proof or disproof of the proposition that a ground form and a syzygant of the same degree and order cannot appertain

to the same binary quantic, "provided that the Editor shall not himself have previously discovered the same, and given public notice thereof." The truth of this proposition has been assumed as a fundamental postulate in the calculation of ground forms, and its importance cannot be over-estimated. It is, however, somewhat of an anachronism to draw attention to it by the offer of a prize. Such prizes exist in Universities and in the older academies, but by many they are not regarded with much favour. It seems unlikely that any competent person would be tempted to investigate the subject by hope of the reward. Pure mathematics offers no mercenary inducements to its followers, who are attracted to it by the importance and beauty of the truths it contains; and the complete absence of any material advantage to be gained by means of it, adds perhaps even another charm to its study.

The late Prof. Benjamin Peirce denoted the base of the Napierian logarithms and the ratio of the circumference to the diameter of a circle by two special symbols turned opposite ways, somewhat resembling a 6 and a 6 reversed. The forms of these symbols would seem to imply that 2·71828... and 3·14159... were regarded as allied to one another, and in some reciprocal or inverse manner too, though it is not easy to see what the author's point of view was. Two writers in the *American Journal* use Prof. Peirce's symbols in place of π and e, and this is to be regretted, as any departure from the recognised notation in elementary matters is always unfortunate. Even if the symbols were happily chosen, which does not appear to be the case, they would require the cutting of new type, and it is absolutely certain that there is not the least chance of their general adoption. If now used by a few prominent writers in America, they may spread to such an extent as to make it very difficult for their successors to get rid of them. The preservation of the international character of mathematical notation is of paramount importance, and the existence of local notations, especially when they find their way into text-books, is a calamity. In England the Cambridge notations, $\sin^{-1}x$, due we believe to Herschel and Babbage, and the factorial notation due to the late Prof. Jarrett, are still retained by many English writers, although it has long been evident that there is no chance of their adoption by continental mathematicians. It is always desirable to adhere to an established notation, if it is generally understood and accepted, even if it is unsatisfactory, rather than attempt to replace it by a better one, unless there seems very good reason to suppose that the attempt will be successful.

In the previous article in NATURE reference was made to the services which Dr. J. E. Hendricks, of Des Moines, Iowa, has rendered to mathematics in America by the publication of the *Analyst*, which he established in 1874, and has continued to the present time. This journal is published every two months, and has now completed its ninth volume. In spite of typographical and other difficulties the editor has published it regularly, and it shows no signs of diminished vitality or interest on his part. It has been self-supporting, and its success is due to the genuine love of their subject felt by the editor and the contributors. A great part of each number is unfortunately devoted to problems—the lowest form of mathematics—and the space available for more valuable matter is thus considerably diminished. One also is tempted to wish that the editor would show greater strictness in curtailing or excluding the writings of certain contributors, but nevertheless the *Analyst* contains not a few useful papers. It is easy to see the blemishes in such a journal by merely turning over the pages, but it is not so easy to estimate the services which it confers upon science by inducing teachers to look beyond the text-books and interest themselves in a subject for which a genuine taste can only be acquired by attempting to do work for oneself. The large quarto page of the *American Journal* and the elaborate nature of some of its papers render it unsuitable for the short notes and the more unpretentious class of papers in which the author lays but little claim to originality. For these the *Analyst* is available; but, after all, the chief value of such a publication consists in the interest in mathematics it excites and fosters in those who could be reached in no other way, and the inducement it affords for those who are unable to devote their whole time to the subject to nevertheless undertake useful and profitable work. No previous American mathematical journal has ever been published regularly for nine years, and Dr. Hendrick has reason to feel proud of the success of his efforts.

In 1877 Mr. Artemas Martin, of Erie, Pennsylvania, issued the first number of the *Mathematical Visitor*, a quarto journal which was published annually until Jan., 1880, and since then has appeared semi-annually. The first volume ended with the number published in January, 1881. The journal consists entirely of problems and solutions, there being a senior and a junior department. Several of the problems relate to probability questions and involve very complicated and elaborate integrations. As the solution of a prize question, Mr. E. B. Seitz gives, in the number for January, 1879, the values of the coefficients obtained by reverting a general series proceeding by ascending powers of the variable, as far as the sixteenth order. The journal is beautifully printed, and is set up by the editor himself. In the number for January, 1880, he says: "This number of the *Visitor* has been delayed some months, in consequence of the sickness of the editor, who has done all the type-setting with his own hands. He is not a practical printer, and never had set up a stickful of type till last May or June."

At the beginning of the present year Mr. Martin issued, besides the *Visitor*, a new publication, entitled *The Mathematical Magazine: a Journal of Elementary Mathematics*, of which four numbers have now appeared. It is of large quarto size, and, like the *Visitor*, is printed by the editor's own hands. No mathematical journal, if it is to contain anything of real value, can be elementary. Mathematics is an old science, and the really elementary parts of it must be acquired from text-books and by means of the examples which the student works out for himself as exercises. Elementary mathematics is a subject for the school-room, but is unsuitable for a journal, and such a publication as Mr. Martin's, if it continues elementary, is educational rather than scientific. In no instance, we believe, has it been found possible to restrict a mathematical journal really to the elements of the subject alone, though of course elementary articles, and articles which are of interest to junior readers, form

a considerable portion of each number of some mathematical publications. Mathematical investigations that are really valuable can never be made elementary, and the questions that can be treated by elementary mathematics are too trivial to deserve recognition in a scientific journal.

We may notice a demonstration of Euclid i. 47, by the late General Garfield, which appears in the first number. If the figure is completed it is in fact an intuitive geometrical proof that $(a+b)^2 = c^2 + 2ab$, where a and b are the sides and c the hypotenuse of a right-angled triangle. The construction is to divide the four sides of a square each into two parts, a and b, in the same order, and to join the points of division. Each of the joining lines is thus equal to the hypotenuse c, and the whole square, $(a+b)^2$, is evidently equal to the inside square, c^2, and the four triangles in the corners, each of which is equal to $\frac{1}{2}ab$. The figure is practically the same as in the well-known proof in which the squares a^2 and b^2 are placed side by side and divided by only two lines in such a manner that the parts may be moved by mere translation (without rotation) so as to form the square c^2, but the special features which give this proof its remarkable elegance are absent. Garfield's proof is Indian in its character, and must have been known to Bhascara, but in the rather more elegant one given in the Vija Ganita (1150) the lines are drawn from the angles of the square c^2 parallel to the sides of the triangle, and include a square $(a-b)^2$, each of the triangles in the corners being $\frac{1}{2}ab$ as before, so that the theorem proved is $c^2 = (a-b)^2 + 2ab$. If the points of division in the figure in § 150 of the Vija Ganita, in which it is shown that $(a+b)^2 - 4ab = (a-b)^2$ are joined, the figure includes both Garfield's and the Hindoo constructions. The construction given by Garfield must have been of course discovered over and over again, and, on its own account, it is so self-evident as only to be interesting historically in connection with the Indian proofs.

If therefore we include among journals one published at such long intervals as half a year there are now no less than four journals, devoted exclusively to mathematics, published in the United States.

With reference to the list of mathematical journals given in the previous article in NATURE, it may be mentioned that the Belgian journal, the *Nouvelle Corréspondance Mathématique*, which was edited by M. Catalan, with the co-operation of MM. Mansion, Brocard, Neuberg, and others, was discontinued at the end of 1880. It has been replaced by a new journal, *Mathesis*, which has since been published monthly under the editorship of MM. Mansion and Neuberg, and has now completed its second volume. In this journal the titles of elementary articles are marked by a cross; there are not on the average more than one or two so marked in each number.

A new Scandinavian mathematical journal is shortly to appear under the editorship of Prof. H. G. Zeuthen, of Copenhagen, and Prof. Mittiag-Leffler, of Stockholm. It is to be hoped that it has a great scientific career before it, and assuredly no journal will bear on its title-page the names of more illustrious mathematicians, or will have started under more favourable auspices.

J. W. L. GLAISHER

QUAIN'S "ANATOMY"

Quain's Elements of Anatomy. Edited by Allen Thomson, E. A. Schäfer, and G. D. Thane. Two volumes. Ninth edition. (London: Longmans, Green and Co., 1882.)

Lehrbuch der Neurologie. Fortsetzung von Hoffmann's "Lehrbuch der Anatomie." Von Dr. G. Schwalbe. (Erlangen: Eduard Besold, 1880 and 1881.)

THE appearance of a new edition of Quain's Anatomy is always regarded with attention and interest by teachers of anatomy. The high reputation of its successive editors, Richard Quain, William Sharpey, G. V. Ellis, Allen Thomson, and John Cleland, and the care which has been taken to revise each edition and to incorporate with it the latest additions to anatomical knowledge, have caused this work to be universally regarded as an authority, and have gained for it the position of a standard treatise on Human Anatomy.

The new edition, the ninth, which has just appeared, has been prepared under the editorial supervision of Professors Schäfer and Thane, and Dr. Allen Thomson. The first volume, which has been revised by Prof. Thane, contains the descriptive anatomy of the bones, joints, muscles, blood-vessels, but not the heart; cerebro-spinal and sympathetic nerves, but not the brain and spinal cord; with a chapter on superficial and topographical anatomy, in which the editor has been assisted by Mr. R. J. Godlee. The second volume has been for the most part revised by Mr. Schäfer, and contains the histology, and the anatomy of the viscera, including the heart and central organs of the nervous system; whilst a special chapter on embryology has been written by Dr. Thomson.

The separation of the anatomy of the heart from that of the other parts of the vascular system, as well as of the anatomy of the brain and spinal cord from the nerves which arise from them, and from the sympathetic system, both of which are so intimately connected both anatomically and physiologically with both brain and cord, was first made in the eighth edition; for prior to that time they had always been described along with, and as parts of their respective systems. This arrangement, which is also carried out in the present edition, is, in our judgment, most unphilosophical, for it both destroys the continuity of description, and leads the student to dissociate in his mind the origin of the nerves and blood-vessels from their distribution. Such a dissociation might indeed, as regards the nervous system, have been excusable at the time when both the distributory portions of the cranial and spinal nerves and the sympathetic system were believed to be developed quite independently of the cerebro-spinal axis, and only to become connected with it secondarily. But now-a-days, since through the researches, more especially of the much-lamented F. M. Balfour, both the cranial and spinal nerves and the sympathetic have been shown to be true offshoots of the cerebro-spinal axis, and like it of epiblastic origin, to dissociate them, even for descriptive purposes, in a systematic text-book, is, we believe, injurious to real progress. The editors of "Quain" would, we suppose, scarcely think of describing in one volume the gangliated cord of the sympathetic, and in another the nerves which arise

from it, and yet to do so would not be more illogical than the course they have pursued of separating the description of the cranio-spinal nerves from that of the central nervous axis. If the anatomical description of the human body is ever to be put on a scientific basis, it must be founded on the facts of comparative anatomy and of development, and the great aim of descriptive writers should be to accommodate their descriptions to these facts.

After this protest against some features in the general arrangement of the book, we may now glance at the manner in which the process of revision has been performed by the different editors. The first volume bears throughout the mark of careful revision by Prof. Thane. We have compared many of the descriptions with those of the corresponding structures in the immediately preceding edition, and we notice many changes both in the matter, and in the mode of expression. Various redundancies have been expunged, errors have been corrected, new facts have been introduced, and to some extent the descriptions generally have been re-arranged. Several new woodcuts have been inserted, and those illustrating the vascular system have been made more diagrammatic by colouring the arteries red and the veins blue. We notice, however, that Prof. Thane, as is unfortunately only too common with some English human anatomists, does not properly discriminate between the meaning of the terms mesial line and mesial plane. In his description, for example, of the recto-vesical portion of the pelvic fascia, he speaks of its being "continuous from side to side across the middle line in front of the bladder," forgetful apparently of the fact that the descriptive term "middle line" expresses a line on the surface, either anteriorly or posteriorly, as the case may be; whilst the imaginary plane between these anterior and posterior mesial lines is the mesial plane of the organ or region.

The greatest amount of change, however, as was naturally to be expected from the subjects discussed in it, has been made in the second volume, and more especially in the chapters edited by Mr. Schäfer. The important section on General Anatomy, or Histology, has been in some measure re-arranged, and many of its chapters re-written. The latest investigations into the structure of the nucleus, the part which if plays in the multiplication of cells, and the process of maturation of the ovum, have been explained and illustrated by woodcuts. The description of the structure of the individual tissues has obviously been carefully revised, and various changes both in the way of addition and omission have been made. Not the least important is the addition to each chapter of the titles of the most recent papers on the subject-matter of the chapter.

If we were disposed to be very critical, we could undoubtedly lay our fingers upon more than one statement to which objection could be taken. And there is indeed one point that we cannot pass over without notice, as it illustrates that in the comparatively small matter of editing a work on anatomy, as in the much larger subject of administering the finances of Egypt, a Dual Control has many disadvantages. Mr. Schäfer, for example, in his references to the layers of the embryo, in which the several tissues take their rise, employs the terms ectoderm, mesoderm, endoderm, to express the three layers of the blastoderm, and in this respect adopts the nomenclature most commonly used by German anatomists; whilst Dr. Thomson, in his references to the same layers, almost invariably speaks of them as epiblast, mesoblast, and hypoblast, which, indeed, are the terms commonly in use amongst British anatomists. The employment in different sections of the same work of two distinct words to express the same structure, is an error in judgment, and certainly not to the edification of the student.

The chapter on the spinal cord and brain has also been greatly modified, and in re-arranging it Mr. Schäfer has largely availed himself of the book, the title of which stands second at the head of this article. The history of this book is somewhat curious. Originally it appeared as a German translation of an earlier edition of "Quain," edited by Prof. Hoffmann. Then, somehow or other, the name of Quain dropped out of the title in the later German editions, and now, as regards the chapters on the Nervous System, written by Prof. Schwalbe, it is essentially a new book, and in our opinion contains the best account of the anatomy of the nervous system in man which has yet been published.

Of the section on Embryology, prepared by Dr. Thomson, we have not space to say more than that it narrates in a convenient compass the successive series of changes which result in the formation of the adult human body; that the descriptions are clear, well arranged, and embrace the latest investigations; and that on points under dispute the author expresses himself with reservation and caution, in a manner characteristic of the writings of this anatomist.

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 ensure the appearance even of communications containing interesting and novel facts.*]

Transit of Venus, December 6

In the morning here the sky was clear, and the sun remarkably free from spots. I noticed only 4 small ones on the disk: quite a contrast to the monstrous appearance a month ago.

Being neither equipped nor qualified for technical astronomical observations, I did not attempt to do more than to give a popular demonstration of the transit of Venus to between 30 and 40 friends interested in the phenomenon. My experience of stargazing was chiefly obtained upwards of 50 years ago, before I became otherwise occupied; and then I found for myself, that the best way of studying solar phenomena, whether eclipses or spots, was by projecting on white paper or cardboard, the image of the sun from the telescope, focussed a little beyond the point for direct vision through the dark eye-glass; extraneous sunlight being shut out by a napkin suspended around the telescope. I presume that this method is well known, and it seems to have been adopted, (with the additions of a dark chamber) by Mr. Campbell of Islay, in the exhibition of the transit at Cannes, so well described by the Duke of Argyll in NATURE (p. 156). In this way with a small achromatic of 32 inches focal length, and 2¼ inches aperture we saw well all the chief features of the transit, (which I need not describe, as this has already been done by more competent observers), and this without fatigue to the eyes, and the unnatural colouring, inseparable from looking through the telescope with darkened glasses. Further, as the time of sunset approached, at about 3.30 p.m., we had in our camera view the additional charm of the colours

of the objects in view. As, in the Italian sky the golden orb sank with the dark planet spot on its disk, under brightly tinted clouds, shaded off in streaks of tender grey into the azure above, with the blue rose-tipped mountains of the Esterets beneath,—the scene was one as fascinating in beauty as it was interesting in science. All these tints appeared distinctly, albeit faintly, in the telescopic image on the card.

One point was remarkable,—that whilst the shades of the mountains were all *blue*, the dark round spot of the planet on the sun was almost *black*. It was the darkest object in the field of view. Partly, but I hardly think entirely, this may be explained by its being higher, and less subjected to the decomposing power of the lower atmospheric layers. I have endeavoured to represent in water-colours this view of the transit of Venus. The result, of course, cannot be reproduced in print, but any of your readers who may be visitors at Cannes will be welcome to see it, as an original kind of reminiscence of a very rare event.

C. J. B. WILLIAMS

Cannes, December 21

The Comet during the Last Month

SINCE my last communication (see NATURE, vol. xxvii. p. 110) the weather and the presence of moonshine has been unfavourable for views of the comet; but I have seen it, more or less distinctly, on seven nights, from November 22 to December 21. I will not take up your space with details, but mention, as the general result of these observations, that the comet has become smaller in dimensions, and much fainter in its light. With moonlight, no trace of a tail is visible; and the nucleus can only be discerned by telescope as a nebulous star of third magnitude. In absence of moonlight, as on December 6, 8, and 12, between 2 and 3.30 a.m., the tail was visible to a length of about 10°, with a breadth expanding from the head, with no distinguishable outline. My last view of it was on the 20th, at 3 a.m., when, with a brilliant starlight after moonset, the comet was in the south-south-east, about 20° above the horizon, with a tail about 8° long, and a nucleus, a nebulous star of third or second magnitude. Its position was about as far to the east-north-east of Procyon as that star is east-south-east of Sirius. It seems likely to be visible in clear moonless nights for two or three weeks longer.

C. J. B. WILLIAMS

Cannes, December 21

The Heights of Auroras

THE observations described in your last number as having been made long since in Siberia, of lunar halos projected on auroras, have not, I believe, been confirmed by other observers; but if correct, possibly this phenomenon may be a peculiarity of auroras in Siberia, or in the Arctic regions. There seems reason to think (see Capron's "Auroræ," pp. 37-40) that auroras may be lower when near the magnetic pole than further south. If this is the case, it is so far favourable to the theory (propounded, I think, by a German writer) described in NATURE (Vol. xxv. p. 320), that the auroral zone is a plane, and not part of a sphere concentric with the earth's surface. The majority of the observations in lower latitudes cited in Capron's "Auroræ," place the phenomenon at a height of 100 miles or upwards.

The height of the spindle-shaped object seen in the aurora of November 17 is thus no argument against its auroral character, which I see no reason to doubt. It is true that in my experience (which, in this northern part of the country is probably much greater than that of your correspondents), I have never seen anything resembling it, judging from the descriptions of it; but I do not think this is a reason for supposing such an auroral phenomenon could not take place. The fact that it moved along a parallel of magnetic latitude is a very strong argument for its auroral character. Besides, its spectrum is stated to have exhibited the characteristic auroral line. I hope some one will collect all possible observations of this beam, especially from the continent, and undertake a careful investigation into its path and height.

T. W. BACKHOUSE

Sunderland, December 23

The Aurora and its Spectrum

IN reference to Mr. Ralph Abercrombie's letter (NATURE, vol. xxvii. p. 173), I may mention that his remarks quite accord with an opinion expressed to me by my friend, H. R. Procter, that the "aurora is generally formed in some imperfect mist or vapour." I am intending some experiments on discharges *in vacuo* under such conditions and reduced temperatures, also on phosphorescence, in connection with which M. Lecoq de Boisbaudran has shown in his "Spectres lumineux," that we get a line in the red, brightening as the temperature is reduced. I do not read the result of my Swan lamp experiment, as Mr. Munro (same number and page) does. The lamp, when perfect, gave quite a bright white glow, with a strong carbon spectrum. I should therefore attribute the absence of the nitrogen spectrum at this time not so much to a high spectrum as to the probability that the lamp had been, as far as possible, exhausted of air, and filled with some form of carbon gas. I am not aware of any air-vacuum point at which the nitrogen bands or lines disappear, except for want of light in the discharge. With regard to the letter of W. M. F. P. on the "Meteor of November 17th," I only assumed the correctness of the figures and heights quoted in mine for the purpose of showing the complex nature of the auroral questions. I am not the less perfectly satisfied that the "beam" was a true aurora, and not a meteor, my spectroscopic observation of it putting this beyond a doubt.

J. RAND CAPRON

Guildown, December 23

The Weather

IT is curious how the recent auroræ have been followed not only by a cold wave, but by a subsequent warm one, and these respectively of such extremes, that 21° at 9 a.m. on the 11th is this day replaced by 48° or 27° of difference. Equally strange have been the effects on animal and vegetable life. During the cold, an almost Arctic season in its ice-bound stillness prevailed, and a flock of wild geese crossing in front of the house (the forerunners, in public opinion, of a hard winter) represented external creature life. Now all is changed almost to spring. Roses, though somewhat nipped by the frost, seem ready to blow; flies and gnats are unthawing, and last night, in going up to the observatory, I noticed the phosphorescent glimmer of a luminous centipede under one of the shrubs, a sight I do not remember ever to have met with in winter before.

J. RAND CAPRON

Guildown, December 19

A Common Defect of Lenses

A CHANCE observation a few weeks since led me to the discovery of a serious defect in the object-glass of the collimator of a spectroscope by Grubb, of Dublin, which I have been using for some time. As further investigation has shown me that the defect is very common, while at the same time it is a source of considerable error in all experiments on the plane of polarisation of polarised light, it seems worth while to call the attention of readers of Nature to it. The object-glass in question has been imperfectly annealed. As a consequence, a plane polarised incident beam is elliptically polarised on emergence from it.

If it be looked at between crossed Nicols in a pencil of parallel rays, the field of view becomes bright, and is crossed by two brushes hyperbolic in form, which for two positions of the lens became two straight lines. If again plane polarised light be allowed to pass through the lens while it is turned round its own axis, there are four positions of the lens for which the central portion of the emergent beam is plane polarised, and can be quenched by an analysing Nicol; for all other positions of the lens, the emergent beam is elliptically polarised, and the light cannot be quenched, but reduced to a minimum. Moreover, as the lens is turned, the position of the axes of the ellipse varies by nearly half a degree. I have since examined a large number of lenses, without finding one quite free from the defect. One well-known London optician declines to attempt to supply me with a two-inch object-glass which shall not show it, while another states he has never known any lens absolutely free from it.

The important bearing of the point on all investigations into the polarisation of light is obvious. The consequences it produces in modifying the results of some recently-published experiments of mine (*Phil. Trans.*, Part ii., 1882) formed the subject of a paper read at the last meeting of the Royal Society.

R. T. GLAZEBROOK

Trinity College, Cambridge, December 20

New Deep-Sea Fish from the Mediterranean

MY letter in NATURE, vol. xxv. p. 535, called forth two important notes from such competent ichthyologists as Mr. J. Y.

Johnson and Dr. Th. Gill (NATURE, vol. xxvi. pp. 453, 574), to both of whom a reply is due, and should have been given sooner had I not been absent from Florence and otherwise engaged.

Firstly, I must correct my assertion as to the occurrence of *Malacocephalus lævis* in the Mediterranean; after having examined the type specimen and that mentioned by Mr. Johnson, both in the British Museum and after a further examination of my specimens, which I had considered as young *Malacocephali*, I have now not the slightest doubt that they are quite distinct. They are an undescribed and most interesting form of Macrurids allied to *Coryphænoides*, which I propose calling *Hymenocephalus italicus*. I have in my possession six specimens, both adult and young; in two of the former I have found the ovaries fully developed with mature ova.

As to the "singular fish of a deep black colour with small eyes, a naked skin, and a most abyssal physiognomy," which I got at Messina, it has no connection whatever with *Chiasmodon niger*, but is, as I before asserted, a Stomiatid, very different from all the known forms, including Dr. Günther's *Bathyophis*. It stands apart in many respects, and is the type of a new genus and perhaps of a new section of that singular family. I intend shortly to describe and figure it under the name of *Bathophilus nigerrimus*, along with other strange fish collected during my deep-sea and ichthyological researches in the Mediterranean.

HENRY HILLYER GIGLIOLI

R. Zoological Museum, Florence, December 17

Electrical Phenomenon

ON retiring to bed shortly after midnight on the 13th inst., I experienced a phenomenon which, though not of itself uncommon, was, I think, unusually developed. On pulling off a flannel vest which I wear next my skin, over my head, I became conscious of a strange sensation in the latter, accompanied by a distinct crackling noise, and bright sparks which were plainly visible in the dimly lighted room. To make sure that I was not the subject of a delusion, I repeated the operation many times, in each case rubbing the flannel half-a-dozen times—not more—against my hair. Not only were the same phenomena observable every time, but also if, after removing the flannel I then approached my knuckles to that part of it which had been in contact with the hair, a whole volley of sparks passed between the flannel and each knuckle at a distance of not less than *two inches*. As often as I repeated the experiment, so often did the phenomena repeat themselves, until I at length retired to bed not altogether without apprehension, that I might awake in the night with the bed-clothes on fire, by reason of the discharge of some extra big spark between my hair and a convenient blanket. No such catastrophe, however, occurred, and on repeating the operations the next morning, I could not reproduce the phenomena. The next evening I again repeated the experiment, and this time by very violent rubbing could just get a faint discharge between the flannel and knuckles when almost in contact. On other nights since these I have not succeeded in getting any such effect, or at most a very feeble one. To what, then, am I to attribute the marked difference of the first night? Was it due to something peculiar in the condition of the hair, the air, or the flannel? Perhaps some of your readers can suggest. As regards the first of these I ought to state that it had, on the afternoon of the 13th, been subjected to the operations of cutting, shampooing, and brushing "by machinery," at the hands of the barber. That was, however, seven hours earlier in the day, and any electricity developed by the friction of the last operation ought to have been dissipated long before twelve o'clock—especially as the night was damp and misty.

A. J. K.

29, Victoria Road, Finsbury Park, December 19

PHOTOGRAPHING THE CORONA[1]

PROBLEMS of the highest interest in the physics of our sun are connected, doubtless, with the varying forms which the coronal light is known to assume, but these would seem to admit of solution only on the condition of its being possible to study the corona continuously, and so to be able to confront its changes with the other variable phenomena which the sun presents. "Unless some means be found," says Prof. C. A. Young, "for bringing out the structures round the sun which are hidden by the glare of our atmosphere, the progress of our knowledge must be very slow, for the corona is visible only about eight days in a century, in the aggregate, and then only over narrow stripes on the earth's surface, and but from one to five minutes at a time by any one observer" ("The Sun," p. 239).

The spectroscopic method of viewing the solar prominences fails, because a large part of the coronal light gives a continuous spectrum. The successful photograph of the spectrum of corona taken in Egypt, with an instrument provided with a slit, under the superintendence of Prof. Schuster during the solar eclipse of May 17, 1882, shows that the coronal light as a whole, that is the part which gives a continuous spectrum, as well as the other part of the light which may be resolved into bright lines, is very strong in the region of the spectrum extending from about G to H. It appeared to me, therefore, very probable that by making exclusive use of this portion of the spectrum it might be possible under certain conditions, about to be described, to photograph the corona without an eclipse.

In the years 1866-68 I tried screens of coloured glasses and other absorptive media, by which I was able to insolate certain portions of the spectrum with the hope of seeing directly, without the use of the prism, the solar prominences (*Monthly Notices*, vol. xxviii. p. 88, and vol. xxix. p. 4). I was unsuccessful, for the reason that I was not able by any glasses or other media to isolate so very restricted a portion of the spectrum as is represented by a bright line. This cause of unsuitableness of this method for the prominences which give bright lines only, recommends it as very promising for the corona. If by screens of coloured glass or other absorptive media the region of the spectrum between G and H could be isolated, then the coronal light which is here very strong would have to contend only with a similar range of refrangibility of the light scattered from the terrestrial atmosphere. It appeared to me by no means improbable that under these conditions the corona would be able so far to hold its own against the atmospheric glare, that the parts of the sky immediately about the sun where the corona was present would be in a sensible degree brighter than the adjoining parts where the atmospheric light alone was present. It was obvious, however, that in our climate and low down on the earth's surface, even with the aid of suitable screens, the addition of the coronal light behind would be able to increase, but in a very small degree, the illumination of the sky at those places where it was present. There was also a serious drawback from the circumstance that although this region of the spectrum falls just within the range of vision, the sensitiveness of the eye for very small differences of illumination in this region near its limit of power is much less than in more favourable parts of the spectrum, at least such is the case with my own eyes. There was also another consideration of importance, the corona is an object of very complex form, and full of details depending on small differences of illumination, so that even if it could be glimpsed by the eye, it could scarcely be expected that observations of a sufficiently precise character could be made to permit of the detection of the more ordinary changes which are doubtlessly taking place in it.

These considerations induced me not to attempt eye-observations, but from the first to use photography, which possesses extreme sensitiveness in the discrimination of minute differences of illumination, and also the enormous advantage of furnishing a permanent record from an instantaneous exposure of the most complex forms. I have satisfied myself by some laboratory experiments that under suitable conditions of exposure and development a photographic plate can be made to record minute differ-

[1] "On a method of Photographing the Solar Corona without an Eclipse." Paper read at the Royal Society by William Huggins, D.C.L., LL.D., F.R.S., December 21.

ences of illumination existing in different parts of a bright object, such as a sheet of drawing paper, which are so subtle as to be at the very limit of the power of recognition of a trained eye, and even, as it appeared to me, those which surpass that limit.

My first attempts at photographing the corona were made with photographic lenses, but uncertainty as to the state of correction of their chromatic aberration for this part of the spectrum, as well as some other probable sources of error which I wished to avoid, led me to make use of a reflecting telescope of the Newtonian form. The telescope is by Short, with speculum of 6 inches diameter, and about 3½ feet focal length. A small photographic camera was fastened on the side of the telescope tube, and the image of the sun after reflection by the small plane speculum was brought to focus on the ground glass. The absorptive media were placed immediately in front of the sensitive film, as in that position they would produce the least optical disturbance. Before the end of the telescope was fixed a shutter of adjustable rapidity which reduced the aperture to 2 inches. This was connected with the telescope tube by a short tube of black velvet for the purpose of preventing vibrations from the moving shutter reaching the telescope. On account of the shortness of the exposures it was not necessary to give motion to the telescope.

It was now necessary to find an absorptive medium which would limit the light received by the plate to the portion of the spectrum from about G to H. There is a violet (pot) glass made, which practically does this. I had a number of pieces of this glass ground and polished on the surfaces. Three or four of these could be used together, castor-oil being placed between the pieces to diminish the reflection of light at their surfaces. Some inconvenience was found from small imperfections within the glass, and it would be desirable in any future experiments to have a larger supply of this glass, from which more perfect pieces might be selected.

In my later experiments I used a strong and newly made solution of potassic permanganate, in a glass cell with carefully polished sides. This may be considered as restricting the light to the desired range of wave-length, since light transmitted by this substance in the less refrangible parts of the spectrum does not affect the photographic plates.

Different times of exposure were given, from so short an exposure that the sun itself was rightly exposed, to much more prolonged exposures, in which not only the sun itself was photographically reversed, but also the part of the plates extending for a little distance from the sun's limb.

Gelatine plates were used, which were backed with a solution of asphaltum in benzole.

After some trials I satisfied myself that an appearance peculiarly coronal in its outline and character was to be seen in all the plates. I was, however, very desirous of trying some modifications of the methods described, with the hope of obtaining a photographic image of the corona of greater distinctness, in consequence of being in more marked contrast with the atmospheric illumination.

Our climate is very unpropitious for such observations, as very few intervals, even of short duration, occur in which the atmospheric glare immediately about the sun is not very great. Under these circumstances I think it is advisable to describe the results I have obtained, without further delay.

The investigation was commenced at the end of May of this year, and the photographs were obtained between June and September 28.

The plates which were successful are twenty in number. In all these the coronal form appears to be present. This appearance does not consist simply of increased photographic action immediately about the sun, but of distinct coronal forms and rays admitting in the best plates of measurement and drawing from them. This agreement in plates taken on different days with different absorptive media interposed, and with the sun in different parts of the field, together with other necessary precautions observed, makes it evident that we have not to do with any instrumental effect.

The plates taken with very short exposures show the inner corona only, but its outline can be distinctly traced when the plates are examined under suitable illumination. When the exposure was increased, the inner corona is lost in the outer corona, which shows the distinctly curved rays and rifts peculiar to it.

In the plates which were exposed for a longer time, not only the sun but the corona also is photographically reversed, and in these plates, having the appearance of a positive, the white reversed portion of the corona is more readily distinguished and followed in its irregularly sinuous outline than is the case in those plates where the sun only is reversed, and the corona appears, as in a negative, dark.

Prof. Stokes was kind enough to allow me to send the originals to Cambridge for his examination, and I have his permission to give the following words from a letter I received from him: "The appearance is certainly very corona-like, and I am disposed to think it probable that it is really due to the corona."

Prof. Stokes' opinion was formed from the appearance on the plates alone, without any knowledge of their orientation, and without the means of comparing them with the eclipse plates taken on May 17.

I have since been allowed, through the kindness of Capt. Abney, to compare my plates with those taken of the corona in Egypt during the eclipse of May last. Though the corona is undergoing doubtless continual changes, there is reason to believe that the main features would not have suffered much alteration between May 17 and September 28, when the last of my plates was taken. This comparison seems to leave no doubt that the object photographed on my plate is the corona. The more prominent features of the outer corona correspond in form and general orientation, and the inner corona, which is more uniform in height and definite in outline, is also very similar in my plates to its appearance in those taken during the eclipse.

Measures of the average height of the outer and of the inner corona in relation to the diameter of the sun's image are the same in the eclipse plates as they are in my plates taken here.

There remains little doubt that by the method described in this paper, under better conditions of climate, and especially at considerable elevations, the corona may be successfully photographed from day to day with a definiteness which would allow of the study of the changes which are doubtlessly always going on in it. By an adjustment of the times of exposure, the inner or the outer corona could be obtained as might be desired. It may be that by a somewhat greater restriction of the range of refrangibility of the light which is allowed to reach the plate, a still better result may be obtained.

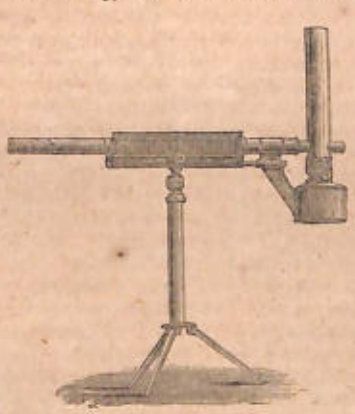
Plates might be prepared sensitive to a limited range of light, but the rapid falling off of the coronal light about H would make it undesirable to endeavour to do without an absorptive screen. Lenses properly corrected might be employed, but my experience shows that excessive caution would have to be taken in respect of absolute cleanness of the surfaces and of some other points. There might be some advantage in intercepting the direct light of the sun itself by placing an opaque disk of the size of the sun's image upon the front surface of the absorptive screen. Though for the reasons I have already stated I did not attempt eye-observations, there seems no reason why, with suitable screens and under suitable atmospheric conditions, the corona should not be studied directly by the eye. There might be some

advantages in supplementing the photographic records by direct eye-observations. I regret that the very few occasions on which it has been possible to observe the sun has put it out of my power to make further experiments in these and some other obvious directions.

P.S.—[I have Capt. Abney's permission to add the following letter this day received from him:—"A careful examination of your series of sun-photographs, taken with absorbing media, convinces me that your claim to having secured photographs of the corona with an uneclipsed sun is fully established. A comparison of your photographs with those obtained during the eclipse which took place in May last, shows not only that the general features are the same, but also that details, such as rifts and streamers, have the same position and form. If in your case, the coronal appearances be due to instrumental causes, I take it that the eclipse photographs are equally untrustworthy, and that my lens and your reflector have the same optical defects. I think that evidence by means of photography of the existence of a corona at all is as clearly shown in the one case as in the other."—*December* 15, 1882.]

A WEDGE AND DIAPHRAGM PHOTOMETER

A NEW photometer, shown in perspective in the figure, has lately been constructed by Mr. Sabine. The stand supports a straight horizontal tube, at one end of which is a paraffin lamp, and at the other an eyepiece. The middle portion of the tube is cut away, and has, slipped over it, a collar to which a frame is attached, carrying a wedge of neutral-tinted glass, adjustable by means of a rack and pinion. Inside the collar is fixed a transverse disc of ground opal glass, which the paraffin lamp illuminates to a definite degree. This disc constitutes the field of comparison, the illumination of which is



adjustable by means of a series of diaphragms of known aperture at the end near to the paraffin lamp. At the side, between the wedge and the collar which carries it, is a narrow pane of ground opal glass, just behind which a small mirror is fixed at an angle of 45° to the axis of the tube. This mirror is supported from the centre of the transverse opal disc in such a way, that the support is hidden from the observer by the mirror itself, an arrangement which insures the apparent juxtaposition of the illuminated surfaces which have to be compared. The light to be measured is placed on the right-hand side of the photometer; and the collar is turned so that the light falls normally upon the face of the wedge, passes through the wedge, through the pane of opal glass, and is incident upon the mirror, which reflects a portion of it to the eye of the observer. The wedge is then shifted, if necessary, to interpose a greater or less thickness of absorbing medium, until a balance is obtained, that is until the apparent illumination of the mirror is equal to that of the field of comparison, in the middle of which it is seen. If the range of the wedge is insufficient to admit of this, the degree of illumination of the field is altered, by means of the diaphragms, and the wedge is then adjusted.

The employment of glass wedges for photometric comparisons is not new, having been already used by both Xavier de Maistre and Quetelet; but no practical photometer based upon this method has hitherto been constructed. The employment of diaphragms for extending the range of the wedge is found to work well and to enable the operator to adjust the illumination of the field with exactitude, the bright part of the paraffin flame being of course, kept opposite to, and so as to well cover the diaphragm aperture. A table is constructed giving for each position of the wedge and for each diaphragm, the value, in standard candles, of any light placed at a distance of one metre from the instrument; and if the light be placed at any other distance, the number in the table has simply to be multiplied by the square of the actual distance in metres. For ascertaining approximately the amount of light which passes through any given coloured glass, for example, orange glass, the eyepiece is furnished with a rotary disc containing small panes of white and different coloured glasses, either of which can be interposed at pleasure.

This photometer is being made by Messrs. Elliott Bros., in two forms, one for use as a portable photometer, as shown in the figure, and the other on a more solid stand, for laboratory purposes.

ON THE OCCURRENCE OF GREAT TIDES SINCE THE COMMENCEMENT OF THE GEOLOGICAL EPOCH[1]

IT will I daresay be within the recollection of many of those who are now present that I was honoured by the invitation to deliver the opening lecture in this hall last year. In response to that invitation I addressed to you a discourse which I ventured to call "A Glimpse through the Corridors of Time." Accounts of it have appeared in very many quarters, both at home and abroad. I am myself responsible for the account which appeared in the columns of NATURE, as well as for the pamphlet form in which the lecture has since been issued. The chief reason why I now recur to the subject remains to be stated. Among the various comments which have been made upon that address, some are by no means favourable to the views I ventured to put forward, and they have been the theme of considerable discussion. Up to the present I have not made any reply to the criticisms which have appeared; I postponed doing so until a suitable opportunity should have arisen for a review of the whole subject. Your kindness in inviting me once again to address this great Institute has afforded such an opportunity, and with your permission I propose to preface the subject of my lecture this evening by a reply to those critics who have honoured me with their attention.

Let me recall to you very briefly the subject of that lecture, so as to enunciate clearly the point as to which an issue has been raised. You will perhaps recollect that the lecture treated principally of the tidal relations between the earth and the moon, of the influence of the tides during ages past, and of the future which awaits the earth-moon system during ages to come. I pointed out that at the present moment the orbit of the moon must be gradually growing in size, that this gradual increase of the distance from the earth to the moon is essentially non-periodic, and thus is totally different to the ordinary lunar irregularities which are recognised in rigid-body astronomy. As a consequence of this incessant growth in the moon's distance we see that in past ages the moon must have been appreciably nearer to the earth than it is

[1] Extract from a lecture delivered at the Midland Institute, Birmingham, on November 20, 1882, by Prof. Robert S. Ball, LL.D., F.R.S. Communicated by the Author.

at present, and that if we look far enough back we must inevitably come to an epoch when the moon would seem to have been quite close to the earth; indeed looking earlier still we are not without reasons for believing that in primeval times the earth and the moon formed but a single body.

Wondrous as this narrative may seem, yet on a due consideration of the mathematical evidence in its favour we are constrained to admit that it must be substantially correct. Unless some notable agency at present unknown to us has intervened in past time, the course of events must have run along the lines we have indicated. We make but little pretence to give the date when the moon seems to have commenced its independent existence, nor to indicate the chronology of the epochs when its distance increased by one thousand miles after another. All that seems certain is that the events we are at present discussing must have occurred millions, many millions of years before man placed his foot on this planet.

The cause of these mighty series of changes is still in hourly operation. The ebb and flow of the tides around our coasts is only the survival of greater tides with which in earlier days the ocean must have throbbed. The earlier we look back the mightier must have been the daily ebb and flow. I even invited you to look back to an excessively remote epoch when the moon was only at a fraction of its present distance, and when the daily rise and fall, instead of being counted in tens of feet, must have been reckoned by hundreds. Even up to this point there has been little or no controversy, there can be none. I do not know that any one has attempted to deny that the earth must once have experienced these mighty tides either in the actual body of the earth, or in the ocean on its surface. The controversy has arisen on the question as to whether these great tides had subsided before the commencement of the geological epoch, or whether they were contemporaneous therewith.

In my lecture in this hall last year, I made the suggestion that the reign of the mighty tides did perhaps extend into the commencement of the geological epoch. I further ventured to suggest that these great tides had left their traces on the solid crust of the earth. I quoted eminent geological authority to show that the rocks at the base of our stratified system are of the most stupendous volume and thickness. It has always been a difficulty to determine how the present geological agents could have manufactured so mighty a mass, and I appealed to the great tides as a grinding engine competent to aid in this work. At this point issue has been taken, and it is now my duty to review the arguments which have been adduced as bearing on this question. But let me here make a single remark which disposes of many of the objections that have been raised. Several of my critics do not seem to have observed that I postulated the mighty tides for the manufacture of the earliest primæval rocks, and *for these alone*. "Take, for example," I said (p. 25), "that earliest and most interesting epoch when life perhaps commenced on the earth, and when stratified rocks were deposited five or ten miles thick, which seem to have contained no living form higher than the eozoon, if even that were an organised being." Again and again I stated that I merely referred to these primitive strata. Yet this is a point that many of my critics have ignored. They have been at pains to prove that colossal tides did not exist in the comparatively modern geological epochs, and many interesting facts have been adduced. But such considerations have only an infinitesimal bearing on the position I adopted. Even the coal-measures are a modern formation when compared with the primeval rocks, for the manufacture of which I suggested the mighty tides.

The controversy as to the great tides has principally ranged around the question as to whether the primitive rocks present any indications of great tidal action. I am not a practical geologist, and am most anxious to obtain the views of those that are. Now these opinions are to be had. They are to be found in the correspondence in NATURE at the commencement of this year; yet there is, as might have been anticipated, considerable differences of opinion. I first refer to Prof. Hull's letter (NATURE, vol. xxv. p. 177), and find that this most competent authority adduces direct evidence of tremendous denudation in the Palæozoic ages, such as might have been produced by mighty tides. On the other hand, Prof. Newberry (vol. xxv. p. 357) says that there is no direct evidence whatever to show that the denuding agencies were greater in former times than now. In the following number of NATURE we have letters from Dr. Callaway and Mr. Hale (p. 385) to show that Prof. Newberry's conclusions are not necessarily valid. Mr. S. V. Wood and Mr. J. Vincent Elsden bring forward facts which go to support Prof. Newberry's view, while Dr. Callaway, though carefully declining to commit himself to the high tides, controverts Mr. Wood and Mr. Elsden (p. 409). Now all these gentlemen speak with special knowledge, but it is not easy to deduce from this correspondence as to which side the balance of skilled opinion really inclines. It would almost seem as if a very fundamental point had escaped attention. Prof. Geikie, in his great work just published, tells us that these great tides could not have existed in geological times, because, if they had done so they must have left certain traces, and we do not find these traces. The fundamental question is, What traces of great tides ought we to expect to find if those great tides had really existed? It would seem that unless this question be first answered, it is impossible to dispose of the question with the brevity which Prof. Geikie has adopted. I apprehend it cannot be doubted that by the great tides the materials of stratified rocks would be rapidly formed, and that in suitable localities these materials would be deposited to form rocks. I can see no necessary difference between a ton of mud ground up by colossal agents in former days, and a ton of mud ground up by the more prosaic agents of modern days. But for each ton of mud now made there would then have been a great many tons. The strata would thus have grown more rapidly in early times, and thus the exceptional thickness of the earliest stratified rocks could be accounted for. It seems useless to assert that vestiges of the great tides do not exist, unless we can form some idea of the sort of vestiges that should be expected if the great tides had existed. I believed at the time I gave my lecture, and I believe still, that we do see vestiges of vast primæval tides. I can even count these vestiges. They are five, or perhaps ten in number; they are the five or ten miles of vertical thickness of stratified rocks which were deposited at the bottom of the ocean during the earliest stages of the geological epoch.

I have derived so much pleasure and so much instruction from the study of Mr. G. H. Darwin's writings, that on this ground alone I would be reluctant to have any difference of opinion with him. Indeed, seeing that the earth-moon history is one which he has made peculiarly his own, and illuminated by discoveries which I believe to be the most important contributions made to physical astronomy in modern times it would seem presumption in me to venture to differ from him. Mr. Darwin, writing in NATURE, vol xxv. p. 213, has asked me to reconsider the views I had set forth as to the probability of the great tides being contemporaneous with geological phenomena. Mr. Darwin shows that at the time when the great tides supposed in my calculation existed, the earth must have been spinning round once in seven hours, and that this would involve trade-winds of 3½ times their present velocity and vertical storms of prodigious violence, and then he adds:—

"Now if this state of things existed in geological history, we should expect to find the earlier sedimentary

rocks of much coarser grain than the modern ones. But I am not aware that this is the case. Again, to understand such blasts, the earliest trees should have trunks of enormous thickness and their leaves must have been very tough, or they would have been torn to shreds. There seems to be no reason to suppose that the trees of the Carboniferous period present marked peculiarities in these respects."

"It is on these grounds that I venture to dissent from Mr. Ball in the geological interpretation to be placed on the tidal theory, and I think we must put these violent phenomena in pre-geological periods."

But is it necessarily true that the prodigious tides must have produced a coarser material as the result of their grinding than is found in the later rocks? I can imagine it to be contended that the more powerful mill would produce the finer flour, but in truth I really do not see that we have any *a priori* grounds for deciding whether the *débris* produced by mighty tides should be fine or coarse. Have we not illustrious authority for invoking our "Domestic Productions" to throw light on obscure questions removed from actual observation. Let us look at the biggest tides we know of, and see whether they are associated with fine mud or with coarse. I appeal to every one who has stood on the Clifton Suspension Bridge or walked on the Beach at Weston-super-Mare to answer this question. In both cases they will see mud of a fineness and a stickiness that is proverbial; yet that mud is washed twice every day by the mightiest tides in the British Islands. I do not say, nor do I believe, that the fineness of the mud in the Avon is the consequence of the great tides; but I think the illustration is a fair reply to an argument which says the tides in ancient days cannot have been of great size, because the mud with which those tides are associated is not coarse.

In the second place, Mr. Darwin urges against me the trees of the Carboniferous epoch, and his inference that the tremendous tides cannot have existed in the Carboniferous epoch is probably well founded. But I have not said that these tides did exist in the Carboniferous epoch. I can only again repeat that my argument supposed that the mighty tides may have existed in the times when the very earliest stratified rocks were deposited. In the course of ages, as the moon receded, so the tides gradually dwindled down until in the comparatively modern time indicated by the Carboniferous epoch, they may have been small enough to be connected with the wonderful coal vegetation.

I had, as I was bound to do, most carefully weighed the words in which I addressed you from this place last year. I was aware that the opinion I advanced would meet with opposition. This was a reason why I should consider the subject most carefully before I spoke, but it was not a reason why I should withhold the views at which I had arrived. I have again considered the matter with the results now set forth, and I have seen no reason to depart in the slightest degree from the position which I had previously adopted.

MARS[1]

THE similarity which has long been thought to exist between our own globe and the planet Mars would naturally commend itself to careful examination at the hands of such observers as possess instruments adequate to the inquiry. The shadowing of large portions of its surface with patches which easily lend themselves to the supposition of being collections of water, the occasional indistinctness of their outlines, so strongly indicative of atmospheric obscuration, the clothing of either pole with the semblance of a snowy mantle obedient in its extent to solar action, all this would bespeak of itself a critical investigation. And the challenge has been taken up from an early period, and to an extent which would probably surprise those who are unfamiliar with the subject. Already in 1873 the number of drawings collected by Dr. Terby of Louvain, than whom no man is more intimately conversant with areography, amounted to 1092, and the nine subsequent years, which have included among others the celebrated representations of Green and Schiaparelli, have greatly augmented that imposing number. We should be mistaken, however, if we were to estimate the progress of our knowledge by the multiplication of designs. In this case the ancient saying πλέον ἥμισυ παντός would probably express too large a proportion. The increase, if in some respects not to be regretted, brings with it additional elements of uncertainty, if not of error. Many representations might be discarded with positive advantage to the final conclusion: like numerical observations whose unworthiness is detected by their wide deviation from the mean of the rest, the result is all the surer for their exclusion. An unpleasant experience proves that the most careful observer is not always the most successful draughtsman, nor in such matters is zeal any pledge of excellence. Comparison of the results obtained by different astronomers leads to the conclusion that, after due allowance has been made for instrumental and atmospheric differences, all men do not see alike, or interpret in the same way what they see, or transfer the image to paper with equal success. Here it is that photography, though not exempt from defects and hindrances of its own, is now beginning to render invaluable aid. But such an object as the disc of Mars would not lend itself very readily at present to the camera, and the pencil and the brush must do the best they can till some further advance is made to supersede them.

But however improved may be our future representations, and whatever may be the result—on every supposition most interesting—of the keen scrutiny that is in store for the next opposition of the planet, it would undoubtedly be an injudicious course to discard as unworthy of study and comparison the delineations of earlier days. Less valuable, if standing alone, they may attain considerable importance in the elucidation of some otherwise unexplained difficulty; and evidence which, unsupported, might be of little weight, may acquire especial consequence from its collateral bearing on more direct testimony. The comparatively rude and defective sketches of a long-passed era, contained in the publication before us, executed in a spirit of unwearied industry and unimpeachable fidelity, but under the influence of a mistaken impression, form a striking illustration of the previous remarks.

The history of the "Areographische Beiträge" is connected with a very lamentable occurrence in the life of the worthy old Hanoverian observer, Dr. Johann Hieronymus Schröter. He had long been settled in a Government office at Lilienthal, not far from Bremen, where his almost innumerable observations on sun, moon, and planets (with stars he did little) had been carried on with reflectors of various sizes—two by Sir W. Herschel of 4 and 7 feet focal length, others by Schrader, of Kiel, of 7, 11, 15, and 27 (26 English) feet, and a 4-inch object-glass by Dollond, equatorially mounted. His passion for observation would never have allowed so interesting an object as Mars to escape him, and accordingly we find that between the years 1785 and 1803 he had accumulated 217 designs, with a corresponding description marked by all the minute preciseness of detail and inference which characterise his other labours. The work had been promised for publication at Easter, 1812, but had been somehow delayed, when an event occurred on the night of April 20, 1813, in connection with the occu-

[1] "Areographische Beiträge zur genauern Kenntniss und Beurtheilung des Planeten Mars." Von Dr. J. H. Schröter; herausgegeben von H. G van de Sande Bakhuyzen, Director der Leidener Sternwarte. 8vo, 447 pp., with Atlas. Leiden: E. J. Brill.

pation of Bremen by the French, under the rapacious and unscrupulous Vandamme, the story of which we may allow the sufferer to relate in his own words.

"Through the most barbarous fury, in consequence of an equally barbarous sentence, the whole unoffending soft "vale of lilies" (Lilienthal) was, without previous inquiry, destroyed by fire. Without possibility of succour, they burnt down also the Royal Government offices; I lost the whole of my furniture, and what was most distressing of all, with a considerable damage also to the bookshops of Europe, the sole stock of my collected works and writings laid up in the government buildings. Even my observatory, preserved by Providence from the conflagration, was a few days afterwards broken into, plundered, and through the destruction of the clocks, breaking off of the finders, and robbery of the smaller instruments, scandalously ruined. Having been displaced from my post, my income had been previously by degrees so very much reduced, that I was compelled to forego everything but absolutely necessary expenditure, and to be laid aside in a scientific slumber." Elsewhere he says that even his journals had perished; and at the date of writing the introduction to his "Observations and Remarks upon the Great Comet of 1811" (January 22, 1815), from which the foregoing passage is taken, he complains that his circumstances were still so reduced, that his observatory, for want of time and money, remained for the most part in a state of confusion. So great are even the minor miseries of those "wars and fightings," of which many speak with such apathetic unconcern. It is painful to add to these sad details that this seems to have been Schröter's final effort, for after a twelvemonth of bodily and intellectual decay, he expired August 29, 1816, leaving behind him a worthy memory, to which, till of late years, our own country has done but inadequate justice.

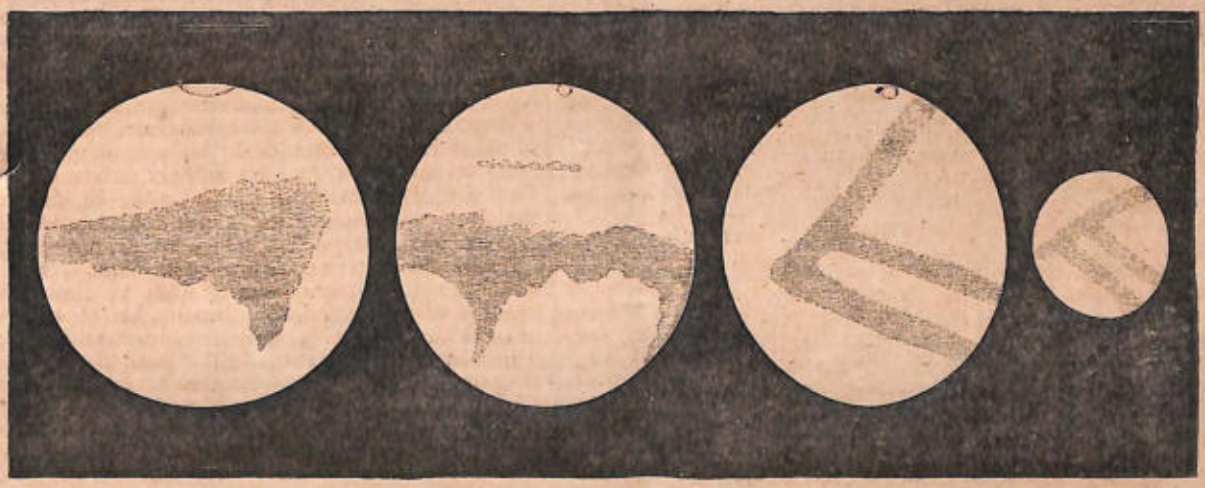
The "Areographische Beiträge" remained in MS. at his death, having escaped the calamitous fire, but so narrowly, that two out of the sixteen copper plates of figures had to be engraved again; no idea seems to have been entertained of publication, but they were safely preserved by the author's family. Their existence having been ascertained many years ago, by the present writer, through the kindness of Dr. Peters of Altona, a negotiation was set on foot for their acquisition by the Royal Astronomical Society; this proved ineffectual; but, in consequence of the attention directed to them, they were allowed to be inspected by Dr. Terby, to whose able and comprehensive analysis of the MS. as published in the *Memoires* of the Belgian Royal Academy of Sciences in 1873, the present notice is deeply indebted; and astronomers will be glad to learn that they have now been purchased by the University of Leiden for the library of that observatory, and that, after an obscurity protracted through seventy years, they have at last been published in a complete and handsome form, under the able and accurate editorship of the director of that institution.

The work, though characterised, like other productions of the same author, by a needless amount of prolixity, is well deserving of careful study, as indicating or confirming some valuable conclusions, and affording material for suggestive thought. The whole observations are pervaded by an impression that the obscurer portions of the disc are condensations in a vaporous atmosphere. The author, with a singular misconception of terrestrial analogy, supposes throughout that such cloudy masses viewed on their upper or enlightened side would appear darker rather than lighter than the surface beneath them; admitting at the same time that the configuration of that surface may so modify the superjacent atmosphere, as to cause a permanence, or, at any rate, recurrence of vaporous formation, from which the rotation may be, and has been determined. The occasional invisibility of dark spots, which has been recorded by too many observers to be brought in question, would be explained by Schröter in accordance with this theory, and may possibly be due to atmospheric causes; though, as Terby has pointed out, it may often have arisen from the difficulty of tracing any markings in the neighbourhood of the limb. It is more difficult to account satisfactorily for the movements ascribed by Schröter to the action of winds, of which he has specified in an elaborate table no less than forty-six instances, not much differing in velocity from those on earth, and in the great majority of cases conspiring with the direction of the rotation. Error may have crept in with regard to the identification of some of the spots; and both from the designs and descriptions a suspicion arises that some of the minuter details, which now serve for the recognition of distinct but similar regions, escaped the observer's notice. There must have been some cause for this unfortunate defect which detracts materially from the value of his work, and the removal of which would have been the one step in advance which, as Terby remarks, would have put him in possession of the true interpretation of what he saw. It would be a ready explanation to refer it to the imperfect defining power of his instruments; and I have somewhere read of a comparison instituted after his time between his much-prized speculum of 9½ inches aperture and 12⅔ feet focal length, and a Fraunhofer object-glass of, I think, about 4 inches, to the disadvantage of the former. Yet on the other hand he began his work with telescopes by the elder Herschel; and his 7-foot instrument by this great maker does not seem to have been superior to that of the same dimensions by Schrader, the manufacturer of all his larger ones. This point is therefore not quite clear. We might have attached some importance to his own admission, in his work on the moon, that his vision was less microscopic than that of his assistant, Harding, but for the fact that the latter occasionally aided him in these observations on Mars. Whatever may have been the cause, the frequent absence of minuter detail must have served to confirm Schröter's misapprehension of what he saw. And it must be borne in mind, in estimating his observations in general, that it was his habit to undertake investigation with a preconceived idea. In the case of the moon, his prepossession in favour of changes no doubt occasionally misled his judgment; and on Mars he might be prepared to look out for atmospheric movement by the known phenomena of Jupiter. An anticipation of this kind may not be without incidental advantage in directing and sharpening attention: our search may be aided, and with perfect fairness and honesty, by the foresight of the result: but at other times such expectations may be equally or more prejudicial; and they probably were so in the instance before us. And it is at any rate a possible suggestion that, with regard to some of these supposed changes, Schröter's ideas may have been unconsciously biassed by his study of the surface of Jupiter. The perspective foreshortening of that great globe having no effect on the aspect of its more conspicuous and familiar markings, from their equatorial direction, and being non-apparent in the transits of the shadows of the satellites, the eye may come to regard it too much as a flat disc, and to appreciate too little the extensive changes which mere foreshortening produces among markings arranged in any other direction.

But whatever explanation may be attempted of Schröter's illusion, which, as his editor remarks, increases the value of his figures by securing their perfect independence, or however we may regret an apparent want in some cases of more distinctive detail, there can be no doubt that the work is worthy of attentive study. Dr. Terby has pointed out one curious inference—that at that epoch certain dark markings bore a relative proportion to each other, too different from that which obtains at present to be easily explained away. Nor does this result by any means stand alone: and it has considerable value as affording

collateral testimony to subsequent observations pointing in the same direction. To say nothing of other authorities, the accurate designs of the deeply-regretted Burton, and the latest delineations of Schiaparelli (independent of the wonderful duplication of the narrow streaks) concur with the drawings of Schröter in indicating one of two suppositions as regards the dark patches of Mars; either they must be liable to long-persistent and very deceptive alteration of visible outline from atmospheric causes, or their own extent must be so variable as to awaken a doubt whether the right key of the mystery is after all in our hands. We have long believed that we hold it, and terrestrial analogy has been thought sufficient to account for all we can see. The result of the next opposition in 1884 may be found to confirm the old hypothesis; but it is not beyond possibility that it may shake it, even past recovery.

Besides the conclusion thus briefly indicated, several other points of varying degrees of interest are touched upon in this comparatively bulky treatise, some of which we may refer to, though only with a passing notice. Schröter paid considerable attention to the polar whiteness; but while he admits the probable analogy of terrestrial snow, he is less confident than some other observers as to any marked influence of solar radiation. Terby, however, has pointed out the cause of his misapprehension, and his substantial agreement with his compeers. He was aware of the irregular outline of the snowy regions, and thought them slightly different in colour, the south pole verging towards yellow, the north blue. On the question of rotation he could obtain no satisfactory result, as might have been expected from his idea as to the instability of the markings; his values being discordant at different periods: the mean, 24h. 39m. 50·2s., was only about 29s. less than that of Sir W. Herschel, but very wide of Proctor's elaborately deduced value, 24h. 37m. 22·735s.—a fact pointing probably to the same conclusion as before, that from some as yet imperfectly explained cause, the exact position in longitude of some of the features of the planet is not fully ascertained. The amount of the polar flattening of Mars is, as is well known, matter of much uncertainty. Herschel made it as much 1-16; Dawes, nothing, or even negative. Our observer, nearest to the great English authority, found it less than 1-81, a quantity fairly evanescent. The method of measurement which he adopted throughout all his researches was that of the apparatus which he calls the "projection machine." In this simple



contrivance both eyes are employed simultaneously, the one in viewing the telescopic image, the other in bringing to coincidence with it, a squared-out area in the case of the moon, a series of discs for the planets, in either instance with provision for varying distance and illumination. This binocular mode of measurement, if open to some sources of error not incidental to the ordinary apparatus, appears hardly deserving of the censure so freely bestowed upon it by Beer and Mädler, who were not always fair towards the labours of Schröter; and notwithstanding the perfection to which the wire micrometer has been brought, might perhaps be revived for some purposes with advantage. The diameter of Mars obtained in this way by Schröter, 9″·84, does not differ much from the 9″ 8‴ (a curious instance, by the way, of notation by *thirds*), of Sir W. Herschel, or from more modern values—some proof, it may be thought, of the competency of the apparatus to obtain a close approximation.

Observations included in this volume of a partial flattening of the limb of Mars and of the abnormal breadth and want of symmetry in the phasis, however improbable they may at first appear, are not without parallel in the case of other planets, or the experience of other observers. If, as it must be assumed, these are nothing more than illusions, the record of them is still valuable in the probable event of their occasional recurrence.

To this brief and imperfect notice are appended three sketches from the Atlas—the two first as specimens of Schröter's mode of delineation—the third as bearing so striking a resemblance to one of my own, shown on a smaller scale beside it, that it might, in the absence of more accurate data, serve as the basis of an approximate value of rotation.

The dates respectively corresponding to these designs are 1798, Sept. 9d. 8h. 4m.; Oct. 17d. 7h. 39m.; Nov. 13d. 7h. 10m.; 1862, Dec. 10d. 9d. 30m.

T. W. WEBB

DESTRUCTION OF LIFE IN INDIA BY POISONOUS SNAKES

IN January, 1870, being then in Calcutta, I collected statistical information which afforded proof that the loss of human as well as animal life in India from the bite of venomous snakes was very great; and as it seemed to me that this ought to be, to a great extent, preventible, I extended my investigations with the view of obtaining accurate information as to the characters and peculiarities of the venomous snakes themselves, the localities in which they most abound; the *modus operandi*

of the poison; the circumstances under which the bites are inflicted; the value of any known remedies in the treatment of those bitten, and what measures might possibly be devised for diminishing this serious evil.

After a long and careful investigation of the whole subject, I drew up a detailed report, containing the results of my inquiry, and presented it to the Government of India, with a request that, when published, it should be distributed throughout India, among civil and medical officers, with a view of enabling them to take measures for the protection of human life, and the destruction of the creatures which caused such frightful mortality. I also endeavoured to point out the mode in which the poison destroys life, and to indicate such rational measures as might be of service in the treatment of those bitten.

I am not aware how far the advice I then tendered has been acted on, but I am glad to find, by a recent resolution published in the *Gazette of India*, that some progress is being made, and that the mortality of 1881 has been somewhat less than that of 1880, from this cause, and that this desirable result is due to the measures that have been taken by Government to procure the destruction of the poisonous snakes.

From the returns furnished to me at the instance of Government in 1870, for the year 1869, I made out that the human deaths from snake-bite were as follows in—

Bengal, including Assam and Orissa	6645
North-West Provinces	1995
Punjab	755
Oude	1205
Central Provinces	606
Central India	90
British Burmah	120
Total... ...	11,416

These were the only returns received, and represent not much more than half of the whole area, but the total, large as it is, cannot be regarded as the real mortality in these provinces, as the information from which the records were framed being probably only partial and imperfect, it rather under-rates than exaggerates the mortality. I expressed a belief that if systematic registration were adopted, the number recorded would prove to be larger, whilst, if information were gathered from the whole of Hindostan, it would be found that not less than 20,000 persons are destroyed annually by snakes.

Certain suggestions were made as to measures for identification, destruction of venomous snakes, and for registration of deaths. These would appear, from the terms of the resolution above referred to, to have been partially adopted, with the result of causing some diminution of the evil. I pointed out that the snakes which are so destructive to life are the cobra, the bungarus or krait, the echis, and the daboia or Russells' viper, all of which are most conspicuous snakes, and easily identified. There are others, such as Bungarus fasciatus, Ophiophagus elaps, which are dangerous, but comparatively rare, and seldom bite men, whilst the hydrophidæ being confined to the sea or estuaries, are, though very poisonous, not so dangerous to man, and the trimeresuri, which are both uncommon, and at the same time are not so deadly as to endanger life. All these are depicted in coloured figures taken from life, which renders their identification simple and easy.

I further remarked that, "meanwhile there exists the obvious necessity of endeavouring to prevent the numerous fatal accidents by making generally known the appearance and habits of the poisonous snakes, and by instituting rewards for their destruction. With a plain description and a faithful representation of each species in colours, every district, medical or police officer, would be able at once to distinguish the venomous from the innocent snakes, and thus knowledge enough, at least for all practical purposes, might be imparted to intelligent native subordinates, to enable them to recognise the poisonous snakes. By offering a larger reward for these only, their numbers would soon diminish, and the people would be made acquainted with the characters that distinguish the venomous from the harmless snakes, and would learn to avoid them. Thus only, I believe, can the evil be remedied, so long, at all events, as the mode of life among the lower and agricultural classes remain what it now is. I would suggest that magistrates, district and police officers, and civil surgeons be authorised to give the following rewards for poisonous snakes:—

	Annas[1]
Cobra	8
Bungarus cæruleus	6
Bungarus fasciatus	4
Ophiophagus	8
Russell's Viper	8
Echis	4
Trimeresurus	2

The sum disbursed would no doubt be large, but the results in the saving of life and destruction of snakes would compensate for the expenditure."

Such was the state of things when I left India in 1872. The Government of India then, at my instance, appointed a commission to continue the inquiry which I had commenced three or four years previously. This resulted in several valuable reports by Drs. J. Ewart, A. Wall, and Mr. Vincent Richards, whilst, in conjunction with Dr. Lauder Brunton, F.R.S., an investigation into the nature of the physiological action of the virus was continued here by me, the results of which have been published in the *Proceedings* of the Royal Society in 1873, 1874, and 1875. Meanwhile the evil continues, and it is probably within the mark to say that, since the subject came under consideration in 1870, 150,000 to 200,000 human beings, to say nothing of domestic animals, have been destroyed by snake bites.

The subject has often received the most anxious consideration of the Indian Government, and a variety of measures have been resorted to, not without a certain measure of success; but it is my belief that not until a system of organised, determined, and sustained efforts for the destruction of the snakes is adopted and carried out on the lines suggested in my report, will the evil be fairly grappled with and overcome. The present resolution shows that the matter is again receiving some consideration, and there is good reason to believe that if the measures be prosecuted with energy and determination throughout India, good results will follow. But I repeat it is only by the *destruction of the snakes* that the evil can be mitigated. Something may be expected from the people themselves as their knowledge of the subject increases, as they become more familiar with the appearance or character of the venomous as distinguished from the harmless snakes, and as they gradually become convinced of the futility of all antidotes charms or spells to protect them; or should they ever alter their present mode of living in huts which have the floor on the ground surface, to huts with raised floors—a consummation devoutly to be wished, not only on account of snakes, but of malaria—but hardly likely to be realised.

For the purpose of hunting out and destroying the evil it is absolutely necessary that a fixed system of rewards should be established, and that in every district there should be an organised body of men whose duty it would be, under proper supervision, to seek out and destroy the snakes, receiving a recompense according to the importance and number of the snakes killed. Such men are to be found among certain castes, and with the aid of descriptions and coloured drawings, such as now are available, there need be no great difficulty in carrying out this much-to-be-desired object. That such a project would be costly is true, but can that cost be considered excessive

[1] Eight annas represent one shilling.

if it save thousands of lives of men and valuable animals? There can be little doubt that wherever such a system has been even partially carried out, it has been effective; it needs but combined effort to make universal, that which hitherto would appear to have been but partial success.

From the tenor of the Government resolution referred to, it seems as though an organised scheme for the destruction of venomous snakes, as well as dangerous wild animals, is now likely to be generally adopted in India, and should it be so, there is good ground for hope that the great mortality will decrease—to quote from a former paper on this subject, I would repeat: "Rewards should be offered freely for venomous snakes only. This, if steadily carried out under some responsible official, would soon diminish snakes and deaths from snake-bite; and I earnestly protest against the opinion expressed by some Indian authorities, that such rewards are useless—useless they may have been, and will continue to be, if distributed without discretion for snakes not poisonous. If this method of dealing with the matter—and who can deny its importance—be adopted (but it must be done willingly, and not with the foregone conclusion that it will fail), I am certain that, as part of a comprehensive scheme for the destruction of noxious animals generally, it will succeed."

The following is the purport of the resolution of November 8, 1882, which shows that in 1881 the number of deaths caused by snake-bite, of men and animals, contrasted favourably with that of the previous year, 1880.

The statement appended to this resolution shows in detail for each province the number of persons and cattle killed by wild animals and snakes, and the number of wild animals and snakes destroyed, with the rewards paid for their destruction during the year 1881, as compared with the previous year. The figures are summarised in the following tables:—

Number of Human Beings and Cattle Killed by Snakes

	Persons killed.		Cattle killed.	
	1880.	1881.	1880.	1881.
Madras	1,182	1,064	227	273
Bombay	972	1,024	89	191
Bengal	10,064	9,208	1,248	154
North-Western Provinces and Oudh ...	4,723	5,010	221	317
Punjab	681	744	78	69
Central Provinces ...	901	985	39	26
British Burma	149	135	194	150
Coorg	3	Nil	Nil	Nil
Assam	211	189	57	16
Hyderabad Assigned Districts	125	197	383	836
Ajmere-Merwara ...	49	54	Nil	Nil
Total	19,060	18,610	2,536	2,032

Snakes killed and Rewards Paid

	Destroyed.	Rewards.	Destroyed.	Rewards.
	1880.		1881.	
		Rs. a. p.		Rs. a. p.
Madras	Nil ...	Nil ...	Nil ...	Nil
Bombay	177,078 ...	6,922 3 6 ...	207,113 ...	6,214 0 0
Bengal	23,201 ...	3,733 3 6 ...	19,282 ...	3,430 5 0
N.-W. Provinces and Oudh...	1,029 ...	10 2 0 ...	1,142 ...	56 5 3
Punjab.....	9,126 ...	635 5 0 ...	22,279 ...	1,587 4 0
Cent. Provinces	866 ...	336 6 0 ...	1,493 ...	562 8 0
British Burma.	997 ...	2 0 0 ...	2,990 ...	27 0 0
Coorg.....	58 ...	Nil ...	16 ...	4 0 0
Assam.....	202 ...	Nil ...	300 ...	34 0 0
Hyderabad Assigned districts	158 ...	23 14 0 ...	332 ...	45 8 0
Ajmere-Merwara	61 ...	Nil ...	21 ...	Nil
Total ...	212,776 ...	11,663 2 0 ...	254,968 ...	11,960 14 3

The deaths of human beings from snake-bite were, in 1880, 19,060; while in 1881 they were 18,610.

In 1880, 212,776 snakes were destroyed at a cost of Rs 11,663.

In 1881, 254,968 snakes were destroyed at a cost of Rs 11,961.

Thus with an increased expenditure of Rs 298 in 1881, 42,192 more snakes were destroyed and 450 lives were preserved, above the expenditure of the previous years.

With regard to the measures adopted for the destruction of venomous snakes, the following remarks are made by the Governor-General in Council:—

"As regards the destruction of venomous snakes, special measures were adopted in some provinces, of which it appears desirable to give a brief account in case they may be considered suitable for adoption elsewhere. In Bengal a scheme has been sanctioned by the local Government in the case of the Patna Division, under which persons destroying snakes can obtain certificates from certain selected planters vouching for the poisonous nature of the snakes destroyed. The production of such a certificate entitles the holder to secure from the local authorities the reward offered whenever he finds an opportunity of applying for it. As observed by the Government of Bengal, this concession will probably be found to add much to the convenience of persons claiming rewards, and to act as an inducement towards the destruction of poisonous snakes. The expediency of extending the scheme will be considered by the Local Government when the result of the current year's operations are known. In the North-Western Provinces and Oudh the Lieutenant-Governor and Chief Commissioner has sanctioned the entertainment tentatively in each district of those provinces of a staff of Kanjars, or men of similar caste, who trap and kill reptiles, for the systematic destruction of venomous snakes. These men will receive pay at the rate of Rs. 2 per mensem, together with an additional reward of two annas for every venomous snake in excess of twenty destroyed by each man during any month. A gang of snake-hunters is also to be employed at each tahsili, and, if the measure proves successful, it is proposed that similar gangs should be eventually appointed to each police circle of other local area. It appears to the Governor General in Council that a plan for the destruction of snakes such as that initiated in the North-Western Provinces and Oudh, is likely to prove far more efficacious than the mere offer of rewards, although it is true that unless such operations are confined to towns and villages and their neighbourhood, where it is believed that the largest number of deaths occur from snake-bite, they will probably be very costly. His Honour the Lieutenant-Governor of the Punjab has issued a circular to commissioners and superintendents in the Punjab, drawing attention to the matter with a view to the adoption of measures for destroying snakes by system of rewards to be granted by district committees and municipalities. Casts and lithographed pictures of the more common species of deadly snakes have already been supplied to the police stations in some districts, and deputy commissioners have been requested to suggest to municipal and district committees the desirability of procuring similar means of reference for the purpose of testing applications for rewards. In British Burma the Chief Commissioner, with a view to encourage village snake-hunts in the rice plains, has arranged to grant sums varying from Rs 10 to Rs 20, according to the number of houses, in aid of a feast or *pweh* at the end of the annual hunt to every village which successfully carries out such an undertaking.

"On the whole, the results recorded during the year under review appear to the Government of India to be more satisfactory than those of the previous year. The Governor General in Council is glad to notice that the question of taking measures to reduce the lamentable loss of life which is at present caused by wild animals and venomous snakes is receiving the earnest consideration of Local Governments and Administrations, and His

Excellency in Council will await with interest the reports showing the results of the special measures which have been adopted in some provinces. It is clear that much still remains to be done; but if sustained efforts are made and well-considered plans adopted for the extermination of wild beasts and deadly snakes, His Excellency in Council believes that the number of deaths from these causes will in course of time be materially reduced.—Simla, November 8, 1882."

From the above it appears that more vigorous measures than any hitherto adopted have been taken for the destruction of venomous snakes, and the contrast of the results of 1881 with those of 1880, warrant the anticipation of further benefit if these measures are only carried out with a sustained determination to succeed. It is mainly a question of perseverance and the expenditure of money, and one can hardly imagine a more desirable object on which to expend both energy and rupees. But it is essential that the system be laid down on some general principles for the whole of India, to be worked out in detail, according to the needs or peculiarities of each district. There should, in short, be a department with a responsible chief and subordinate agents, for whom certain rules should be laid down to be carried out steadily and without hindrance throughout the country, leaving much of the detail to the discretion of local authorities. I would insist on the importance of carrying it out on broad principles everywhere. When such a department is constituted under a proper head—and there are many persons well fitted for such a duty—then, I believe, venomous snakes and other noxious animals will decrease in numbers, and people will cease to be startled by these appalling losses of life. J. FAYRER

SIR J. WHITWORTH'S MECHANICAL PAPERS[1]

THE fact that, by an order in Council of August 26, 1881, some 300 Whitworth gauges of various dimensions have been adopted as standards by the Board of Trade, is so important a recognition of the value of the labours of Sir J. Whitworth in improving mechanical measurement, that the occasion has been selected for republishing certain papers which have been long well known among engineers, but which have not hitherto been accessible to the public generally.

The first paper in the series is on plane metallic surfaces, and the proper mode of preparing them, and contains an account of an invention of great simplicity, but of the highest practical importance. Such plates, when worked up to an extreme degree of accuracy and finish, form an approximation to a plane surface which would surprise and delight any geometrician who had an opportunity of critically examining and testing their qualities. They consist of an assemblage of minute bright surfaces very evenly distributed over a plate of cast iron, and very near together.

As to their qualities, there is not space here to describe them, but they have formed the subject-matter of an excellent lecture by Prof. Tyndall, at an evening meeting of the Royal Institution in the year 1875.

Passing from these so-called true planes, we refer to a step involving an original conception which has led to the construction of the new standard gauges. The production of an approximately true plane surface gave an increased value and importance to the feeling of contact between prepared metallic surfaces, and resulted in the invention of a measuring machine which was made to depend on the sense of touch instead of upon optical contrivances, and was founded entirely on truth of surface.

[1] "Papers on Mechanical Subjects." By Sir Joseph Whitworth, Bart., F.R.S., D.C.L. Vol. I. True Planes, Screw Threads, and Standard Measures. (London: Spon.)

The improvement consisted in the substitution of end for line measure, and inasmuch as these are technical terms, it may be well to explain them.

As stated in the last paper of the series, the English standard yard is an example of line measure, being represented by the interval between two lines drawn across two gold studs sunk in a bronze bar about 38 inches long, the temperature being at 62° Fahrenheit.

The standard yard, from the subdivisions of which the standard inch has been obtained on the Whitworth system, is a rectangular metal bar with plane sides capable of resting along its whole length in rectangular V grooves, which are plane surfaces, while the ends of the bar are planes lying perpendicular to its axis. The bar is exactly 36 inches long, and the measurement is complete when the degree of contact between its ends and two small true planes abutting against them is ascertained. Such a measurement is, of course, end measure, and its accuracy depends throughout upon truth of surface, and also upon truth of position of surface. The ends of the bar must be perpendicular to its axis, and the planes which feel those ends must be truly parallel to each other, and one at least must be movable to and fro without deviating at all from the position of parallelism to its fixed neighbour,

Then comes the question of the amount of shifting of the movable plane. That is done by a micrometer screw, the linear motion for one graduation of the micrometer head, which can be easily read without a lens, being in some cases 1-10,000th of an inch, and in other cases 1-1,000,000th of an inch.

There is not space to discuss the measuring machine, whether as capable of producing cylindrical gauges varying by 1-10,000th of an inch, or as capable of reproducing a standard inch or a standard yard to a degree of accuracy which leaves the microscope far behind in the contest.

It must suffice to point out that the reprinted papers are full of interest, as showing the manner in which Sir J. Whitworth has thought out and accomplished the work of improving the construction of machinery, and it is matter of regret that those who are occupied in teaching mechanics have not better opportunities than now exist of becoming practically conversant with the subject-matter of the collected papers.

NOTES

FROM Punta Arenas, near the extremity of South America, intelligence has been received that the fourth section of the German expedition sent out to observe the transit of Venus has been particularly successful, Professor Auvers having managed to take exceedingly good photographs and numerous measurements.

A TELEGRAM received from Monte Video states that the *Volage* has anchored in these roads from Santa Cruz in Patagonia. Capt. Fleuriais and observers of the transit of Venus were on board, returning to France with their instruments, photographs, and other documents.

M. TRÉPIED, in a communication to the Paris Academy on his observation of the transit in Algiers, states that clouds rendered the ordinary observations of little value, but that some good results were obtained with the spectroscope on the borders of the planet in the region from A to E; while some photographs were obtained in the green, the blue, and the violet. The examination of the spectral lines in the groups A, B, α, in the regions comprised between α, D, E, did not show, M. Trépied states, anything which could be attributed to a selective absorption produced by an atmosphere on the planet. The same inference is deduced from the photographs.

AT a recent conference of members of the British Association, held in the rooms of the Geographical Society, a protest was drawn up against the proposed meeting of the Association in Canada in 1884.

AT the Conference of Head Masters the other day one of the subjects discussed was the teaching of geography in schools, in which many varied and vague opinions were expressed. There is in this country too great a tendency to treat geography as mere topography, the mere dry bones of the subject, which can only be clothed with flesh and endowed with life through the medium of the physical and natural sciences. We advise those teachers who desire to make the subject of geography both interesting and useful to make themselves acquainted with the programmes of German schools and universities under that head.

THE Société d'Encouragement has held its annual meeting for 1882, and awarded its gold medal to M. Gaston Planté for his work in the accumulation of electricity.

IN a recent number of the St. Petersburg Academy's *Bulletin* (1882, t. xxviii. p. 163), Herr Kortazzi reports on his observations of Jupiter at Nikolajus from September, 1879, to December, 1881, giving, in four plates, forty-seven drawings of the planet. The time of rotation, calculated from the red spot, he finds to have continually diminished, but not according to an ascertained law; more recently an increase has appeared. The spot can hardly (he considers) be regarded as gaseous; it is more likely a liquid or even solid mass forming part of the planet's surface. In the former case it might be considered a large lake in an ocean of other liquid, which covers the southern hemisphere of Jupiter, and it might be expected that this lake, owing to currents flowing over the surface of the planet, would gradually be diffused and spread over the whole surface, or at least over the whole parallel. If the spot were a solid projection from the solid body of the planet (if such a body there be), it would be impossible to account for the observed changes of position. The most plausible view is, that it is a solid floating mass on the surface of an ocean; but even this hypothesis the author considers bold, since we are not entitled to infer by analogy from terrestrial phenomena the nature of forms on Jupiter which may be very different in internal nature from the earth.

A DOE having horns, which gave it the appearance of the male animal, was recently killed in the woods of Herr Pönsgen, near Aix-la-Chapelle. The longer horn was about 19 centimetres in length. Such a case is rare, though small rudiments of horns are sometimes met with in old does. A picture of the animal is given in the *Revista Scientifico-Industriale*, October 31.

TO illustrate the effect of expansion of the bulbs of liquid thermometers on the indications of those instruments, Prof. Govi connects a capillary tube with a bulb of ebonite, and partly fills it with mercury. Such a thermometer does not indicate gradual variations of temperature (within certain limits). With rapid variations, the mercury shows *inverse* movement (descending with heat and rising with cold), but after some time the original level is restored, while the excess of heat or cold is lost. The phenomena are due to the almost perfect equality of the coefficients of cubical dilatation of ebonite and mercury, at least between zero and 50° or 60° C.; and to the fact, that with sudden changes of temperature, the bulb responds first, and being a bar conductor, transmits slowly to the mercury.

A RECENT report by M. de Bezerédy, Government Commissioner for cultivation of silk in Hungary, shows that the industry is making considerable progress in that country. In 1881 there were 2976 producers, who obtained 41,537 kilogrammes of cocoons in 426 communes, and the produce was sold for 41,816 florins. The corresponding figures for 1880 are: 1059 producers, 10,132 kgr., 109 communes, and 11,062 florins. The Commissioner sold in Italy the produce of 1881 for 63,000 florins, and the profit so realised allowed of the institution of a model school for silk-cultivation, without exceeding the credit voted by the Chamber. This school has received three primary teachers sent by the Minister of Public Education, and three from the Minister of Commerce; three more are maintained at private expense. These nine will acquire knowledge to be afterwards utilised in their place of residence. Further, a professor in the Model School of Graz has given public lectures on the rearing of silkworms in several villages, and more than 80 kgr. of cocoons have been distributed continuously to cultivators. Lastly, 28,956 mulberry trees have been planted at Government expense. The report recommends the establishment of spinning mills in the country, and the plantation of mulberry trees on land belonging to the communes, and on the Government roads. The climate of certain regions of Hungary is highly favourable to the production of silk.

THE *Times* Geneva correspondent states that the recent heavy rains, which recommenced on Friday, with, if possible, greater violence than before, are producing disastrous consequences in various parts of Switzerland. A considerable extent of ground, covered with vines, at Espesses, in Canton Vaud, is slipping rapidly towards Lake Leman, and, unless the measures taken by the engineers succeed in arresting its progress, must soon be engulfed. An earthslip has also taken place near Troistorrents, and another at Pully, in the same neighbourhood. Up to the end of November there had been 200 rainy days in that part of Switzerland since the beginning of the year, and only 50 days of sunshine.

AN international exhibition will be held in Calcutta next December. There will be nine principal sections: (1) fine arts; (2) apparatus and application of the liberal arts; (3) furniture and objects used in dwellings; (4) clothing, including fabrics; (5) products of mining industry, forestry, &c.; (6) apparatus and processes in the common arts; (7) food; (8) artisans' workmanship; and (9) children's work. An attempt will also be made to hold an exhibition of live stock, agricultural and horticultural products, and of a loan collection of paintings, sculpture, and works of art generally. The usual gold, silver, and bronze medals will be awarded by special juries of experts. The exhibition will be opened on December 4, 1883, and will close on February 29, 1884.

M. GERMER BAILLIÈRE has published an edition of Father Secchi's "Les Étoiles" in two volumes, as a part of the Bibliothèque Scientifique Internationale.

THE Academy of Moral and Political Sciences has announced the conditions of the competition opened every year for the prize of 200*l.* to be devoted to the author of the work, which is to "faire aimer," morality and virtue, and "faire repousser," vice and egotism.

M. DE CHANGY, the first electrician who attempted to manufacture incandescent lamps *in vacuo* about twenty years ago, has constructed a small model for demonstration. The carbon is rectilinear, which permits a very small length to be given to it. It is to be lighted with bichromate of potassium elements. In his former attempts M. de Changy advocated very small carbons cut in the graphite from the retorts. Now his fibres are carbonised according to the common practice.

THE introduction of western improvements into China by Europeans is evidently a work beset with many difficulties. Some years ago the only railway in the country was purchased by the Government from the proprietors and promptly torn up; but now the officials themselves are laying down railroads from the mines in North China to the nearest canal. The telegraph also

had to encounter a vigorous opposition from the authorities and people for many years; at present, however, the capital is connected by wire with the coast. The electric light is the latest improvement which has excited the suspicion and dislike of the Mandarins. The foreign settlement at Shanghai has for some time been lighted on the Brush system, apparently much to the comfort and jubilation of the denizens of the "model settlement," as the foreign portion of the city is generally called. The promoters appear, however, to have reckoned without the Chinese officials. They probably thought that where gas was permitted, there could be no objection to electricity. The Chinese Governor of the district appears to be of a different opinion. He has addressed a letter to the senior Foreign Consul requesting the removal of all the electric lamps. He has read, he says, in translations from European papers, that terrible accidents have arisen from electricity, and flatly refuses to permit the residents of Shanghai to be exposed to such dreadful risks. Hundreds of thousands of houses might be destroyed, millions of lives might be lost; even the walls of the city might be blown down if anything went wrong with the machines. He has strictly forbidden his own countrymen to use it, and has peremptorily ordered those who have already adopted it to discontinue it forthwith. Whether this ukase will be immediately obeyed or not it is impossible to say; but past experience leads us to the conclusion that if the Chinese have determined to set their face against the electric light, no power on earth can get them to permit it in their territory. Their leading principle in these matters seems to be a dislike of all innovation until its necessity is clearly demonstrated by *their own* experience, and a determination that new inventions or appliances shall not be foisted or forced on them from outside. The late difficulty with Russia showed them the imperative necessity of being prepared for war, and of having their capital in direct communication with the outer world. Ironclad ships and rifled guns are accordingly being purchased with extraordinary rapidity; forts are being erected at various points on the seaboard, and a telegraph line about 800 miles in length was constructed in the course of a few months. Perhaps, after all, the Chinese policy in this respect is not so wrong-headed as it sometimes appears. It certainly saves them from the wiles of speculators and promoters of all sorts.

THE additions to the Zoological Society's Gardens during the past week include two Bonnet Monkeys (*Macacus radiatus* ♂ ♀) from India, presented by Mr. Nathaniel Cotton; two Slender Loris (*Loris gracilis*) from India, presented by Dr. H. W. Lentaigne; a Leopard (*Felis pardus*) from India, presented by Capt. Park; a Crimson-crowned Weaver Bird (*Euplectes flammiceps*) from Madeira, presented by Mr. E. W. Gain; a Common Heron (*Ardea cinerea*) from Scotland, presented by Mr. W. H. Henderson; eleven Muscovy Ducks (*Cairina moschata*) from South America, presented by Major Finlay; a Hoary Snake (*Coronella cana*), a Crossed Snake (*Psammophis crucifer*), a Rhomb-marked Snake *Psammophylax rhombeatus*) from South Africa, presented by the Rev. G. H. R. Fisk, C.M.Z.S.; two Golden-winged Woodpeckers (*Colaptes auratus*) from North America, purchased; a Golden-Eye (*Clangula glaucion* ♂), British, on approval; a Molucca Deer *Cervus moluccensis* ♀), born in the Gardens.

OUR ASTRONOMICAL COLUMN

STELLAR PARALLAX.—The results of a series of observations with the filar micrometer on the Washington refractor for the determination of the annual parallax of α Lyræ and 61 Cygni have been printed in advance of the publication of the yearly volume of observations. The measures were made by Prof. Asaph Hall, those of α Lyræ extending from May 24, 1880, to July 2, 1881, on seventy-seven nights, and those of 61 Cygni from October 24, 1880, to December 7, 1881, on sixty-six nights. The magnifying power employed was 383. Prof. Hall remarks that since observations of the angle of position made with the micrometer-circle are less accurate for distances that enter into the determination of parallax, he observed simply the difference of declination of α Lyræ and the companion of the tenth magnitude, and in the case of 61 Cygni the difference of declination of the smaller component and a star of 9·5 magnitude about 3′·3 south of the double star, which is D.M. + 38°, No. 4345. α Lyræ was observed both with bright and dark wires, for 61 Cygni only the dark wires were used. It may be noted that the star measured is the following component of the double star. The course of observation pursued for each night's set of measures is described, and except on one occasion the same programme was followed throughout.

The resulting parallax for α Lyræ is, 0″·1797 ± 0″·00561; the time required for light to pass from the star to our sun is thus found to be 18·11 Julian years.

For 61 Cygni the parallax is 0″.4783 ± 0″·01381, and light requires 6·803 Julian years to traverse the space that separates this star from the sun.

The parallaxes it will be seen, are obtained by the differential method, and are thus relative, or they are the differences of the parallaxes of the two stars. To get the absolute parallax of the bright star it is necessary to add the parallax of the small star. Prof. Hall says that he might have effected this by means of the parallaxes for stars of different magnitudes given in Struve's table in his "Études d'Astronomie Stellaire," but as the whole matter is uncertain, he has omitted this reduction.

Dr. Ball, Astronomer Royal for Ireland, continues his researches on stellar parallax, at the Observatory of Dunsink, Dublin, and has lately published a determination of the parallax of 6 (Bode) Cygni, which is the well-known double star No. 2486 of Struve. The components are of 6 and 6·5 magnitudes. The existence of a parallax to a very measurable amount was suggested during the course of a series of preliminary observations in 1879 and 1880 for the detection of such proximate objects, and a systematic course of observation was commenced on October 3, 1880, and continued to December 22, 1881. 6 B. Cygni is No. 196 of Argelander's list of 250 stars having large proper motion, given in vol. vii. of the Bonn Observations, where it has attributed to it an annual motion of 0″·636 on an angle of 346° 27′; Argelander's positions belong to the preceding component. Dr. Ball has employed the following one in his investigation. Measures were obtained on twenty-six nights, the mean date being 1881·5207; they were made from a star *n.f.* of the 10·5 magnitude, the adopted mean distance of which is 170″·692.. and position angle 78° 18′ 61″. If this small star is assumed to be at rest, and Argelander's proper motion attributed to the double star, the annual increase of distance is + 0″·02, and that of angle + 12′·796; thus almost the whole proper motion applies to change in the position angle. The observations show that there is no regular increase of distance, and hence, Dr. Ball observes, there is *primâ facie* evidence that the comparison star does not participate in the proper motion.

The resulting parallax of Σ 2486 is—

From the distances	0″·5039 ± 0″·060
From the angles	0″·383 ± 0″·13

Combining these two values, we have for the parallax 0″·482 ± 0″·054. It is intended to make another series of observations of this star, the present result being regarded by Dr. Ball as merely provisional, though he thinks it can hardly be doubted that a parallax of very considerable amount really exists. The place of the star is in right ascension 19h. 8m. 20s., with 49° 35′·3 north declination for 1855·0.

COMET 1882 *b*.—The following positions of this comet for midnight at Greenwich, though liable to an error of several minutes of arc, may serve for finding it in the telescope without difficulty.

	Right Ascension. h. m. s.	Declination. ° ′	Log. distance from Earth.	Log. distance from Sun.
Dec. 31	7 14·9	−29 28	0·2365	0·3883
Jan. 2	7 9·2	29 10		
4	7 3·7	28 49	0·2489	0·3991
6	6 58·4	28 26		
8	6 53·3	28 2	0·2622	0·4096
10	6 48·4	27 36		
12	6 43·8	27 8	0·2763	0·4196
14	6 39·4	26 40		
16	6 35·2	26 10	0·2912	0·4294
18	6 31·2	25 40		
20	6 27·4	−25 9	0·3067	0·4388

AMERICAN RESEARCHES ON WATER-ANALYSIS

AT the instance of the U.S. National Board of Health, a comprehensive investigation relating to analysis of water has been recently conducted by Prof. J. W. Mallet, F.R.S., of Virginia, assisted by several chemists and others. It was proposed to examine carefully the chief processes in use for chemically determining the organic matter or its constituents, in drinking water, to test the absolute and relative accuracy of the results these processes are capable of yielding, and, as far as possible, to ascertain the nature and scope of the practical conclusions available for sanitary purposes, which might thence be secured.

A preliminary report of this inquiry has appeared in a recent supplement (No. 19) of the National Board of Health *Bulletin*, and we propose here to give our readers some idea of the nature of it.

Three chemists took charge severally of the so-called "combustion process" of Frankland and Armstrong, the "albuminoid ammonia process" of Wanklyn, Chapman and Smith, and the permanganate process as advocated by Tidy; they were, Mr. W. A. Noyes, who worked at Baltimore, Dr. Ch. Smart, U.S.A., at Washington, and Dr. J. A. Tanner, U.S.N., at Virginia. The water-samples were collected and distributed to these three places by Prof. Mallet, and all three chemists were required to examine their several samples on the same day. Prof. H. Newell Martin undertook a simultaneous microscopic examination, and pathological observations on the effect of injecting the waters, concentrated by evaporation at a very low temperature, under the skin of rabbits.

After a large amount of preliminary and special work, nine classes of waters were obtained or prepared, for the main series of test analyses, as follows :—

Class I.—Natural waters, believed to be wholesome (including the water-supply of some of the principal cities).

Class II.—Natural waters which were believed to have actually caused disease in those who drank them.

Class III.—Natural waters of doubtful, but more or less suspected character.

Class IV.—Artificially prepared waters, made by adding to wholesome water, certain amounts of various infusions of *vegetable* organic matter, such as drinking water is liable to be contaminated with.

Class V.—Waters prepared with various forms of *vegetable* refuse, from manufacturing or industrial operations.

Class VI.—Waters prepared with *animal* (or partly animal) organic matter of natural origin.

Class VII.—Water prepared with *animal* refuse from manufacturing or industrial operations.

Class VIII.—Water prepared by adding morbid products of human disease.

Class IX.—Solutions, in distilled water, of carefully determined amounts of pure substances of definite chemical compositions.

The report first deals with the *degree of accuracy* of the three processes examined, a matter which may be looked at in two ways: first, as to the concordance of the results of each process in duplicate or triplicate experiments on the same water; and secondly, as to the agreement of the results with the actual, quantitatively known, contents of a particular water.

In the case of multiplied experiments on the same water, then, the author first shows in three successive tables (for the three processes), the divergence of individual results from the mean, as *percentage on the mean*. It appears that, on the whole, the most closely concordant results were furnished by the permanganate process, and the least so by the combustion process, the albuminoid-ammonia process holding the intermediate position.

Next, a table is given showing the extent of agreement of results obtained by the different processes with quantities of organic constituents known to be actually present. The figures strikingly indicate certain important defects of the several processes, though (it is pointed out) they must be looked at in a broad, general way, remembering the small number of organic substances treated and their special characters.

The Report proceeds to deal with the effects on the results by the different processes of varying the extent of dilution of the same organic substances in water. Here, as regards the combustion process, distinct confirmation is had of the existence of two forms of constant error affecting evaporation. The weaker the solution the less is the amount of organic carbon obtained, and the larger the figure for organic nitrogen. If the usual interpretation of Frankland's C : N ratio be applied, the curious and important result of these sources of error follows, that the more dilute an organically-polluted water is, the more animal-like in origin will its polluting material seem to be; while the stronger it is, the greater will be the tendency to refer the contamination to a vegetable source—a distortion of conclusions manifestly in the opposite direction to that commonly assumed to be safe.

As to the albuminoid ammonia process, the weaker the solutions, the higher are the results obtained, both for free and albuminoid ammonia, the influence common to both being probably that of imperfect condensation in the distillation having a less effect as the quantity of ammonia is stronger. The lower results from the stronger solutions for albuminoid ammonia, may be partly due to the fixed charge of alkaline permanganate to the quantity of organic matter to be acted upon.

The results of the permanganate process are shown to be much less influenced by varying dilution within the limits of those experiments than those of the other processes.

The following, briefly stated, are the author's

Special Conclusions as to the Combustion Process

1. The combustion itself, carried out according to Frankland's directions, is a process of great delicacy, and quite satisfactory in its details, with proper precautions, and in trained hands. Gaseous volumetric analysis with the aid of the Sprengel vacuum, is sufficient.

2. The Frankland process is quite within reach of the manipulative skill of any fairly-trained chemist, but it requires practice and probably pretty constant practice. It is better adapted for large public laboratories, where many samples of water are examined, than for occasional use by a private individual.

3. The defective point is the failure of the evaporation to leave a residue representing the original organic matter; this (suspected hitherto) is regarded as now established. There are two constantly present errors (greatest with little organic matter), viz., loss of carbon, and gain of nitrogen from the atmosphere, the latter probably partly balanced by loss of that originally present in the water.

4. These errors, affecting unequally the carbon and nitrogen, are liable to alter the statement of the C : N ratio, and so distort sanitary conclusions.

5. The result for organic nitrogen, by the combustion process, is also affected indirectly by the errors connected with determination of the ammonia ("free ammonia"), as the nitrogen belonging to this has to be subtracted from the gross result.

6. A further, indirectly operative, cause of error as to the nitrogen arises from the varying loss of ammonia by dissociation of its salts during evaporation. The time occupied in evaporation, as well as the amount of ammoniacal salts present, will influence the amount of loss. Such error will mostly be very small, but may affect considerably the result for *organic* nitrogen.

7. The presence of nitrates presents a special difficulty in the combustion method. Mr. W. Williams's application of the copper-zinc couple deserves more precise quantitative examination than it has yet had. The simultaneous presence of urea with nitrites and nitrates, presents a case of peculiar difficulty, with several sources of error.

8. The formation of sulphuric acid during evaporation with sulphurous acid seems to occur oftener than has been recognised. It is much to be deprecated, though its effect, at any rate on the carbon determinations, has not seemed so great as might have been expected.

9. The combustion process, in its present form, cannot be considered as determining the carbon and nitrogen in a sense to justify the claim of "absolute" value for its results, which has been denied to those of other methods. It is but a method of approximation, involving sundry errors, and in part, a balance of errors.

10. There is, however, good ground for believing, that in many, perhaps most cases, its results for organic carbon may, with proper precautions, be made more valuable than the indications of the permanganate process, and its results for organic nitrogen more valuable than the indications of the albuminoid ammonia process.

Special conclusions as to the Albuminoid-ammonia Process

1. In the determination of both "free" and "albuminoid" ammonia there is a loss, which may be quite considerable, from imperfect condensation of the ammonia during distillation. This varies especially with the efficiency of the cooling apparatus and the time occupied.

2. Where waters contain urea and other amidated bodies, such as the leucine and tyrosine of putrefactive decay, some ammonia is so easily formed from these substances by boiling with sodium carbonate, or even without this addition, that it is impossible to distinguish sharply between pre-existing "free" ammonia (of ammoniacal salts), and that formed by the action of alkaline permanganate, the so-called "albuminoid" ammonia. This source of error as to free ammonia reacts (as noticed above), on the result for organic nitrogen by the combustion process.

3. There is no satisfactory evidence for Wanklyn's view, that, in distilling with alkaline permanganate, definite and simple fractions of the nitrogen of organic matter are given off as "albuminoid" ammonia. Such results may be varied at pleasure for most substances, by modifying the conditions of distillation.

4. If the distillation with alkaline permanganate be carried out according to Wanklyn, the nitrogenous organic matter is often so gradually acted upon, as to make the ending of the process indefinite; ammonia is still coming off when the distillation has to be stopped, the contents of the retort being nearly dry. Here an unknown fraction of the possible amount of albuminoid ammonia fails to be collected, and is but vaguely indicated by + after the figures recorded.

5. There is evidence that in some cases nitrogenous matter is volatilised during the distillation for free ammonia, which, if it had been retained, would have yielded up its nitrogen as albuminoid ammonia. Not affecting the Nessler reagent, such matter escapes detection.

6. The albuminoid-ammonia process proper, *i.e.* distillation with alkaline permanganate and determination of the ammonia evolved, is admittedly simple, and easily carried out with very little preparatory training.

7. The value of the results by this process depends more on watching the *progress* and *rate* of evolution of the ammonia than upon determining its total amount.

8. The recorded results by this process show a good deal of similarity between the figures for albuminoid ammonia and those for organic nitrogen (by the combustion process), but with frequent discrepancies of varying extent, such as prevent the one being taken as the accurate measure of the other.

Special Conclusions as to the Permanganate Process

1. The results by the Tidy method (the acidified permanganate at common temperature) and that of Kubel (operating at boiling point) differ irregularly from each other, the latter usually giving much higher figures, as was to be expected, but the ratio between the results by the two methods varies much in different cases.

2. On the whole, there seems to be a nearer approach to proportionality with the quantities of organic carbon found by the combustion process on the part of the Kubel process than on that of the Tidy process, but to this there are some very notable exceptions.

3. In a good many cases, the Kubel results are, contrary to the general rule, lower than those by the Tidy method. This seems to be due to loss of organic matter by volatilisation with the escaping steam from the boiling liquid before time has been afforded for action on the permanganate. Of course, a similar loss may have occurred in other cases, but not to the extent of reversing the general rule; and this may in part explain the absence of any uniform ratio between the figures yielded by the two methods.

4. The results by the Tidy process are liable to variation with the atmospheric temperature at the time of operation.

5. The amount of oxygen consumed by a specimen of water is probably in all ordinary cases much below that required for complete oxidation of the organic matter present, and does not stand in any fixed ratio thereto; it cannot be taken either as a measure of the organic carbon or of the total organic matter. Still a distinct general resemblance may be traced between strongly marked results, high or low as the case may be, for the consumption of oxygen on the one hand, and organic carbon (by the combustion process) on the other, and closer agreement is observable regarding waters of generally similar character.

6. The permanganate process is capable of giving more valuable information in regard to a water by watching the *progress* and *rate* of the oxidation of organic matter present than by any single determination of the actual amount of oxygen consumed in a given time.

7. For such observation of the progress of oxidation, the two determinations prescribed by Tidy, viz. of oxygen consumed in one hour and three hours respectively, are not sufficient, nor is the latter period of three hours long enough to indicate the general behaviour of the water with the acid permanganate.

As to other chemical determinations, the discrepancies in those of total solids left on evaporation, of the loss on ignition of this solid residue, and even of chlorine, are noted as illustrating the comparative roughness of the methods with which those results were obtained when very small quantities have to be dealt with. A coincidence is often presented between alkaline reaction of a water and the occurrence of nitrites and nitrates in considerable quantity, suggesting a recollection of the conditions under which nitrates are produced on a large scale in the decay of nitrogenous organic matter. Those salts, however, also occur pretty largely in some cases without alkaline reaction, and in other cases there was alkaline reaction and also much nitrogenous matter, but no nitrites nor nitrates. Ammonium nitrates seem to be rare, the basis-constituent being rather mostly non-volatile—no doubt calcium, magnesium, or one of the alkaline metals; this is noticed as in relation to possible reduction to nitrite, and consequent loss of nitrogen in the combustion process. Experiments with tannin showed the utter worthlessness of this group reagent of Kämmerer for the purpose for which he has advocated its use. The general series of analyses of dissolved gases illustrate how the results are influenced by varying conditions of oxidisability of organic matter present, temperature, extent of exposure to the atmosphere, and interchange with it, in both direction, of gaseous constituents.

With regard to the *microscopic and pathological results*, Prof. Mallet, feeling himself incompetent to properly discuss these, prefers leaving them to speak for themselves, and merely remarks on some of the difficulties of such research, and, at the same time, on its importance and value when rightly conducted.

Passing now to sanitary conclusions and interpretation of results, the Report deals with

Chemical and Biological Results as contrasted with the actual Sanitary History of the Natural Waters Examined

Now on inspection of the tabulated results it appears that *no strongly marked generic difference is presented by the results from any of the processes for estimation of organic matter or its elements between the generally wholesome waters of Class I. and the waters of Class II. medically condemned and fairly assumed as pernicious.* This applies equally to the highest, the lowest, and the average results. No one could, with those figures to guide him, refer a water of unknown origin to one or other of the two classes, on the basis of chemical analysis by any or all of the three methods. Attention is called to the smallness of the amount of organic matter indicated as present in many of the most dangerous waters, giving important evidence against any chemical theory of the production of disease from this source (on the simple assumption that some of the chemical products of decomposition of organic matter are poisonous or noxious in their effect on the human system). Thus in the case of two waters of highly dangerous character, if the whole of the organic carbon and nitrogen present existed as strychnine, it would be necessary to drink about half a gallon of the water at once, in order to swallow an average *medicinal* dose of the alkaloid. It is not easy to believe that the ptomaines, or other chemical products of putrefactive change, can be so much more poisonous than the strongest of recognised poisons. While most of the mischief in drinking water is probably attributable to living organisms, the possibility is noted, that indirectly a large amount of organic matter in water may be more dangerous than a smaller quantity, as furnishing on a greater scale the suitable material and conditions for development of organisms. Whether variations in the mere quantity of organic matter within such limits as occur in water likely to be used for drinking are of much importance in this respect, is a question on which (in the author's opinion) depends largely the utility of all attempts to estimate the quantity of organic matter or its constituents as such.

A much more conspicuous difference between the waters of Classes I. and II. is presented by the results for nitrites and nitrates. These salts are either absent or present in but trifling

amount in the wholesome waters of Class I., but almost universally present, and often in large quantity, in the pernicious water of Class II. They are very variable as to presence and amount in the doubtful waters of Class III. This result is worthy of special attention in view of the different opinions which have been expressed (by Wanklyn, Angus Smith, Frankland, Griess, Ekin, Haines, &c.) as to the sanitary conditions of nitrites and nitrates in water.

Among the artificially polluted waters were a number of samples of such general character as to be under the gravest suspicion on sanitary grounds (suspicion corroborated in sundry cases by biological tests), in which, nevertheless, nitrites and nitrates were not found; but these waters had an extraordinarily large amount of organic matter, generally accompanied by very large amounts of ammonia.

Looking at the results for Classes I. and II., and bearing in mind the conclusions reached by Müller, Schloesing, and Muntz, Störer, Warrington, and others, as to the process of nitrification being due to presence of an organised ferment or ferments of bacterial character, "the idea suggests itself whether the noxious character of waters containing largely nitrates and nitrites—themselves presumed to be harmless—and but very little organic matter—which ought to be present, of some sort, to support the 'previous contamination view—*may not be in reality due to the presence of a special nitrifying ferment, itself to be classed among the lower organisms capable of propagating disease.*'"

Two points are noted as requiring caution in regard to the above conclusions: first, the samples may have undergone some chemical change in the interval from their collection to their reaching the analysts (but such changes could hardly have been great); secondly, it was necessary to take *exaggerated instances* of mischief; and the organic impurities present in the waters concerned may not be the same as those which would produce slighter, but, in time, serious ill effects. Slighter forms of disease, really attributable to drinking water, may perhaps be numerous, and possibly of various types, but generally the difficulty will be too great of securing, in view of the many factors concerned, any satisfactory evidence as to their cause.

In regard to determinations of chlorine, the results are in many cases of water from shallow wells, significant enough of contamination by fluid animal excreta. The amount of chlorine in the case of several wells near the sea, shows the need of thought as to the natural source of a water in drawing conclusions from the presence of chlorides. Even where chlorine has come in with organic matter, this impropriety in too hastily deciding, as is sometimes done, that a small quantity indicates vegetable, and a large quantity animal contamination is illustrated by several cases.

Prof. Martin and Dr. Hartwell were asked to independently mark waters as "dangerous" and "suspicious" on the basis of the biological observations. The results, as summarised in a table, prove that these methods will not afford the means of deciding between a wholesome and an unwholesome natural water. Several of the waters believed to be fairly wholesome, and certainly in use on a large scale, are marked "suspicious," while not one of the waters believed to have proved themselves pernicious when used by man, are set down as "dangerous." In many cases the waters which affected rabbits most, contained *very large* amounts of organic matter, so large as to probably invalidate comparison with natural waters or with the much more dilute specimens of prepared water. On the other hand, with three strengths of a solution of organic material, it was not the strongest that produced the most marked effects. The pernicious character of waters containing relatively but very little organic matter, seemed to be proved by several cases; probably supporting the idea that it is not mainly the amount of organic matter, but the presence and nature of low organisms that render drinking-water unwholesome. Much difficulty in interpretation of the biological results seems to have arisen from too great differences of absolute strength in the solutions of organic matter used.

SCIENCE AT KHARKOFF[1]

THE Society of Naturalists at the Kharkoff University is one of those which were founded a few years ago for the advancement of the natural sciences generally, and especially for the study of the natural history of Russia in the provinces that surround University towns, and which have already rendered most valuable services in both these directions. The Kharkoff Society of Naturalists, which numbers 117 members, has already published fifteen volumes of their Transactions (*Trudy*), which contain many valuable papers. Of those in the earlier volumes we will only mention, in geology: The chemical researches of rocks and coal of the Dnieper basin, by A. S. Brio; geological explorations in the government of Kharkoff and in the Coal-measures of the Don, by A. W. Guroff; and in the basins of the Dnieper and Kalmius, by M. F. Klemm; the explorations of the Delta of the Dnieper, and microscopical analyses of the Dnieper granites and of the fossil trees of Southern Russia, by M. E. Krendovsky; the very interesting researches into the formation and shapes of valleys in Southern Russia; on the crystalline rocks of the Dnieper; on black earth, on the Devonian formation of the Sosna and Tim river, and on the structure of the mountains of Taurida, by Prof. S. F. Levakovsky; and on the hydrography of the Northern Dönets river, by J. T. Morozoff. The attention of the Kharkoff zoologists was especially attracted during recent years to the obnoxious insects which destroyed the crops, and we find in the *Transactions* of the Society several papers devoted to the subject, such as a complete description of the locusts and other insects inhabiting corn-fields, by P. W. Ivanoff; on the parasites of the locust and the corn-beetle, by P. T. Stepanoff; and on obnoxious insects of the province of Kharkoff, by W. A. Yaroshevsky. The same author has published also nearly complete lists of the Hemiptera, Heteroptera, Diptera, and Lepidoptera of the province of Kharkoff. Among many other contributions in zoology and physiology we notice physiological researches into the structure of the eyes of birds, on the movements of protoplasm, on the air-sacs of birds, and on the mechanism of their breathing; on the movements of *Unio*, and of *Anguis fragilis* (all with numerous plates), by R. F. Byeletzky; on water-acarides, by M. E. Krendovsky; on the *Bythotrephes* of the Sea of Azov, and on a new *Polyphemida*, by N. P. Pengo; on Infusoriæ, Turbellariæ, and Lepidoptera of the province of Kharkoff, by Madame S. M. Pereyaslavtreff; on the development of Nematodes, and on *macrobiotus macronyx*, Duj., by the late G. M. Radkevitch; and on the Araneæ fauna of the province of Kharkoff, by W. W. Reinhard. There are but few papers on botany in the *Transactions*. K. S. Gornitsky contributes a "Conspectus plantarum" of the Walki district of the province of Kharkoff; E. M. Delarme has two contributions on the anatomy of Coniferæ and on the Kirkazon plants; N. F. Kransakoff publishes a list of plants of the neighbourhood of Taganrog, and Novocherkask; and L. W. Reinhard, on the conjugation of zoospores, and on the Characeæ of Middle and Southern Russia. All these papers are profusely illustrated, and sold each separately at very low prices.

The recent (fifteenth) volume of the *Transactions* (*Trudy*), contains the work done by the Society in 1881. M. Stepanoff contributes a paper on the very unsettled question as to the metamorphosis of Bombylides. He has found larvæ of Bombylides in cocoons of *Stauronotus vastator*, Stev.; they support very well temperatures as low as −20° Cels., and can remain at life for more than one year. The opinion of M. Zetterstedt as to the larvæ of Bombylides living also freely, non-parasitically, in the soil, seemed to be confirmed by M. Stepanoff, who found them in the autumn and in the spring in the soil, but they might have already abandoned their former dwellings. M. Stepanoff gives also a complete description (with coloured drawings) of the larvæ of *Systœchus leucophagus*, Mg. —M. Kulchitzky contributes two papers; on the endings and ramifications of the motor nerves of the lower vertebrata (the author doubts that the motor nerves necessarily end in small lamellæ under the sarcolemma, as it was observed by Herr Kühne); and on the origin of the coloured globules of the blood of Mammalia; these last—the author says—arise, not out of protoplasm, but from globules of lymphoid elements which undergo a whole series of very complicated metamorphoses.—M. Yaroshevsky gives a list of Neuroptera and Hymenoptera of the province of Kharkoff. The Neuroptera of the close neighbourhoods of the Kharkoff city number no less than sixty-one species. The Hymenoptera number 400 species, of which no less than 235 are known in the neighbourhood of the Kharkoff city. The same author, in company with M. Sokoloff, contributes a paper on the state of larvæ of the corn-beetle (*Anisoplia*) during the winter. The recent ravages of the corn-beetle in Southern Russia had provoked new researches on this

[1] *Trudy Obshestva Estestvoispytatelei pri Kharkovskom Universitete* (Transactions of the Society of Naturalists at the Kharkoff University), vol. xv. 1882.

subject, and a controversy had arisen among Russian entomologists, some of them being of the opinion that the larvæ remain during the winter in the upper frozen sheet of the soil, and are in a state of sleep, while others affirmed that they go deeper into the unfrozen soil, and eat there the roots of plants, but die completely if exposed to temperatures below the freezing point. The researches of MM. Yaroshevsky and Sokoloff proved that these larvæ fell asleep when exposed to temperatures below zero, but immediately returned to life as soon as exposed to a warmer temperature. In the frozen soil, whose temperature was one degree below zero, they found plenty of larvæ of *Asilus*, *Elateridæ*, *Heliothis dipsaceus*, and whole nests of ants with their larvæ. All returned to life when warmed. M. Byeletsky contributes a paper on the respiration of the gigantic Salamander, *Cryptobranchus japonicus*, Hœv., one metre long, and weighing four kilograms (several individuals of the same species measure, as is known, four feet, and weigh nine kilograms). Siebold had already observed the very long pauses between the breathings of this Salamander, sometimes lasting for half an hour. M. Byeletsky found that at a temperature of water about 15° Celsius, his Salamander remained without breathing sometimes for an hour and a half. In the air it breathed more often. M. W. Reinhard contributes an elaborate paper on the structure and development of freshwater Bryozoa. After a sketch of our present knowledge of the subject—up to the last works of Messrs. Nitsche, Hatschek, Hyatt, and Allmann—the author describes at length the structure of *Crystatella mucedo*, giving special attention to the development of the statoblasts, and the sexual multiplication of *Alcyonella fungosa*. The paper is accompanied by seven well-engraved plates.

THE HIBERNATION OF ALETIA XYLINA, SAY., IN THE UNITED STATES, A SETTLED FACT[1]

I HAVE already shown in previous remarks before the Association that there were various theories held by competent men, both entomologists and planters, as to the hibernation of this *Aletia* (the common Cotton Worm of the South), some believing that it hibernated in the chrysalis state, some that it survived in the moth state, while still others contended that it did not hibernate at all in the United States. I have always contended that the moth survives within the limits of the United States, and in this paper the fact of its hibernation, principally under the shelter of rank wire-grass, is established from observations and experiments made during the past winter and spring. The moth has been taken at Archer, Fla., during every winter month until the early part of March, when it began to disappear, but not until eggs were found deposited. The first brood of worms was found of all sizes during the latter part of the same month on rattoon cotton, while chrysalides and fresh moths were obtained during the early part of April.

The fact thus established has this important practical bearing:

"Whereas upon the theory of animal invasion from some exotic country, there was no incentive to winter or spring work looking to the destruction of the moths, there is now every incentive to such action as will destroy it either by attracting it during mild winter weather by sweets, or by burning the grasses in which it shelters. It should also be a warning to cotton-growers to abandon the slovenly method of cultivation which leaves the old cotton-stalks standing either until the next crop is planted, or long after that event; for many planters have the habit of planting the seed in a furrow between the old row of stalks. The most careful recent researches all tend to confirm the belief that Gossypium is the only plant upon which the worm can feed, so that, in the light of the facts presented, there is all the greater incentive to that mode of culture which will prevent the growth of rattoon cotton, since it is very questionable whether the moth would survive long enough to perpetuate itself upon newly-sown cotton, except for the intervention of rattoon cotton."

[1] Abstract of a paper read at the Montreal meeting of the Am. Ass. Adv. Sc., by Dr. C. V. Riley.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—The following Boards of Electors have been thus constituted:—

Professorship of Anatomy: Professors Flower, P.Z.S., Allen Thomson, Paget, Huxley, A. Newton, Liveing, Dr. Michael Foster, and Mr. J. W. Clark.

Downing Professorship of Medicine: Sir G. Burrows, Bart., Drs. Farre, Lauder Brunton, R. Quain, Professors Paget, Liveing, Humphry, and Mr. Main.

Professorship of Pathology: Professors Bardon Sanderson, Latham, Humphry, Paget, Sir James Paget, Drs. Michael Foster, J. F. Payne, and W. H. Gaskell.

Professorship of Political Economy: Messrs. L. H. Courtney, M.P., A. Marshall, H. S. Foxwell, R. H. Inglis Palgrave, H. Sidgwick, V. H. Stanton, H. J. Roby, and Prof. James Stuart.

Dr. Michael Foster is appointed an additional member of the Special Boards for Medicine, and for Biology and Geology.

Candidates for the Plumian Professorship must send in their names to the Vice-Chancellor on January 6; the election will take place on January 16.

A report has been issued recommending various modifications in the Previous and General Examinations; it, however, contains no indication of any approaching relief from examination in Greek, or of the introduction of French or German into the ordinary curriculum, or of any natural science subject. As the syndicate contains several names of scientific weight, this appears rather surprising.

SCIENTIFIC SERIALS

Bulletins de la Société d'Anthropologie de Paris, tome v. fasc. iii., 1882, contain the concluding part of M. G. D'Hercourt's "Ile de Sardaigne." In this paper the author considers at length the nature and presumed purpose of the massive conical structures known as *nur-aghes*, of which there are upwards of 3000 on the island of Sardinia, generally on, or near the coast. Since Diodorus of Sicily, who ascribed their origin to Dedalus, they have been a puzzle to the learned. The author's remarks on the intelligence of the modern Sardi, notwithstanding that craniometrically they rank among the lowest European races, gave occasion to various discussions at subsequent meetings.—A communication from M. Beauregard in regard to a discovery, made last January by M. Crevaux, of an ancient city of the Incas, at 10 kilom. from Salta, in the Argentine Republic, whose geographical position the latter was engaged in determining at the time.—On the various races inhabiting French Cochin China, by M. G. de Clanbry, who confirms the general view of the moral and social degradation of the Annamites. He draws attention to the slight distinctions perceptible between the men and women of these tribes in voice, length of hair, gait, features, &c., and supplies interesting details in regard to the local flora.—M. Topinard, in presenting to the Society Hölder's craniometer, based on geometric methods, described the craniometric and anthropometric instruments in use from Camper's time to our own.—On the merits of M. Beaumanoir's system of comparing the facial and cranial areas, by M. Corre.—A report by M. Deniker of the result of the official examinations for the Society, of an adult ourang-outang, and a young female chimpanzee, recently brought to Paris. The latter, as in the case observed by Darwin, showed its temper like a petulant child, by pouting, kicking, grinding its teeth, and *shedding tears*.—A paper by M. Corre, on the craniometric relations of certain anthropomorphous apes.—Report by M. de Mortillet of the labours of the Commission appointed to examine and protect the megalithic monuments of France. By the efforts of the Commissioners the remains at Carnac have been secured from further demolition, and the Locmariaquer group, including in the so-called "Roi des Menhirs" the largest known monolith, has passed by purchase under the control of the State.—On the abnormal development of the teeth in a child's jaw, belonging to the Stone Age, and found at Erlen, near Colmar, by Dr. Collignon. The general dental system shows a low racial character, while the large permanent molars had come up before the milk teeth had been shed.—A communication by M. Hovelacque, on certain ethnographic survivals in Marne and Berry. In the former province it is deemed specially unlucky to use the horses of a deceased person till after his funeral; in the latter the hives must have a black ribbon attached to them while the family wears mourning, and to avert evil fortune from the house of a departed master, one of his nearest relatives must proclaim to the bees that their former owner is dead.—M. Chervin, on the census of the French people in 1881. The author shows that the augmentation since 1876 has been only 20 per 1000 in France, while in England it was 145, and in Germany as much

as 574 per 1000! Maine and Normandy, notwithstanding their natural productiveness, are conspicuous for the regular diminution of their populations.—On a new form of sclerosis of the cerebral convolutions, by M. Pozzi, with special reference to the cerebral lesions common in insanity.—M. Duval's demand, in the name of a large number of his *confrères*, for the foundation by the Society of an annual Darwinian Conference, was opposed by M. Mortillet in as far as the term Darwinian was concerned, which he proposes to replace by that of *transformist*, arguing that the adoption of the word "Darwinism" is an act of injustice to Lamarck, whose researches entitle him to be regarded as the father of transformism. The question has been referred to the Central Committee.—M. Topinard's explanation of the funereal objects collected in the Philippines by M. Marché's mission.—A discussion on the project for a general manual of ethnographic questions, as drawn up by M. Letourneau for the Society. The plan followed, which is that adopted by the Florentine Society of Anthropology, is criticised at great length by M. Dally, who strongly objects to the phraseology and definitions employed in the questions, and in consequence of his objections M. Letourneau's proposed "Questionnaire" has been referred to a special commission for further consideration.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, December 14.—Note on a discovery, as yet unpublished, by the late Prof. F. M. Balfour, concerning the existence of a Blastopore, and on the origin of the Mesoblast in the embryo of *Peripatus capensis*, by Prof. Moseley, F.R.S., and Adam Sedgwick, M.A., Fellow of Trinity College, Cambridge.

The late Professor Balfour was just before his death engaged on the preparation of a monograph on the anatomy and development of the members of the genus Peripatus, together with an account of all known species. He left a series of notes, completed MSS., and drawings, which will be edited by the above authors, and issued shortly in the *Quarterly Journal of Microscopical Science*. His discoveries, however, concerning the early embryology of *P. capensis* are so remarkable that the above preliminary note has been communicated at once to the Royal Society.

The discovery is shortly as follows:—That a widely open slit-like blastopore is formed in the early oval embryo of Peripatus, which blastopore, occupying the median ventral line, becomes closed in its centre an anterior portion remaining open as the mouth, whilst a posterior portion apparently becomes the anus. The mesoblast is formed from the hypoblast at the lips of the blasotopre, and makes its appearance as a series of paired hollow outgrowths from the cavity of the archenteron. This most primitive method of the the formation of the mesoblastic somites closely similar to that occurring in Amphioxus and other ancestral forms, is of the greatest morphological significance, and it is especially interesting to find that it survives in an entirely unmodified condition in Peripatus, the adult organisation of which proves that it is a representative of an animal stock of the most remote antiquity.

Mr. Sedgwick, by examining some embryos in Prof. Balfour's collection of material as yet uninvestigated, has been able to confirm his results, and also by finding earlier stages to verify certain points in the developmental history which rested at the stage at which Prof. Balfour's inquiry ceased, mainly on inference. A discussion took place, in which Prof. Huxley, Prof. Lankester, and Mr. A. Sedgwick took part. The latter pointed out the close resemblance of the early embryo Peripatus with open blastopore to an actinia, the mesoblastic pouches corresponding to intermesenterial cavities, and the blastopore to the mouth, and urged that the discovery tended to confirm Prof. Balfour's published theory as to the origin of the bilateralia from the elongation transversely of a disc-like ancestor, the ventral nerve-cords having been formed by the pulling out into long loops of a circum-oral ring.

Prof. Lankester expressed his opinion that the view that the blastopore represented astructure, which in an ancestral form acted as a mouth, must be abandoned. The blastopore is very probably merely an aperture necessarily formed in the process of production of the hypoblast by invagination, and has never had any special function. Prof. Huxley pointed out the essential difference between the peripheral nerve ring of Hydromedusæ and a true circumoral nerve ring.

Geological Society, December 6.—J. W. Hulke, F.R.S., president, in the chair.—Charles Bird, Enoch Cartwright, Henry Eunson, William Johnstone, Henry Liversidge, Henry George Lyons, Joseph Mawson, Horace W. Monckton, Henry Alexander Miers, John Postlethwaite, and Thomas Viccars, were elected Fellows of the Society.—The following communications were read:—Note on a Wealden fern, *Oleandridium* (*Tæniopteris*) *Beyrichii*, Schenk, new to Britain, by John E. H. Peyton, F.G.S.—On the mechanics of glaciers, more especially with relation to their supposed power of excavation, by the Rev. A. Irving, F.G.S. Generally, the author concluded, from mechanical and physical considerations, that far too much *erosive* power has been attributed by some writers to glaciers, and that it is doubtful if the work of actual *excavation* has been accomplished by them at all. The *differential movement* of glaciers he attributed to three causes: (1) cracking and regelation (Tyndall and Helmholtz); (2) generation of heat by friction within the glacier (Helmholtz); (3) the penetration of the glacier by *luminous solar energy*, the absorption of this by opaque bodies contained in the ice (stones, earth, organic germs, &c.), and the transformation of it in this way into *heat*. To this last he attributed the greater differential movement of the glacier (*a*) by day than by night, (*b*) in summer than in winter.

Physical Society, December 9.—Prof. Clifton, president, in the chair.—New members: Mr. H. E. Harrison, B.Sc., Mr. S. T. H. Saunders, M.A.—Prof. G. Forbes read a paper on the velocity of light of different colours. The author concluded from his experiments described to the Society a year ago, that blue rays travel quicker than red rays. M. Cornu had endeavoured to explain this result by peculiarities of the apparatus employed; but this explanation seemed doubtful. It was suggested that the experiments might be repeated with such modifications of the apparatus as would set the question at rest.—Professors Ayrton and Perry read a paper on the resistance of the voltaic arc, or the opposition electromotive forces set up. The electromotive force was measured by a voltmeter connected between the terminals of the lamp. Keeping the width of arc constant the E.M.F. was found to diminish as the current increased. Keeping the current constant, the E.M.F. increased rapidly, at first with an increasing width of arc, and afterwards more slowly. The authors gave a curve representing the change. About 80 volts are required to produce an arc of one-third of an inch. For further increase of arc E.M.F. is therefore proportional to increase of length of arc. The authors also read a paper on the relative intensities of the magnetic field produced by electromagnets when the current, iron core, and length of wire, &c., are constant, but the wire differently distributed. In *a* case the wire was wound uniformly from end to end; in *b* case it was wound from the middle to one end; in *c* case it was wound only at both ends; in *d* case it was wound only at one end. The field was measured along a line running through the axis of the poles beyond the magnet of the above plans; *a* gave the strongest field, except at short distances, when *b* was best.—Professors Ayrton and Perry also exhibited a set of three Faure accumulators in series feeding twenty Swan lamps, each lamp giving over 1 candle power. The electromotive force of each cell was about 2 volts.

Anthropological Institute, December 12.—Mr. M. J. Walhouse, F.R.A.S., in the chair.—Mr. A. L. Lewis exhibited some Neolithic flint implements and flakes found by him at Cape Blanc Nez, near Calais.—A paper by Mr. A. W. Howitt, F.G.S., on the Australian class systems, was read, in which the author discussed and explained the various rules with respect to marriage adopted by several of the native tribes.

SYDNEY

Linnean Society of New South Wales, September 27.—Dr. James C. Cox, F.L.S., &c., in the chair.—The following papers were read:—On a resinous plant from the interior, by K. H. Bennett. Specimens of the gum or resin of this plant, which Mr. Bennett described as *Myoporum platycarpum*, R. Br., were exhibited.—On three new fishes from Queensland, by Charles W. De Vis, B.A. This paper was a description of a new genus of the family Berycidæ, and a species of *Homalogrytes* and *Scolopsis*.—Contribution to a knowledge of the fishes of New Guinea, No. 2, by William Macleay, F.L.S., &c. This is a continuation of a list of the fishes found at Port Moresby by

Mr. Andrew Goldie.—Description of two fishes lately taken in or near Port Jackson, by William Macleay, F.L.S., &c.—On the physical structure and geology of Australia, by the Rev. J. E. Tenison-Woods, F.L.S., &c. This paper dealt at length with all the physical features of the Continent, viz. :—its mountain systems, its inland plains, and the portions intervening between the tableland and the sea, and its river-systems. Secondly the author enumerated the formations which had been recognised in Australia from the fundamental granite up to the recent alluvial. Showing that none of the large groups of rocks which are known in other parts of the world are absent from this continent. References were made to the character of the fossils found, and the soils resulting from the rocks.—On a large cretaceous *Mytilus*, from the Barcoo, by the Rev. J. E. Tenison-Woods, F.G.S., &c. This paper was descriptive of a very large fossil *Mytilus* (*M. ingens*. sp. nov.), which was found in some mesozoic strata in Queensland, of probably Oolitic age. The paper also contained a brief reference to the collections of Mesozoic fossils made in Australia.—Notes on the inflorescence and habits of plants indigenous in the immediate neighbourhood of Sydney, by E. Haviland The author gives an account of his observations on the mode of fertilisation of two species of rutaceous plants common in the neighbourhood of Sydney—*Philotheca australis* and *Boronia pinnata*. In the former species the arrangement of the parts of the flower is such as apparently to specially favour self-fertilisation, but a closer observation shows that this is rendered physiologically impossible by the maturing and discharge of the pollen of each flower before the stigma comes to maturity. A similar phenomenon was observed in *B. pinnata*, and the author suggests that the close opposition of the anthers to the stigma in these species until the pollen is almost ripe, may be designed in order to prevent, to some extent, the access of light and heat, and thus retard the maturing of the stigma until the pollen of its own flower has become discharged.—Note on some seaweeds from Port Jackson and adjacent coast, by E. P. Ramsay, F.L.S.—Mr. W. A. Haswell read a note on some points in the anatomy of the pigeons referred to by Dr. Hans Gadow in a recent paper on the anatomy of Pterocles.—Prof. Stephens exhibited a collection of rocks and fossils illustrating the structure of the Western coal-fields, as explained by Mr. Wilkinson in his map of Wallerawang (1877).

BERLIN

Physical Society, December 1.—Prof. Kirchhoff in the chair.—Dr. Hertz described and exhibited an apparatus he had constructed for demonstration of such weak electric currents as change their direction very often, several thousand times in a second. He called attention to the defects of the electro-dynamometers previously employed for the purpose, and showed that the electric heat-effect could most fitly be used in this case. The new dynamometer consists of an extremely thin horizontally stretched silver wire, the extension of which by heat, produced by the alternating currents, is observed. To this end the wire is, at its middle, wound round a vertical cylinder of steel capable of rotation about its axis, by turning of which the wire is stretched. Each extension of the wire through electric heating turns the cylinder the opposite way to his torsion, and its rotation is observed by means of a mirror and telescope. This dynamometer, as Herr Hertz showed, is only applicable when the currents are weak, and the current reversals are very frequent; that is, precisely in cases where other measuring instruments fail.—Prof. Helmholtz then spoke on his thermodynamic investigations of chemical processes, and their relation to the electromotive force of galvanic batteries, and fully explained his views both on the reversibility of chemical processes and the electromotive forces in batteries; also the experimental verification of these views in a "Calomel battery" comp sed of zinc, chloride of zinc solution, mercurous chloride, and mercury. The results hitherto obtained in these experiments and considerations, were brought by the author before the Berlin Academy of Sciences in July, and he is at present still engaged with the inquiry.

Physiological Society, December 8.—Prof. du Bois Reymond in the chair.—Prof. Munk read a paper upon two investigations which had been carried out in his laboratory. The first of these was by Mr. M. Preusse, on the Tapetum in the retina of some mammals. It appeared from this chiefly anatomical investigation that a tapetum is always present in the eyes of dogs, horses, and cats; and further that this tapetum is of an irregularly triangular shape and that the greater part of it is situated in the outer and upper quadrant of the retinal surface; so that it is specially impinged upon by the rays that enter the eye from beneath; over the median line and the equator of the retina the tapetum extends only a little, and this inwards and under. The point of entrance of the optic nerve always lies to the inside of the tapetum, which attains its greatest height above the nerve-papilla. In the case of all the animals that were examined, the situation of the tapetum corresponds with the region of most distinct vision. Hence is seen the correctness of Mr. Brücke's view that the tapetum acts as a mirror at a plane behind the cones and rods that are sensitive to light, which sends back a second time through the axes of these cones and rods the rays of light that have already passed through them. This arrangement is of particular service to animals when the illumination is feeble, and it explains how the above-mentioned animals can distinctly see objects lying on the ground even when slightly illuminated, and consequently also at night-time. The second investigation on which Prof. Munk reported was that made by Dr. Karlin on the vaso-motor nerves. It is well known that Prof. Goltz has, from experimental evidence, laid down the doctrine that the blood-vessels have ganglion-cells on or in their walls, which cause the blood-vessels to contract, and which are connected with the central organs by means of vaso-motor nerves which generally dilate but also occasionally contract the blood-vessels. The well-established fact that a section of a nerve, *e.g.* of the sciatic nerve, is followed by an expansion of the vessels in its tract was regarded by Prof. Goltz as the result of the action of the vaso-dilator nerves stimulated by the section, and the after occurring contraction of the vessels as the result of the action of the peripheral vaso-motor centres which in course of time attain the preponderance. This doctrine had received support from Prof. Bernstein's experiments, in which a great dilatation of the vessels was observed to occur, on stimulation of the divided sciatic nerve, in extremities in which contraction of the vessels had been induced by a great lowering of the temperature, and consequently a strong dilatation of the vessels was caused by direct electrical stimulation of the nerve. Dr. Karlin repeated the above experiment, and found its results confirmed only when very strong currents were employed; when, however, weak or moderate stimulation was applied, a contraction instead of a dilatation of the vessels took place. Accordingly the dilatation of the vessels on powerful stimulation is to be regarded as due to a paralysis, and the experimental evidence for the existence of vaso-dilator nerves as inconclusive.

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THURSDAY, MARCH 12, 1885

THE SNAKE-DANCE OF THE MOQUIS OF ARIZONA

The Snake-Dance of the Moquis of Arizona; being a Narrative of a Journey from Santa Fé, New Mexico, to the Villages of the Moqui Indians of Arizona, &c. By John G. Bourke, Captain Third U.S. Cavalry. (London: Sampson Low and Co., 1884.)

THE Pueblo Indians of New Mexico and Arizona have this general name from living in towns (Spanish *pueblo*, from Latin *populus*). Near a river, or oftener on the top of a steep-cliffed *mesa* or table-rock, may be seen these picturesque communal settlements, with their close rows of flat-roofed dwellings, walled with stone and mud, rising in terrace above terrace reached by wooden outside ladders, the whole forming a fortification strong enough to resist a sudden attack of the Apaches or Navajos of the plains, whose ravages in old times led the ancestors of the present Moqui, Zuñi, and other Pueblo tribes to resort to their peculiar architecture. Though these peoples were brought more or less under Spanish rule from the sixteenth century, and had to conform more or less to the Roman Catholic Church, the general barrenness and inaccessibility of their region saved them from being Europeanised to the obliteration of the native culture, like the nations of Mexico proper. In the Pueblos the archaic system of society, framed on maternal descent and exogamy, is still in full vigour, while the complex native religion seems almost as perfectly preserved as if the missionaries had never made the Indians wear silver crosses to their necklaces and march in procession to church on Corpus Christi. Thus it has come to pass that now, when the country has become United States territory, and the traveller bound for San Francisco passes close under the mud-walls of Laguna, there is made accessible to anthropologists a remarkable phase of barbaric society among a mild and intelligent people, where its study can be followed into the minutest detail. A few years ago, Mr. Cushing's papers in the *Century Magazine*, describing his life in Zuñi, excited wide interest. Now we have another instalment of Pueblo literature from Capt. Bourke, the officer selected by Gen. Sheridan to examine the manners and customs of the Indians of the South-Western Territories, and who in August 1881 went with a party to see one of the great rites of the Moqui religion, never before witnessed by a white man.

On his way to the Moqui towns, Capt. Bourke paid a visit to the Pueblo of Santo Domingo. Here the Indians profess to be Catholics, but (as the cura of the parish last year admitted to the writer of the present notice) they keep their old religion too. This comes out in the description of the festival Capt. Bourke's party were present at, where the procession-dance was performed by men with bodies painted pink and white, and wearing only the cotton kilt of their forefathers, while the women's headdresses were thin wooden tablets of Zuñi make, cut in the step-pattern which in Pueblo art conventionally represents the rain-clouds, for the coming of which to fertilise their arid country the ceremonies of Pueblo religion are one unceasing prayer. The clowns had the same prominent position as in the Zuñi dances sketched by Cushing; naked all but the old Mexican *maxtli* around their loins, and painted all over in black and white stripes, with tortoise-shells rattling at their knees, and their hair tied in with corn-shucks, they pranced hither and thither among the dancers. The whole purpose of the dance has been so far changed that it has become a procession bearing offerings to the shrine of St. Dominic, but even here the clowns are allowed their old licence, and chaff the Saint himself quite familiarly. There seem to have been more secret rites which the visitors were not allowed to see; indeed, when Capt. Bourke and Mr. Moran attempted to descend, note-book in hand, by the ladder through the sky-hole into one of the *estufas*—that is, the large cellar-chambers which serve as temples and council-houses—they were seized and ignominiously "fired out" by the yelling crowd below. A few days later, however, when they reached the rocky *mesa* on which stand the three Moqui Pueblos of Suchongnewy, Hualpi, and Hano or Tegua, to visit which was the object of their journey, Capt. Bourke found his way so well prepared by Mr. Cushing, that he was allowed the utmost liberty in examining everything connected with the snake dance, the great event around which all social and religious life naturally centred at the time.

A few days before, the young men had been out to the north, west, south, and east to collect snakes, and in one of the *estufas* Capt. Bourke found the whole catch stowed away in three great earthenware *ollas*. Next day the reptiles were to be seen turned out in a writhing mass, while two very old men lying on the ground were "herding" them: whenever a snake tried to wriggle away, they sat up, and with their eagle-feather wands gently brushed it till it turned back to the heap. These snakes were of several kinds, but mostly rattlesnakes, and youths came down the ladder from time to time bringing others, up to five feet long, wriggling in their hands. When the time approached for the ceremony, the visitors were politely got away to sit on a terrace-roof, where they could command a view of the procession, close to the sacred rock in the *plaza* or square, near which was planted in the ground a cottonwood sapling, apparently as a symbolic sacred tree; between the two stood a miniature conical lodge covered with buffalo hide, imitating in shape the *tepi* of the Sioux, and strongly suggesting a past time when the ancestors of the Pueblos may have lived as roving hunters on the prairie. The house-tops were crowded with women and naked children waiting for the procession. A noise of whirring and rattling, and there came forth from the arcade an old man sprinkling water on the ground, another carrying a basket of the sacred meal, men and boys with rattles, and another old man bearing a ceremonial bow, and whirling around his head a flat slip of wood fastened to a cord, in which we may recognise the "bull-roarer" known alike to the sacred rites of Australians, Kafirs, and ancient Greeks. Then came a party of dancers with their bodies painted green-black and faces blackened down to the upper lip and pipe-clayed below, with kilts of painted cotton, coyote-skins

hanging behind, rattles clanking at their knees, and eagle-feather wands in their hands. There was chanting, stamping, and a circuit made around the sacred rock, with the pantomimic dance of planting corn; after which the women and girls, gay in blankets of scarlet and white, carried around their baskets and scattered corn-meal. The dancers' party filed off through the arcade, but soon returned marching two and two, the left-hand men carrying snakes, some in their hands, some in their mouths or actually between their teeth, while the right-hand men, toward whom the snakes' heads were kept turned, tickled them with the feather-wands. Slowly the dancers tramped round the *plaza*, raising their knees to waist-height, the snakes writhing and squirming to get free till their bearers dropped them on the ground at the east corner, and the squaws half-smothered them in showers of the sacred meal. They were picked up by men and boys and passed on to safe keeping in a receptacle lined with buffalo-skins in the sacred lodge. Again and again the dancers came round with more snakes held in their teeth, even two at a time by one daring performer, till all, above a hundred, had been carried round, when they were passed out again, placed within a circle of meal in front of the sacred rock, smothered in meal again, prayed over by the chief priest, then caught up in handfuls by the dancers, who rushed with them to the eastern crest of the precipice and down the break-neck trails to the foot, where they released the reptiles to the four quarters of the globe.

The question how this extraordinary performance is managed may be in part answered. The idea of its being a mere trick may be set aside, as the snakes have not their fangs drawn, and indeed it is mentioned that the youths, though they handle the creatures recklessly while stretched at length, call in the aid of the old men as soon as a rattlesnake begins to coil ready to strike. It may be suspected, however, that the snakes have been made to bite cloths or such things before the dance, so as to reduce their poison and make them less dangerous. It is plain that the wands with the eagle-feathers are highly effective in keeping the snakes back by fanning and tickling. We are not told exactly how they act, but the Moquis believe that the snakes dread their enemy, the eagle, whose mode of attack, they say, is to tap the serpent gently with one of his wings, and exasperate it into making a spring. When the snake has lunged out all its force and struck nothing but feathers, its strength is gone, and it lies uncoiled on the ground, where the eagle seizes it in his talons and flies off with it. There may be in this story a hint of the actual purpose of the feather-wand. Through want of knowledge of the Moqui dialects, Capt. Bourke's party did not get much information on the spot as to the origin and purpose of the snake-dance, but this want was in some measure supplied at Zuñi, where Nanahe, a Moqui by birth but a Zuñi by adoption, gave an explicit account in the Zuñi language, which Mr. Cushing translated. The care and preparation of the dance, Nanahe said, belong to a secret order first established in the Grand Cañon of the Rattlesnakes, and the Moqui ancestors migrating eastward brought it with them. At first all members of the order were of the Rattlesnake gens, but as time passed, that clan became numerous and mixed with the other clans. To keep the order from getting too big, no members were taken in unless belonging (that is, by descent through the mother) to the Rattlesnake gens, or unless when a member dies his son is taken in, as was Nanahe's own case; but a man would not come in merely by inheritance if he had not the proper qualities, and on the other hand a man of brave heart and good character would be likely to be admitted, although neither his mother nor his father was a Rattlesnake. "From the Moqui villages the order spread to other villages, but the headquarters remained among the Moquis. If a man was bold and courageous, and had a stout heart, and led just such a life as the order told him, and obeyed its orders, he could carry snakes in his mouth and they couldn't hurt him; but if he did not conform his conduct to such requirements, a bite from one of the snakes would be as fatal to him as to any one else." Here we seem to see the main point of the whole rite—that the snake-dance is primarily a ceremony of the Snake clan, to which the living snakes are considered to stand in the relation of patrons or kinsfolk. The present reviewer thinks this Nanahe was one of the Moquis he saw at Zuñi last year, who put his crossed fingers in his mouth to show how two snakes are held at once, describing also how, by chewing a mouthful of clay, a better grip is got of the slippery reptiles. We may fairly trust his account given here of the ceremonies of the order, the use of the four medicine-roots, the bathing and fasting, the smoking of the sacred pipe, and the ceremony with which the young men, when they catch a snake, seize it behind the head, hold it up toward the sun in their left hand and stroke it lengthwise with the right, praying to their father, the Sun, "Father, make him to be tame; make him that nothing shall happen that he bring evil unto me. Verily, make him to be tame"; then addressing the rattlesnake, "Father, be good unto me, for here I make my prayers."

Capt. Bourke quotes from *Harper's Weekly*, March 25, 1882, a description of a snake-procession in Central America considerably resembling that of the Moquis. This illustrated newspaper is not readily met with in England, but it would be worth knowing what authority there is for the account. If trustworthy, it would add another fact to the list of Central American or Mexican analogies in the Pueblo culture. Among these are the manufacture and ornamentation of the Pueblo pottery, excellently described by Col. Stevenson in the second *Report* of the Bureau of Ethnology; also the use of the *metate* or stone corn-crusher (perversely printed *metale* in this book). The description of a Moqui marriage, quoted from a Mormon bishop, which consisted in bathing the couple and then tying them together by the ends of their new cotton garments, bears an almost perfect resemblance to the well-known Aztec marriage ceremony. On the whole the new evidence which comes in as to the Pueblo Indians conforms to the judgment which Buschmann long ago formed on such scanty vocabularies as had been made of their languages. These languages he classed in the Sonoran family, not belonging to the Aztec family, but showing strong traces of Aztec intercourse and influence.

EDWARD B. TYLOR

SCIENTIFIC ROMANCES[1]

Scientific Romances. No. 1. "What is the Fourth Dimension?" By C. H. Hinton, B.A. (London: W. Swan Sonnenschein, 1884.)

THE subject discussed in this short but carefully worked out pamphlet of 32 pages, seems to be coming to the front once more. Helmholtz, in his classical paper on "The Origin and Meaning of Geometrical Axioms" (*Mind*, No. 3, July 1876), clearly states our position with regard to its representation: "As all our means of sense-perception extend only to space of three dimensions, and a fourth is not merely a modification of what we have, but something perfectly new, we find ourselves, by reason of our bodily organisation, quite unable to represent a fourth dimension."

In this article, as also in the excellent paper on "Measurement," contributed by Dr. Ball to the "Encyclopædia Britannica" (vol. xv.), many references are given to writers who have touched upon this point, but our present author has made a contribution to the subject which is independent of these writers, and puts it clearly before his readers. There are many backward glances to the inferior spaces, and here and there we find slight points of contact between our author and him of "Flatland," which show that the two were thinking of the same matter, possibly at the same time.

"By supposing away certain limitations of the fundamental conditions of existence as we know it, a state of being can be conceived with powers far transcending our own. When this is made clear it will not be out of place to investigate what relations would subsist between our mode of existence and that which will be seen to be a possible one." From a simple illustration it is shown that in our space there are three independent directions, and only three (as Helmholtz says, by the motion of a surface, a surface or a solid is described, but by the movement of a solid a solid and nothing else is described). Why should there be this limitation? He then discusses the cases of the inferior beings, which we put thus: it would be as surprising for a Flatlander to be lifted out of his closed pentagonal house and put outside as it would be to an ordinary human being "if he were suddenly to find himself outside a room in which he had been, without having passed through the window, doors, chimney, or any opening in the walls, ceiling, or floor."

The upshot of the first chapter is that beings can be conceived as living in a more limited space than ours.

A straight line by a movement at right angles to itself begets a square, but the Linelander can only conceive of movement in its straight line. The square in the same way can be made to move so as to beget a cube, yet the Flatlander has no idea of movement perpendicular to its plane. Now proceed similarly with the cube: "We must suppose the whole figure as it exists to be moved in some direction entirely different from any direction within it, and not made up of any combination of the directions in it. What is this? It is the fourth direction."

Arguing from the analogy we know, we arrive at the following results: The line has 2 points, the square 4 (angular) points, the cube 8 points, the foursquare (Mr. Hinton's name for the fourth dimension figure) 16 points: in the respective cases the lines are 1, 4, 12, and $2 \times 12 + 8$, *i.e.* 32; the plane surfaces are 0, 1, 6, and $2 \times 6 + 12$, *i.e.* 24. We get then the foursquare with 16 points, 32 lines, 24 surfaces, and bounded by 8 cubes: to us, if it were resting in "space," it would look like a cube. Of course there are other details. We pass on to Chapter III., in which are discussed the relations which beings in four dimensions would have with us. To us, of course, they would have the appearances of beings in space (as to a Flatlander a sphere appears to be a circle). "Why, then, should not the four dimensional beings be ourselves, and our successive states the passing of them through the three-dimensional space to which our consciousness is confined?" This is discussed in some detail and illustrated by means of threads. We confess to not quite following our author in his conclusion: "It is needless to say that all the considerations that have been brought forward in regard to the possibility of the production of a system satisfying the conditions of materiality by the passing of threads through a fluid plane, holds (*sic*) good with regard to a four-dimensional existence passing through a three-dimensional space. Each part of the ampler existence which passed through our space would seem perfectly limited to us. We should have no indication of the permanence of its existence. Were such a thought adopted, we should have to imagine some stupendous whole, wherein all that has ever come into being or will come, co-exists, which, passing slowly on, leaves in this flickering consciousness of ours, limited to a narrow space and a single moment, a tumultuous record of changes and vicissitudes that are but to us (*sic*). Change and movement seem as if they were all that existed. But the appearance of them would be due merely to the momentary passing through our consciousness of ever-existing realities."

The concluding chapter leads up from the inferior dimensions, and shows how, in four dimensions, the "box trick" might be effected. Some interesting illustrations from liquids and gases follow, and then, on the hypothesis of there being a fourth dimension, two possible alternatives are discussed. "If we are in three dimensions only, while there are really four dimensions, then we must be relatively to those beings who exist in four dimensions as lines and planes are in relation to us. That is, we must be mere abstractions. In this case we must exist only in the mind of the being that conceives us, and our experience must be merely the thoughts of his mind—a result which has apparently been arrived at, on independent grounds, by an idealist philosopher. The other alternative is that we have a four-dimensional existence. In this case our proportions in it must be infinitely minute, or we should be conscious of them. If such be the case, it would probably be in the ultimate particles of matter that we should discover the fourth dimension, for in the ultimate particles the sizes in the three dimensions are very minute, and the magnitudes in all four dimensions would be comparable."

We have said enough to show that the "Romance" is a curious one, and not without interest to many of its readers, to whom we commend it.

[1] For some remarks on the subject of this article, by Mr. G. F. Rodwell, we refer the reader to NATURE, vol. viii. pp. 8, 9.

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.*]

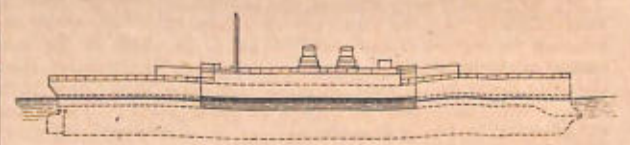
The Relative Efficiency of War Ships

I HAVE a complaint to make against certain of the statements made in the article upon "The Relative Efficiency of War Ships," which appe ared in your number for February 26. It is incorrect to declare that I advocated before the Committee on Naval Designs, in 1871, the system of construction upon which the ships of the *Admiral* class are built. The *Ajax*, *Agamemnon*, *Colossus*, and *Edinburgh* are designed upon a citadel system which I originally devised and advocated under certain limitations; but I deny, and always have denied, that any of those ships conformed to the fundamental and indispensable condition which I laid down as part of my system: viz. that the armoured citadel should be of ample dimensions to command the whole structure, keeping it afloat and upright, notwithstanding any amount of injury to the unarmoured ends. As this system has been violated in all the four ships above-mentioned, it is most unfair and improper to state that even those vessels are constructed upon a system which I advocated. But as regards the ships of the *Admiral* class they do not at all conform to the system which I advised, and the writer of the article in question could only have supposed them to do so from a serious misapprehension of the ships themselves. The article stated that the central part of all the ships in question, including the *Admiral* class, are "plated completely around with very thick armour, which extends from the upper deck to several feet below the water-line." This is a very incorrect description of the *Admiral* class, the armour in which does not rise to the upper deck at all, but is stopped in the form of a shallow belt rising but a foot or two, or possibly slightly more, above the water's surface. I repudiate with indignation the statement that such a system of construction as this, in association with the long unarmoured ends of the *Admiral* class, was ever recommended by me. For this reason I complain likewise of the statement in your article to the effect that my recent letter to the *Times* is but a continuation of the old and well-remembered *Inflexible* debate. So far is this from being so, that I distinctly pointed out in that letter that the cutting down of the armour to a mere belt of short length separated the ships of the *Admiral* class from the others, and imported "a new and terrible cause of danger." Another statement of which I complain, and which I desire to have corrected, is to the effect that I "refused to give evidence" before the *Inflexible* Committee. Were this true, it would constitute, in my judgment, a most serious ground of complaint against me, but it is not true. The *Inflexible* Report and its Appendices clearly exhibit the fact that within two days of the appointment of the Committee, and on the very day on which my evidence was asked for by the Committee, I handed in to that body a most elaborate mass of evidence, occupying no less than eighteen columns of the *Inflexible* Report, and illustrated by two sheets of drawings, this evidence setting forth in great detail my views of the subject, and the grounds of my dissatisfaction with such ships. It is true that four months later I was asked by telegram to attend the Committee, but asked to be excused on the ground that I objected to take part in the dilatory proceedings of the Committee, which I regarded as frustrating the objects with which it was demanded by Parliament. My full evidence was, however, already before the Committee, and had been for several months.

The above are the points of which I complain, and wish to have corrected. I do not ask as a matter of right, but I desire to have stated, that the long explanation which was given in the article in question for the purpose of showing that mere displacement is not, under all circumstances, a measure of the power of a ship, was, in my opinion, wholly unnecessary—at any rate, in so far as either Mr. Barnaby or myself was concerned. Both Mr. Barnaby and myself knew perfectly well that displacement is but a very rough measure of the power of ships, and no measure at all when ships of wholly different classes, and kinds, and dates, and systems are closely compared together. The only use that I made of the principle in my letter was to accept it for the moment as a rough basis of comparison between the ten latest French and the ten latest English ships, and I consider that for that purpose it was a good enough principle to indicate the inferiority of the English ships. But the acceptance of the principle for that purpose in no way precluded me from going further and showing that this rough comparison did not by any means bring to light other elements of grave inferiority, and even of danger, in the English vessels.

In the accompanying diagram the great difference between the *Inflexible* or *Agamemnon* class and the ships of the *Admiral* class is clearly illustrated. In both figures that part of the armour which is above the water is shown in full black, the part below the water being indicated by dotted lines. A glance at the diagram is sufficient to make it readily understood that the

Agamemnon



Collingwood

Agamemnon, whose side armour rises several feet above the water, can be inclined to a considerable angle before her armour is brought under the water, whereas a very slight inclination only is necessary to bring the extremely shallow armour of the *Collingwood* under the water. In the case of the *Agamemnon*, therefore, the armour she possesses affords her a considerable amount of resistance to capsizing, while the resistance thereto derived by the *Collingwood* from her armour is almost *nil*. The same remark applies, of course, to the buoyancy of the armoured out-of-water parts of the two ships, the *Collingwood* having but a small fractional part of that which the *Agamemnon* possesses.

E. J. REED

[We give insertion to this communication from Sir Edward Reed with great pleasure, because one of the chief objects we sought in our article was to support his view that the stability of the ships of the *Admiral* class under the conditions which might be expected to occur in a naval engagement was open to grave question, and to reassert that further scientific experiments should be made.

We regret that the fundamental difference, so far as *fighting* stability is concerned, between ships of the *Inflexible* and *Admiral* type, which is now brought out so well by Sir E. J. Reed's diagrams, was not emphasized in the article so strongly as it should have been.—ED.]

How Thought Presents Itself among the Phenomena of Nature

In your paper of the 5th you give a short abstract of a recent lecture at the Royal Institution by Mr. G. Johnstone Stoney, on the question "How Thought presents itself among the Phenomena of Nature." In this abstract I observe an assertion which is quite new to me, and, I must add, quite unintelligible. It occurs in the first paragraph. The assertion seems to be that there is an absolute distinction between molar and molecular motion, inasmuch as that, in the case of molecular motion there is no authority for the conviction that there must be some "thing" to be moved. The conception of motion involves the conception of matter as a necessary or inseparable concomitant—although the abstract idea of motion may, in a sense, be separately entertained. Is there any difference in this respect between molar and molecular motion? A molecule is a group of atoms, and an atom is only conceivable as an ultimate particle of matter. I hope that some further explanation may be given upon this point, which is one of the highest interest and importance, both as a matter of physical and of metaphysical speculation.

Inverary, March 8 ARGYLL

The Compound Vision and Morphology of the Eye in Insects

Mr. Sydney Hickson, in your issue of February 12 (p. 341), makes certain statements concerning my paper in the *Transactions* of the Linnean Society on this subject. I will not follow Mr. Hickson through his entire article, as I conceive it is sufficiently refuted by my paper itself. He says: "It would be tedious to bring evidence of this kind to confirm a theory which is already fully established." I would ask Mr. Hickson if anyone can explain the vision of the compound eye intelligibly on the received theory? I would also remind your readers that Prof. Huxley, writing of the crayfish in 1880, accepted the view with extreme caution; he said, "The exact mode of connection of the nerve fibres with the visual rods is not certainly made out;" that Claparède never accepted it, and Max Schultze admitted that there were grave physical difficulties in the way of its acceptance.

Mr. Hickson is very anxious, apparently, to deny me what I never claimed—*i.e.* the discovery of a layer of definite structure beneath the basilar membrane. What I do claim is the discovery of the nature of its elements. I deny, in my paper, that the optic nerve passes through these structures, and I deny that these consist of a fine reticulum of nerve-fibres. These are questions of fact and observation, not of theory or deduction. If I am wrong, I am wrong. But the way to test my work is by working out the eye as I have worked it out. I have spent nearly ten years in this work, and I do not expect to have my views generally accepted for another ten years.

The absence of pigment and retinal purple is a secondary question. I do not know, nor does any one know, whether there be retinal purple or not in this layer. I admit that pigment is absent in the retina (my retina) of some insects and crustaceans, and I have recorded the fact. I am not yet convinced that we can say vision is impossible without it. Albinos have vision undoubtedly in the absence of retinal pigment. He would be a bold man who asserted that vision could not be effected without pigment in the retinal region. The colourless collodion film of the photographer is affected; why not retinal rods? Here, again, it is a question of fact, not theory.

The presence of pigment proves nothing with regard to the function of the great rods, any more than it shows that the iris of a vertebrate is sensitive to light.

The absence of my retinal layer in Periplaneta and Nepa is imaginary on the part of my critic, for I have examined it carefully in both, and I figure the elements from the former. I maintain that the same structures exist in all the crustacea, although they are short and more difficult to demonstrate.

Again, in the morphological question my views are not fairly stated by Mr. Hickson. I admit his facts, but deny his deductions. The hypodermis forms the dioptric structures, as the epidermis of the vertebrate forms the lens; my contention is that the retina in the insect, like the same structure in the Vertebrata, is developed as an outgrowth from the nervous system.

Benjamin Thompson Lowne

65, Cambridge Gardens, Notting Hill, W., February 23

I do not wish to undertake a lengthy controversy with Mr. Lowne on the question of the retina of insects, but I cannot refrain from making a few remarks on the letter you publish above.

I am afraid Mr. Lowne has misunderstood my criticism when he asks me "If any one can explain the vision of the compound eye intelligibly on the received theory?" My criticism was not meant for any theory of pure optics, but for the theory that the retinulæ are not the true nerve-end cells.

Mr. Lowne's statement that albinos are devoid of retinal pigment is not strictly accurate, for Kühne pointed out, and any one can see for himself, that all albino rabbits and other vertebrates possess a true retina purple. Moreover, the rods of Cephalopods and of Pecten, which seem to be devoid of pigment in spirit specimens, possess, as Hensen has pointed out, a true retina purple. In fact, I know of no exception to the rule I laid down—namely, that optic nerve-end cells are pigmented, and I should be glad if any of your readers could point out any exceptions to it.

Mr. Lowne's reiterated statement that the optic nerve fibrils do not end in the retinulæ is, as I said, contrary to my own observations. I have submitted my preparations to several eminent naturalists, who agree with me in my account of their distribution. I shall be happy to submit them to any others who may feel interested in this matter.

The other statements in my notice which Mr. Lowne controverts I will not refer to again here, as they will be fully explained and illustrated in my forthcoming paper in the *Quarterly Journal of Microscopical Science*, the proof-sheets of which I have now in hand. Sydney J. Hickson

Anatomical Department, Museum, Oxford, February 25

Civilisation and Eyesight

In connection with Lord Rayleigh's letter in Nature p. 340, on the above subject, I venture to hope that the following may be of interest:—

In the "Expression of the Emotions" the late Mr. Darwin quotes some observations—if I recollect correctly—by Gratiolet tending to show that, under the influence of *fear*, the pupils of animals' eyes dilate. Observations extending over some years have convinced me that fear is undoubtedly capable of thus causing dilation of the pupils (see Dr. Hack Tuke, "Influence of the Mind on the Body"); and in general literature, such as travels, novels, &c., I have met with many instances in which the eyes of both men and animals under this condition have been so described by the writers.

Is dilation of the pupil under the influence of fear to be explained on the assumption that the increased aperture of the eye enables a more effective scrutiny of the object causing terror, and has thus been of service in the struggle for existence?

An answer to this question is not easy to give, for, although dilation of the pupil under the influence of fear may have originally been of direct service to an animal, yet this condition may in time have come to be associated with other emotions in which it is not so easy to trace any such direct benefit.

Observations upon the subject are by no means easy (varying light, for instance, varies the aperture of the eye), but in the course of my observations I became much inclined to believe that other strong mental emotions besides fear (*e.g.*, joy or pleasure) may be capable of giving rise to dilated pupils.

Charlotte Brontë, in "Jane Eyre," is one of the only writers who associates a dilated pupil with other emotions than fear. Here is the sentence:—"Pain, shame, ire, impatience, disgust, detestation, seemed momentarily to hold a quivering conflict in the *large pupil dilating* under his ebon brow."

It is to be feared that the experimental investigation of eyesight with artificially contracted or dilated pupils is scarcely practicable, for drugs, such as atropine or eserine, act not only on the pupil, but also on the power of accommodation for distance. J. W. Clark

Liverpool, February 21

P.S.—I see Dr. M. Foster, in his "Text-Book of Physiology," mentions the dilation or contraction of the pupil which attends the adjustment of the eye for distant or near objects respectively, and also its dilation "as an effect of emotions." It thus seems highly probable that strong and very different mental emotions may give rise to dilated pupil. Dr. Herdman has suggested to me, as an explanation of this, that an intens

excitation of one brain centre may possibly act in the same way as a direct inhibitory impulse by partially paralysing an adjacent centre.

The Forms of Leaves

THERE are several points in Sir John Lubbock's lecture (NATURE, February 26, p. 398) which seem to invite some little criticism. That "the size of the leaf . . . is regulated mainly with reference to the thickness of the stem" seems somewhat self-evident, as a large leaf must have a large stem to carry it, as, *e.g.*, may be seen by comparing the slender shoot of a Deodar with a cabbage-stalk; but he adds: "The size once determined exercises much influence on the form." This is a *deduction* which seems to require *verification*. Sir John gives the area of a beech-leaf as about 3 square inches, but the form remains the same whatever the size. Size rather depends on vigorous growth, as in the following instances: *Populus alba* leaves on a vigorous basal shoot were $6\frac{1}{2} \times 3\frac{1}{2}$ inches, the diameter of the shoot being $\frac{1}{8}$ inch; on the upper branches of the same tree many leaves were only $1\frac{1}{2}$ to $2\frac{1}{2}$ inches long, the diameter of the shoot being also $\frac{1}{8}$ inch. Similarly growing oak leaves of the same shape were 6×3 inches and $2 \times \frac{3}{4}$ inches respectively. An *Aucuba japonica* bore rounded leaves on a basal shoot $4 \times 3\frac{1}{4}$ inches, but those on the stem were 4×1 inch. In this case, as in other plants with (normally) dimorphic leaves, as ivy, it is difficult to see what connection there is between size and form. Indeed leaves of every degree of superficial area can be found amongst the lobed ones on the climbing stem of ivy, and the entire ones of the flowering branch. Sir John adds that "the form of the inner edge [of the beech] . . . decides that of the outer one." He does not seem to have verified this deduction. The two edges are symmetrical in this leaf, but they are not so in the elm and lime. How will the inner edge explain the cause of their obliquity? If, however, the *buds* of the lime be examined, a more probable cause (as it seems to me) will be discovered in the conditions of development. He describes the *Eucalyptus*, when young, as having "horizontal leaves, which in older ones are replaced by scimitar-shaped phyllodes." Bentham and Hooker say of *Eucalyptus*: "Folia in arbore juniore sæpe opposita, in adulto pleraque alterna," but makes no mention of phyllodes. Speaking of evergreen leaves, he says: "Glossy leaves have a tendency to throw [snow] off, and thus escape, hence evergreen leaves are very generally smooth and glossy." This sentence appears to imply that such leaves are glossy in anticipation of snow! a deduction which certainly requires verification. Again: "Evergreen leaves often have special protection . . . by thorns and spines. Of this the holly is a familiar illustration; and it was pointed out that in old plants above the range of browsing quadrupeds, the leaves tend to lose their spines and become unarmed." The inference the reader draws from this is that when the holly grows out of reach of browsing animals it has no necessity to produce prickly leaves, and so changes them accordingly, thereby implying that unarmed leaves were in some way preferable. This is another instance of deductive reasoning which requires verification, for it seems to be attributing to the holly a very unexpected process of ratiocination! But it is not at all usual for hollies to do this. I have several from six to nearly twenty feet high, and not one has borne an unarmed leaf. Though my cows do not touch a holly hedge, yet one young bush lately planted has taken their fancy, and they have bitten it all to pieces. On the other hand one bush (in the garden), a variety with unarmed foliage, occasionally throws out a branch with prickly leaves, though the cows are not admitted where it grows.

"Fleshy leaves were principally found in hot and dry countries, where this peculiarity [*sic*] had the advantage of offering a smaller surface, and therefore exposing the plant less to the loss of water by evaporation." Surely the usual explanation, that it is the thick cuticle which prevents rapid exhalation is a better reason than Sir John's deduction from the small size of the leaves? Speaking of aquatic plants, he says that the submerged "cut up" leaves of such plants presents a greater extent of surface;" and adds that "such leaves would be unable to support even their own weight, much less to resist any force, such as that of the wind.." I should be glad to know if he has verified the first statement by actual measurements; for an *à priori* assumption leads one to fancy that a complete leaf would have a greater surface than one represented by its ribs and veins only. With regard to the second and third statements a "natural experiment" completely refutes his deduction, for I know a place where a small pond dried up last summer, and a large portion of the ground was covered with a dense velvet-like carpet, composed of the *erect* filiform branchlets of the "cut-up" leaves of *Ranunculus aquatilis*, which had become modified by their new medium, and perfectly adapted to enjoy an aërial existence.

In offering these few criticisms for Sir John Lubbock's consideration, I would venture to remark that he seems to have followed too closely in the deductive methods of another writer on leaves, and which called forth the following remark from Prof. Lankester:—[He] "gives us hypotheses, suppositions with insufficient evidence, and deductions from the generalisation of Evolution, but he is relatively deficient in 'verification'" (NATURE, vol. xxviii. p. 171). GEORGE HENSLOW

Drayton House, Ealing

The Fall of Autumnal Foliage

MR. FRASER alludes to "the unpursued inquiry into the cause of leaves falling in autumn" (NATURE, February 26, p. 388), and I do not find it mentioned in Sach's "Text Book"; but Dr. Masters, in Henfrey's "Elementary Course of Botany," fourth edition, p. 515, speaks of "a layer of thin-walled cells being formed across the petiole," but does not say whence this layer is derived. Duchartre, however, gives a pretty full account of opinions up to 1877 ("El. de Bot.," deux. éd. p. 443), which he reduces to two, viz. Schacht's, who attributes it to a growth of periderm, and that of Mohls, who recognises a special layer which he calls *couche séparatrice*, considering the peridermic layer as being often, but not always formed. Subsequently, M. Ledgeganck

examined different plants and corroborated Schacht in regarding the periderm as the *cause prédisposante*, and cold to be the *cause efficiente*, which contracts "le tissu de la base du pétiole, spongieux, aéré, élastique à un degré beaucoup plus considérable que celui du coussinet." From my own observations on the horse-chestnut, ash, &c., it appears to be in these clearly a continuation of periderm produced by the phellogen of the branch, which invades the base of the petiole, till it meets in the middle, cutting right through the fibro-vascular bundles of the petiole. As this suberous layer dies, the leaf necessarily falls off. But as long as a leaf is in vigorous health it would seem to resist this invasion, and last longer, as do evergreens. I inclose a figure I possess of a slide showing the process in the horse-chestnut.

Drayton House, Ealing GEORGE HENSLOW

Forest-Trees in Orkney

IN NATURE of February 26 (p. 388) Mr. A. T. Fraser says that "a peculiarity of Caithness and the Orkney and Shetland Islands is that no forest-trees can be got to grow," and he proceeds to explain this by the preponderance of polarised light. As far, at least, as Orkney is concerned, I am prepared to rebut this calumny. It is true that forest-trees are not the striking feature of the Islands, but they do occur. At Binscarth, between Kirkwall and Stromness, there are willow, ash, sycamore, and Scotch fir. They require to be protected—from the wind, I presume, and not from the light—by hedges of bour-tree (elder). In the street at Kirkwall itself there is a fair-sized sycamore.

Trinity College, Cambridge JAMES CURRIE

YOUR Indian correspondent, Mr. A. T. Frazer, can hardly be acquainted with the primitive jungles of Southern India, or he would have observed that there, at one and the same time, the aspect of all the four seasons is displayed in the vegetation.

When in Coorg, in two different years, during the months of January and February, we not unfrequently drove up to Mercara, the capital, a distance of ten miles from the place where we were staying. On the way thither we saw some trees in their winter condition with perfectly bare branches, others had the tender foliage of spring, some again were in all their summer glory, and some were clothed with the most brilliant autumnal tints; this was most probably due to the great variety in the species of trees in that district. COSMOPOLITAN

A Tracing Paper Screen

As several inquiries have been made of me as to where the proper tracing paper can be obtained, perhaps I may be allowed to state that I got mine through Mr. George Smith, 26, Colebrooke Row, City Road, N., who was the first, I believe, to recommend the use of this valuable material.

CHARLES J. TAYLOR

Toppesfield Rectory, Halstead, Essex

GEOFFREY NEVILL

WE have to announce the comparatively early death of Mr. G. Nevill, which took place at Davos Platz, after a long and lingering illness, on February 10. This removes from among us another of the scanty band of English conchologists, whose ranks, only a few days before, suffered a similar loss in Mr. J. Gwyn Jeffreys. Mr. Nevill's labours have been principally confined to India, where he was for many years one of the assistant-superintendents under Dr. J. Anderson in the Indian Museum, Calcutta; his work is, therefore, better known to those who have collected in the East and written on the molluscan fauna of that part of the world. For many years he was a constant correspondent and colleague of the writer's, who can testify to the large and varied knowledge Mr. Nevill possessed of the different forms. A very large number of species were sent him by Mr. Nevill from time to time, many of which still remain to be described. Mr. Nevill was the author of many papers on his favourite study, most of which are to be found in the *Journal* of the Asiatic Society of Bengal; but perhaps his best and most useful work, particularly to those interested in distribution, was the "Hand List of Mollusca in the Indian Museum" (Part I. comprising the Pulmonata and Prosobranchia-Neurobranchia published in December, 1878, and is remarkable for the accuracy with which the localities of the different species is given, and the collections from whence they were received. He also catalogued the Ampullariacea and Valvatidæ and Paludinidæ). Unfortunately, the whole catalogue of the Gastropoda is incomplete, for his health failed him altogether in 1881. Yet he struggled on to the last with his task, even when unable to leave his room to go as usual to his office in the Museum, and was compelled eventually to give up his appointment and return to Europe. The entire arrangement of the Mollusca in the new Museum formed a part of his work when there, and it was well and admirably done. Almost his last work in the field was at Mentone, in 1878-79, where, in the post-Tertiary beds, he made a careful collection of the shells, particularly the smaller species, a list of which he published in the Zoological Society's *Proceedings*. Yet even so late as last summer, when hardly able to move from weakness and partial paralysis, he was getting together the land-shells to be obtained in the country around the Lago de Como.

Geoffrey Nevill was born at Holloway on October 5, 1843; he was the second son of Mr. Wm. Nevill, F.G.S., who resided for many years at Langham Cottage, Godalming, a gentleman who made mineralogy his study, and whose collection of meteorites was well known. As is often the case, his son inherited kindred tastes, for, when quite a boy, his attention was directed to shell-collecting both in Germany and in England. Most of the English species in the Calcutta Museum originally formed a part of this collection, and bear labels from near his early home at Godalming. He received his education at Dr. H. D. Heatley's school at Brighton, and afterwards spent some time at Bonn in the house of Dr. F. H. Troschel, Professor of Zoology, and this no doubt confirmed his early taste for natural history and directed his future career.

He was never strong, so, after entering into mercantile life in his father's house, and his health breaking down, he was ordered abroad, and he proceeded to the Cape, the Mauritius, and Bourbon, where he collected largely, and formed a valuable and rich collection. Some of the results were described in joint papers by himself and his brother, Hugh Nevill, of the Ceylon Civil Service. He went on to the Seychelles Islands in 1868, where he remained some time, still further enriching his collection, and then went on to Calcutta. At this time an appointment offered itself in the New Museum, which he took and filled for many years. Here in Calcutta during this period a little band of workers in conchology were drawn together, most of whom were employed on the different surveys of the country. Season after season, on return from the field, the results of their labours in every part of India accumulated and were examined. Ferd. Stoliczka, one of the first to be removed, was one of the most ardent workers, and all benefited from his deep, more advanced knowledge of the subject.

The survivors will recall those pleasant intellectual gatherings when they hear of Geoffrey Nevill's death, and future students and collectors of Indian Mollusca will appreciate the work he lived to perform, and which will render their work in the galleries of the museum in Calcutta more easy.

REPORT OF THE COMMISSIONER OF EDUCATION IN THE UNITED STATES FOR THE YEAR 1882-83[1]

IT is impossible to read the account which the United States Bureau of Education, in the opening pages of this Report for 1882-83, gives of itself and of its labours, without being convinced of the value of the matter therein contained. A total of over 10,000 institutions of education of various kinds are in correspondence with, and supply information to, the department. An idea of the work also which falls to it may be formed from the fact that some questions addressed to it have necessitated months of research by several clerks, while the labour which its publications have entailed, as well as the value placed upon them, are shown by the fact that one of them was *asked for* by 10,000 persons of different addresses. Since all is voluntary, the Bureau claims to work the most complete system of the kind in existence. The wide compass of its survey is indicated by the very full account given, among other foreign intelligence, of the Report of the English Commission on Technical Education. Besides itself circulating through the world 20,000 copies of its Report, the office is require dto print 18,000 copies more for the use of, and distribution by, other members of the Government. Its library—where all the items of information which it is possible to collect, down to cuttings from newspapers, are gathered together and classified—is an immense work; and we can well believe that, "if this office were put in possession of a small sum annually for the purpose, it would make effective and useful displays at exhibitions, of American education . . . the most unique feature of our national life."

The report of this education generally is far more satisfactory than in other years. There has been a general increase, first in the number of scholars, even in Maine where the population has become smaller, and in New Jersey, New Hampshire, Connecticut, South Carolina,

[1] Washington Government Printing Office, 1884.

and Kansas, where schools have become fewer. Though the contrary might have been expected in an increasing country, a great complaint of the Report is the multitude of small schools which require consolidating for the sake of employing better teachers and apparatus. The suggestion is made that each State should fix a minimum of salary to be paid to any teacher; this not only must be good for the children, but would of itself urge forward the consolidation, where distance allowed it, of small schools of less than ten or twelve scholars.

In Rhode Island, and in city schools generally, the competition of factories is lamented. The deficient average attendance is imputed to the demand for cheap labour; and obligatory laws are quoted, among other things, as an antidote. It should not be forgotten that the inexorable enforcement of those laws is what is in reality the greatest kindness to poor families; for if the cheap labour of young untaught children once enters the market in the smallest quantities, it becomes impossible to gain a fair price for the work of those older and better taught. But, protected from all such unfair competition, the child's education becomes a common necessity. No doubt the difficulty is much felt in Alabama, North Carolina, Louisiana, and Mississippi, the only States whose reports are generally unsatisfactory: States where negro labour keeps down the wages of white children.

There has been an increase, again, in the number of teachers: with regard to which it is interesting to note that in three States the number of men has fallen off, while in them, and even in frontier States, that of women has increased: and an increase also in the item of teachers' salaries; even in Illinois with fewer of them, in Indiana, where the population has decreased, and in Michigan, where in past years the amount had fallen off.

The variation in different States of the expenditure on education, however, is still exemplified in the fact that Massachusetts pays fifteen times the amount per head that Alabama pays!

The educationists of Kentucky, where whites and blacks are treated alike with regard to schooling, appeal to the Peabody Trustees for advice to the Legislature. This latter body, who are gaining an influence like that of our Charity Commission, have concentrated their money upon training teachers, with successful effect over school work in the south. Another benefactor has bequeathed over 700,000 dollars to the whites of New Orleans for educational purposes.

The improvement in the organisation of systems, the greater efficiency of work, and the deeper interest felt by the people, is indicated by the public schools in some States superseding the private ones; and Gen. Eaton attributes to the influence of the superintendents (officers whom we have before quoted as combining the knowledge of our inspector with the zeal of our chairman of School Board) the two most promising general movements now going on, viz. the increase of local taxes for education in the Southern States, and the effort to abolish small independent, irresponsible districts in the older Northern States.

Still, nothing can be more depressing than that, in a community naturally the leading people of the world, a sober report of a patriotic commissioner should still find it necessary to say more than once in his Report, that a work so all-important to the future of that community as education should be marred by school commissioners persisting to license the cheapest teachers they can procure, and using the license as a means of favouring relations, political supporters, and such like; thus rendering useless the efforts of examining bodies, who have pointed out the really competent persons for this most responsible office.

We have no need to enlarge again here upon the United States difficulty, the education of the negro. The burning question of course is, Who is to pay for it? The Report speaks confidently of securing national aid, the need of which has been so strongly urged before. One gentleman gave 1,000,000 dollars towards the work, but religious denominations have so far been the great supporters of black education.

We, in England, can better enter into the labours of those who are trying to raise the street Arabs to a generally higher level. Few things ought so much to convince anxious reformers how little their improvements depend upon the form of government, as to see how the struggle of the poorest for existence is as sharp and demoralising in the large towns of the United States as it is in England. One of the leaders of the Kindergarten system lays it down that "the best energies of the faithful teacher are often required when the work of the schoolroom is over. There is much visitation to be done to look up absent children, and, where sickness invades, the teacher is often called upon to supply medical aid and other necessary help; and, where death ensues, there is sometimes no one but the Kindergarten helpers to see the little one decently buried;" and, in fact, not only to take all the duties and responsibilities off the hands of parents, but to provide an antidote to their mischievous example and teaching. Their success in many cases must lead its supporters on to the venerable yet now radical proposition, which will be most offensive to Mr. Herbert Spencer, that education from infancy should be the work of the State; and, strange as such a suggestion must seem among English homes, it is very much in harmony with modern division of labour which makes the parent less able to educate, in the full meaning of the word, a family, and the professional Kindergartens so much more so. And the same principle is to be traced in the recommendation that homes, as well as training-schools, should be found for nurses.

Both in primary and secondary schools witness is borne to the improved teaching. The importance to the former of the example of good teaching to be found in the normal schools, as well as the precept on the subject, is fully insisted upon; a difficulty often met with being the work of correcting bad teaching in the lower schools: while, on the other hand, the multiplication of teachers well trained in public normal schools is, as we have said, urged as the surest, and, in the long run, the most economical means of raising the standard of education throughout the country.

Examinations like our Oxford and Cambridge Locals, held by the regents of New York, are leading to greater uniformity in the teaching of the second-grade schools.

Perhaps the most striking thing in the Report is the important part which women are now taking in study, as well as in teaching, in the United States. The demands and attractiveness of commercial life to the young men of America, with the energy and self-reliance of its women, are leading to the result that the latter are becoming the learned class there. We have already remarked upon the large and increasing proportion of female teachers in all the elementary schools. But, moreover, while twice the number of women begin a high school course, three times as many women as men complete the fourth year. Although the increase is not large this year, there are over 40,400 women in institutions of superior instruction. At Purdue University, where practical mechanics is taught, a number of young ladies have been among the special students, and "have done the same work as the young men, and, though progressing much slower, have been nearly as successful." Educated women are now also the leaders of many philanthropic movements.

The education of the blind and the feeble-minded is urged as a matter of public economy, their cost if left uncared for amounting to much more. The same considerations have many times been urged in favour of reform schools. But they are all attempts to counteract laws of nature that all these diseased specimens shall be inexor-

ably extirpated, and it is hard to see a satisfactory result of these efforts in the long run. A singular mischief has recently been commented upon by Prof. Graham Bell (see NATURE, No. 795), arising from the system of teaching deaf-mutes a language and literature, intelligible among themselves, but not familiar to the general public. Hence they prefer their own society, and are trying to form deaf-mute settlements which must result in hereditary transmission to the whole community of this terrible degeneracy. It will be a curious experiment if allowed to take its course.

A most healthy sign of the times is that the increase of students at the schools of science is far larger than the increase in the number of establishments. It shows a general appreciation of their work, and in an enterprising country like America will soon bring about an increase in the number of schools. Institutions are becoming more general which undertake to train students for the higher schools of science. The cost of laboratories and apparatus and the scarcity of teachers are two of their difficulties, indicating at the same time the high standard of work they aim at. We note with pleasure that the sole purpose of the Wisconsin Agricultural Experiment Station is the discovery of new truths and laws which may be of benefit to agriculture, and farming is taught there as a scientific pursuit. In the Storrs Agricultural School at Mansfield, Conn., though of less ambitious character, "students receive instruction both in the class-room and on the farm. In the class-room they study those branches of natural science which have a directly useful bearing on New England farming, such as general and agricultural chemistry, natural philosophy, farm mechanics, surveying, botany, zoology, geology, animal physiology, mineralogy, and theoretical agriculture, stock-breeding, and composition. The general principles of these sciences are taken up first, and afterwards their special applications to practical agriculture, which includes the improvement of the soil by tillage, draining, manuring, and irrigation; the culture and handling of the various field, garden, and orchard crops of New England—grass, grain, roots, vegetables, and fruits—from planting to market; the use, care, and repair of farming tools, implements, and machines; the breeding, rearing, training, and feeding and use of live stock; the best methods of dairying, the business and management of the farm in all its details. . . . The intellect being called into play, farm work is divested of its monotony and robbed of the repressive influence derived from it when viewed as mere physical labour."

It is well urged in favour of an institution like the St. Louis Manual Training School, that through the minute division of labour which necessarily attends our increased machinery, the old method of teaching a trade is rapidly and inevitably disappearing; that it is only at a technical school that the *toute ensemble* of a trade can be learned so as to be intelligently carried on and fresh inventions led to; that there is an idea afloat that it requires no education to be a mechanic, and hence the despising of both craft and craftsman, whereas the thorough understanding of both theory and practice of a skilled industry makes its owner "the peer of the statesman; and from the union of his head- and hand-work come a large part of the civilising agencies of the nineteenth century."

The English Commissioner on Technical Education reports on the efficiency of the American workman, which is mainly attributed, by all who have inquired into the subject, to the primary education acquired, by them during a prolonged attendance at school, and now the idea is to be traced through all the Report upon the subject, that to teach the pupil his trade should henceforth be the work of a school; as much one part of education as the three R's the other part.

And not the work of a primary school only, but it is even urged that it should be the work of the Universities to send forth young men, fitted by technical training to lead in the development of the State; its fields, mines, quarries; its railroads and water-power; its manufactures and commerce." And already at Cornell University, as well as at Massachusetts Institute of Technology, electrical engineering is taught sufficiently extensive to prepare a man for ordinary electric work or advanced study. To Terre Haute, Ind., a small town of 26,000 inhabitants, the splendid legacy of a property bringing in 25,000 dollars a year was left for a technical school, in the starting of which great care as well as energy have been shown.

Very different, however, from these buoyant views is the record to be found also in this Report, that in Austria the higher schools for technical instruction have been decreasing for the last few years.

Nor again is science only, but art also in its more marketable shapes is becoming rapidly the work of schools. A public art school, under the direction of Mr. C. G. Leland, has been trying an experiment as to what children, nine-tenths of them from thirteen to fifteen years of age, could do in the way of art manufactures by being taught designing and art processes. Besides developing inborn talent, this school not only finds a commercial value in their productions, but insists upon what is becoming generally observed, that technical teaching, though shortening school hours for other work, by no means reduces the amount of progress made in the latter, brighter wit and interest being excited by hand-work at intervals with head-work. Elsewhere in the Report a protest is quoted from Harvard University which will be re-echoed from the breast of many an English *paterfamilias*, against athletic sports being made too much a business or profession, instead of a recreation. Besides the waste of time which, it is urged, might be given to other things, such a standard of excellence as the few attain makes the game very exclusive and confined to a small number. Of course we know the reply often made to this, viz. that the best players are also the best workers; but do not these simultaneous experiences strongly suggest that some technical art might take the place of a dangerous game, thus infusing intelligence into the former, and providing the student with a means of competency in case of reverses? Many arts are more intellectual and less laborious than football or agriculture as carried on at Rugby, England, or Rugby, Tennessee.

The unsatisfactory condition of the medical profession in the United States, which has been remarked upon in previous reports, is in this one traced back to the thinness of population a century ago; a population also of vigorous physique occupied in clearing and settling an enormous territory, and free from most of the diseases that afflict humanity of lower vitality, and under less favourable circumstances. The early colonial physician often combined other functions with those of healing: sometimes he was a minister of the Gospel, sometimes a farmer, a shopkeeper, or a mechanic. The bulk of the profession at the beginning of the century, and for many years afterwards, did not possess any medical degree. The result followed that men of natural boldness revolted against the frequent ignorance and numerous errors of such physicians, and became followers and advocates of special medical doctrines, and supported the "botanic" school of practice, that of Hahnemann—hydropathy, physiopathy, vitopathy, electropathy, or other "medical heresies." Degrees have been too easily obtainable through numerous schools competing for popularity, and offering them for little money and less work, with the natural result of their being little valued. The Report, therefore, after going largely into the subject, and deprecating the present state of things, urges fewer schools and higher degrees, which will be worth jealously guarding, to be given by State-appointed examiners only, on the attainment of a much higher standard. Since we are told that ten colleges have agreed upon a uniform entrance examination to the great help of masters pre-

paring boys for their studies, it may be hoped that a more general union may be arrived at with regard to this standard.

Free libraries are still progressing, and so interesting are the statistics of these "universities of the people" in the United States, that Gen. Eaton promises a special publication on the subject, reprinting such parts of the great Report of 1877 as have permanent value. Several magnificent bequests and donations of books to large libraries show how naturally large private collections will gravitate to the free public library, where the locality is happily provided with one. One such, that of Dr. Toner's, containing 27,000 books and 12,000 pamphlets, was thus bequeathed to the Library of Congress. This latter institution, at the end of 1882, already contained 480,076 volumes and 160,000 pamphlets, and the forthcoming plan of a new building to keep in utilising order this rapidly growing mass is intended to embody the best appliances, arrangements, and ideas about library construction which such enormous accumulations render indispensable. An excellent precaution also against knowledge being locked up in over-large supplies of literature is taken at Chicago, where Dr. Poole, the great cataloguist, receives schools or teachers on a Saturday, surrounded by all the books of the library bearing upon some matter. By showing how interesting that subject is as a department of human thought and industry, and how much the contents of the library may help the student to a knowledge of such a subject, he has succeeded in producing a profound beneficial effect upon the upper grades of the school system.- W. ODELL

BIRDS BREEDING IN ANTS' NESTS

THE following communication to Mr. Grant Duff, Governor of Madras, has been forwarded to us for publication by Sir John Lubbock:—

To Major Awdry, Private Secretary to His Excellency the Governor of Madras

OOTY, *January* 18, 1885

SIR,—I beg to acknowledge your letter of yesterday's date.

The Southern Chestnut Woodpecker (*Micropternus gularis*), always, as far as I have observed, uses an ants' nest to nest in, and Mr. Gammie, the Superintendent of the Government Cinchona Estates at Mongphoo, near Darjeeling, has noticed the same thing with regard to the allied northern species, *Micropternus phaioceps*, and the peculiarity probably extends also to the allied species found in Burmah, Siam, &c.

Mr. Gammie thinks that when an ants' nest has been taken possession of by the bird that the ants desert the nest. This is a point on which I cannot speak with certainty. Mr. Gammie has taken nests of the northern species in which, although the bird had laid, the ants remained, and he has taken other nests where not a single ant remained; but there is nothing to show that these nests were not deserted before the bird took possession. I myself have taken nests of the southern form, in which, though the eggs were partially incubated, the ants remained, showing that some considerable time must have elapsed since the bird took possession. This is a point that I hope to be able to elucidate within the next few months, when the birds will be breeding.

When *Micropternus* is breeding the feathers of the head, tail, and primaries of the wings get covered with a viscid matter, having a strong resinous smell, and this substance is usually rather thickly studded with dead ants (*vide* "Stray Feathers," vol. vi. p. 145).

Two species of kingfishers also to my knowledge nidificate in ants' nests—viz. *Halcyon occipitalis*, confined to the Nicobar Islands, and *H. chloris*, which ranges from India as far south as Sumatra.

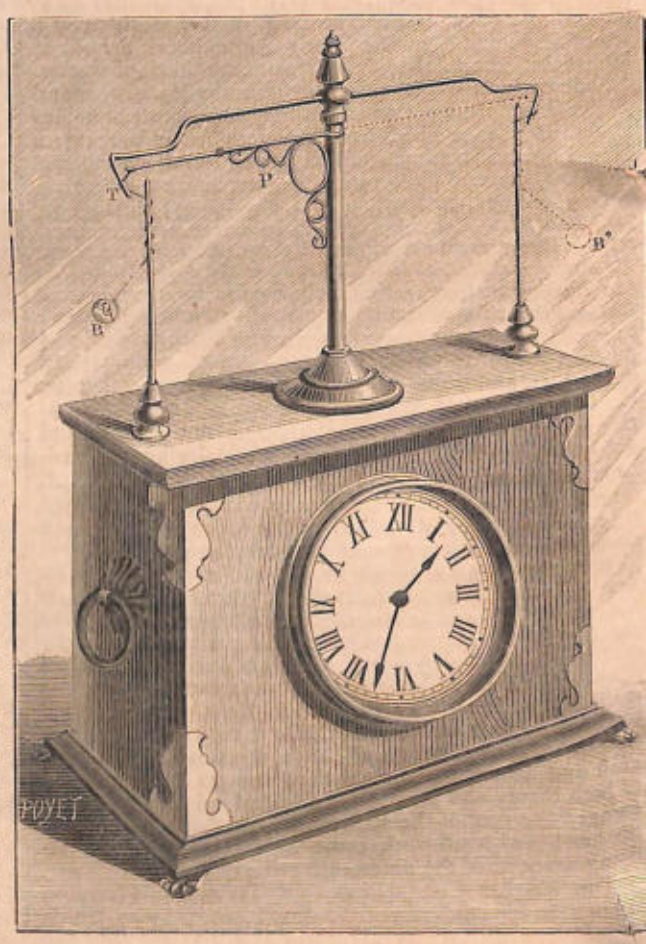
At Mergui, in South Tenasserim, I found a nest of *H. chloris* in a hornets' nest, and although I saw the birds repeatedly enter the hole they had made in the hornets' nest the hornets did not seem to mind it, but they resented in a very decided manner my attempt to interfere with the nest.

I am sorry I cannot give His Excellency more certain information as regards the desertion or otherwise of the ants from their nest after the birds have taken possession of it, but I hope to be able to finally settle the question shortly.

I am, Sir, yours obediently,
(Signed) WM. DAVISON

A NEW AMERICAN CLOCK

THE accompanying figure from *La Nature* illustrates a new American clock of ingenious construction. It is distinguished from all other clocks by the singular and original form of its pendulum: or rather of the system which serves to maintain a synchronism more or less perfect between the passage of time and the indications on the dial. The arrangement of this clock is based on



the principle of torsion. It has to be wound up daily, and the phase of the pendulum—that is to say, the time which elapses between two identical positions of the regulating system—is six seconds. The general mechanism does not differ from that of ordinary clocks; we find the main spring and other usual parts, and a train of wheels giving rotation to a vertical axis which is seen over the case and the rate of motion of which is to be regulated.

Here the new mechanism comes in. This vertical axis supports a sort of bracket, P, to the extremity of which is attached a small bead or ball, B, by means of a thread a few centimetres long. Putting out of view meantime the other parts resting on the case, it will be seen that the axis, by the action of the main spring, will turn with a rapid movement, drawing the ball B along with it. To regulate this movement, it is sought to interpose in its path suitable obstacles; this is the object of the horizontal wire terminating in the hooks T, and of the vertical pillars fixed on the case. The bracket P draws the thread in its movement and makes it strike against the arm T; it is thus arrested, and by virtue of its acquired speed, the ball B winds the thread around the pillar on the left; then follows an unwinding of the thread and a rewinding in an inverse direction, which enables the thread to pass the point T. But in unwinding it strikes a second time against the pillar, winds and unwinds anew, and only succeeds in passing this double obstacle after four successive windings, twice in one direction, and twice in the opposite direction around the same pillar. The thread thus set at liberty permits the bracket to turn 180° around the vertical axis. After this rotation it encounters two analogous objects placed on the right of the clock, and is delayed a certain time before passing these objects and returning to the pillar on the right. By suitably varying the length of the thread, which is easily done by means of a runner on the bracket, we obtain the complete phase of the movement with its eight successive windings of the thread, lasting exactly six seconds; and the clock is thus regulated, if not with all the precision of a chronometer, with an approximation said to be sufficient for ordinary use. The principle applied in this clock might possibly be utilised in cases where it is sought to regulate a slow movement of rotation by simple arrangements, both economical and uncumbrous.

A CLOUD-GLOW APPARATUS

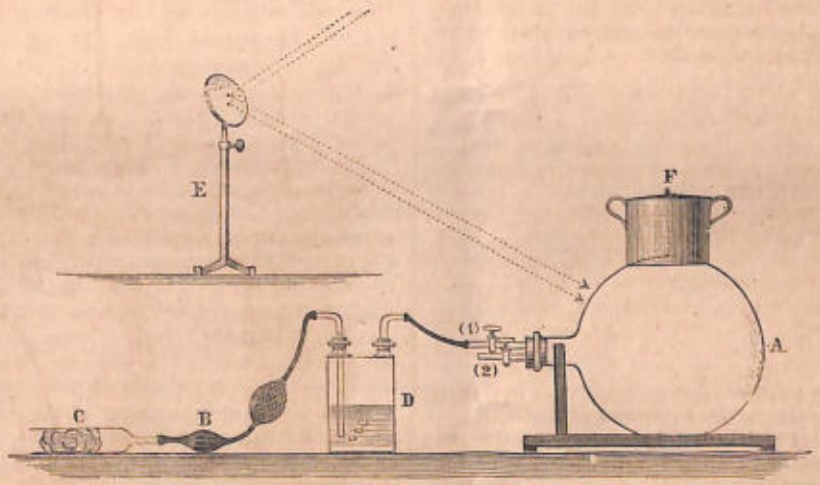
BY the kindness of Prof. J. Kiessling, of Hamburg, we illustrate a simple and easily arranged piece of apparatus which he has designed for the purpose of exhibiting on an experimental scale some of the many colour-phenomena which are produced when direct sunlight, or electric light, penetrates a moist or a dry cloud. In particular the apparatus can be used to produce on an artificially excited mist the same kinds of intense colorations which were visible in such extraordinary brilliancy in the winter 1883–84 during the hours of twilight at almost every place the whole world over.

The following pieces compose the apparatus:—

1. A glass globe, A, Fig. 1, holding about 20 litres, fixed in a wooden support, and closed by a rubber stopper bored with two holes. Through these holes enter two tubes of glass (1) and (2), with taps ground in.

2. An air-filter, C, consisting of a glass tube 30 centimetres long, filled with cotton-wool.

3. An india-rubber pump, B, for producing spray or mist. This is simply part of a common spray-apparatus, and is set so that it draws air from the air-filter and delivers it into the globe. By this means a pressure of one-sixth to one-fifth of an atmosphere is readily obtained. Suppose 15 or 20 grammes of water to have been introduced into the globe and such a pressure to have been produced, and then after about 10–15 seconds the other tap (2) to be suddenly opened, or removed quite out of the tube, the release of pressure will result in a sudden



lowering of the temperature, and the production of a tolerably homogeneous mist, the density of which will depend on the quantity of aqueous vapour present.

4. A simple heliostat, E, consisting of a mirror capable of being turned either in altitude or azimuth on an iron stand, and also of being clamped at any desired height.

5. A Woulff's wash-bottle, D. This can be filled with hot water so as to yield a supersaturated atmosphere; or, by the addition of ammonia or of hydrochloric acid, may furnish vapours of these materials for experiment in the globe.

6. A cylindrical tin-ware vessel, F, with a spherical bottom, to be set upon the glass globe, to heat or cool it as may be desired.

The following experiments may be made with this apparatus:—

[1] *The Ordinary Lunar Halo.* First cover the surface of the mirror with a card disk having a central circular opening 2 centimetres in diameter, covered with tissue paper. In direct sunlight observe the bright surface of this circle of tissue paper (which serves as an artificial moon) through the mist that is produced in the globe by letting in a stream of moist vapour from a flask of hot water for a few seconds. The halo is yellowish with a red-brown edge.

[2] *Blue Sun.* Pour into the globe a little hydrochloric acid, and blow in air through the wash-bottle, having filled the latter first with liquid ammonia. A dust-cloud of fine particles of sal-ammoniac is thereby produced. A ray of direct sunlight viewed through this is curiously coloured, appearing at the first moment red, and then changing to bluish violet and to full blue.

[3] *Artificial Cloud-Glow.* For producing the intense diffraction colours of the cloud-glow it is necessary to procure a cloud consisting of small particles all about the same magnitude. This is best attained if the air before entering the globe is first led through hot water. If the conditions are favourable the colours are sufficiently intense as to permit of their being received on a white screen one metre distant. The colours change rapidly in a regular gradation of order, each colour appearing first at the centre of the field, and moving outwards.

Several additional phenomena are to be observed with this apparatus; and its inventor has devised an ingenious proof of the once-disputed point that the particles of mist are spherules, not vesicles. This he does by showing that certain diffraction phenomena which depend on the size of the particles remain unchanged during a sudden change of external pressure, which, if the particles were bubbles or vesicles, would at once cause them to expand.

ILLUMINATION OF MICROSCOPES AND BALANCES

IN measurements and weighings where high scientific accuracy is needed it is sometimes necessary to use artificial means of illumination, and it is found that when reflected light cannot be conveniently introduced, the heat from ordinary lamps causes variations of the temperature of the room, &c., which slightly affect the accuracy of the results to be obtained. By using, however, an incandescent electric lamp fitted inside a glass vessel of water, the light may be even brought near to the microscope or balance without any appreciable interference with temperature. The glass vessel is provided with a pierced cover or shade, and a little stream of water of a uniform temperature may be kept flowing through the vessel.

By means of a "chromozone" battery, supplied by Mr. O. March, it has been found, at the Standards Office, that a light may be maintained at an insignificant cost for fifty hours without, of course, any attention. During a recent comparison made by Mr. Chaney of two standard kilogram weights it became necessary to use the lamp, but the action of the balance was not interfered with by the proximity of the lamp, the probable error of the result being only ± 0·005 mgr.

NOTES

IN an overflowing Convocation at Oxford, on Tuesday, the battle of vivisection was fought out a third time. The victory of sound sense over false sentiment has again been won; and on this occasion the vote is unmistakable. In spite of the most vigorous exertions of the opponents of physiology, the decree to endow the Physiological Laboratory—as the other scientific departments in the University are endowed—has been carried by the large majority of one hundred and sixty-eight. The Dean of Christchurch opened the debate in a moderate speech recommending the grant. He pointed out that the vote was for teaching purposes, and in no way concerned vivisection, for Prof. Burdon Sanderson had given the most complete assurances that he would not use painful experiments on living animals for the purposes of teaching. Canon Liddon opposed the decree on the ground that the Council should have introduced further safeguards against the indiscriminate use of vivisection. He admitted that vivisection was justified in certain cases, and spoke of it as a painful necessity. The Bishop of Oxford denied the moral right of man to inflict pain in order to advance knowledge, and declared vivisection to be degrading to the sensibility and humanity of the operator. The vote was supported by Prof. Dicey and Sir W. Anson, and unintentionally damaged by Dr. Acland. The last speakers were much interrupted by a clamour which prevented their remarks being heard. The announcement of the result—*placets*, 412; *non-placets*, 244—was received with great enthusiasm, both in the arena and in the undergraduates' gallery. It is to be hoped that this decisive vote will put an end to the warfare waged against the teaching of physiology in Oxford.

GEOLOGISTS throughout the world will be interested to learn that Dr. Franz Ritter von Hauer, who for so many years has so admirably guided the progress of the Geological Survey of Austria, has resigned his post as Director of that institution, and has been appointed Intendant of the Imperial-Royal Natural History Museum, Vienna. He carries with him into his new sphere of labour the hearty good wishes of a large circle of friends and well-wishers, who hope that the official duties he must now perform will in no way diminish the service he has rendered to science so long and so usefully.

IT has been proposed that, for the present session, in place of the formal receptions which have hitherto been held, the rooms of the Royal Society should be kept open on certain nights in order that Fellows and their friends may meet together for conversation and for the examination of such objects of interest as may be collected for the occasion. The first of these meetings will take place on Thursday, March 19, from 7.30 p.m. Any one desirous of showing on that evening any experiments, apparatus, or specimens illustrating any inquiry in which he may be engaged, should communicate with the Assistant Secretary, in order that appropriate arrangements may be made.

THE death is announced of the eminent Russian geologist, George Helmersen, at the age of eighty-two. He studied at Dorpat under Engelhardt, whom he accompanied on his scientific journey along the course of the Lower Volga and the Ural. He subsequently took part in Hofmann's and Humboldt's explorations of the Ural region. Having completed his studies, especially in mineralogy, he spent some years, by direction of the Russian Government, in geological travels through Germany, Austria, and Switzerland. In 1835 he joined the body of mining engineers, and was appointed Director of Studies at the Mining Institute in St. Petersburg. During leisure periods he carried out a series of important geological journeys over the Kirghiz Steppe, through Norway and Sweden, the coal districts of Poland and Silesia, the mining districts of Lakes Onega and Peipus, and the bituminous coal region in the governments of Kherson and Kiev. He also thoroughly explored the gold mines at Beresovsk, and traced the course which has been followed in making the Ural Railway. The results of his indefatigable industry have been published in numerous memoirs of the Russian Academy of Sciences and other works.

WE have heard with regret of the untimely death of the eminent Russian naturalist, Mr. N. Severtsoff, which occurred on the evening of January 11, when driving across the Don, in the Government of Voronej, his horses and vehicle breaking through the ice. The coachman managed to extricate Mr. Severtsoff, but the thermometer stood at − 10° Réaumur, and, before he could be taken to a neighbouring village, he was frozen to death. It is a singular coincidence that Prof. Fedchenko, another of the greatest of Central Asian naturalists, who, like Mr. Severtsoff, had so often risked his life in the pursuit of science in Turkestan, was also frozen to death in Europe. Mr. Severtsoff so early as 1867 explored the Thian-Shan as far as the sources of the Narin. His work on the vertical and horizontal distribution of Turkestan animals was written in Russian, and he has since published original researches on the birds of the Pamir. Certain portions of his remarks on Turkestan mammals and birds have been translated, and it is chiefly to him that we are indebted for what information we have in English respecting the mammals, birds, and reptiles of

Turkestan. We are glad to see, however, from Messrs. Sampson Low's catalogue the announcement of a book by Dr. Lansdell, on Russian Central Asia, in which are promised the enumeration of 4600 species of fauna and flora, in about 20 lists, with introductions to each.

PROF. SILVANUS P. THOMPSON, of University College, Bristol, has been appointed Principal and Professor of Physics at the Finsbury Technical College. The duties of Principal have hitherto been discharged by Mr. Philip Magnus, the Director and Secretary of the Institute, who temporarily undertook them pending the complete organisation of the College. As Professor of Physics at Finsbury Prof. Thompson succeeds Prof. Ayrton, F.R.S., who has now been appointed Professor of Physics at the Central Institution.

THE gift to the nation by Messrs. Osbert Salvin, F.R.S., and F. Du Cane Godman, F.R.S., of two valuable and highly instructive collections, is announced. One collection, presented on certain conditions, comprises the entire series of American birds brought together by those gentlemen, numbering upwards of 20,000 specimens, and illustrating more than any other collection in existence the life-history and geographical distribution of the birds of tropical America. No labour or expense has been spared in the formation of this splendid group of ornithological rarities. The other gift, which is unconditional, comprises a very fine collection of Central American Coleoptera of the families of *Cicindelidæ* and *Carabidæ*. It contains 969 species, and, moreover, 7678 examples, of which more than 400 are types of new species described in the work entitled "Biologia Centrali American," now in course of publication by Messrs. Salvin and Godman. To this collection will be ultimately added, by gift, the remaining families of Coleoptera, with other entomological specimens.

PROF. JEFFREY BELL has succeeded the late Mr. E. C. Rye in the editorship of the *Zoological Record*.

THE French Minister of Education has appointed a Commission, composed of astronomers and others, to report on the opportuneness of extending the decimal system to astronomical distances and time.

M. WOLF having received a sum of money from M. Worms, of Romilly, for the purpose, will begin at the Observatory of Paris a series of experiments for redetermining the velocity of light.

A COMMITTEE has been formed for organising the celebration of the centenary of the birth of Arago, who was born in Perpignan on March 17, 1786. The younger brother of Arago, M. Etienne, is director of the Luxembourg Museum.

MR. H. L. BIXBY, of Chelsea, Vt., U.S., is taking steps, *Science* states, to introduce a system of weather warnings throughout his State by means of blasts from factory whistles. The signals are as follows: after the first long, unbroken blast, usually given at about 7 a.m., a single five-second blast indicates fair or probably fair weather for the day; two blasts, foul weather; three, fair, changing to foul; four, foul, changing to fair; five, doubtful or irregularly variable. After any of these, five short blasts signify a cold wave or unseasonable frosts. The managers of the *Free Press* at Burlington undertake to send the necessary telegrams on payment of a small fee. Randolph is the first town to adopt the system: the signals are regularly given there now from a 10-inch steam-whistle.

AN experiment is being tried in the Jefferson physical laboratory, we learn from *Science*, which promises to be successful. An ordinary seconds clock, with a wooden pendulum, is controlled by the signals from the Harvard College Observatory, with no other mechanism than a fine spring connecting the pendulum to the armature of a telegraph instrument in the circuit. If the signals are interrupted during the day or night, the error of the clock, which seldom exceeds half a second in that time, will generally be rectified within an hour of their recurrence. The rate is in no way affected by the irregular signals caused in storms by the interference of the wires, and the regular impulses conveyed at intervals of two seconds increase but slightly the swing of the pendulum. The attachment can easily be made to any seconds clock at the cost of a few dollars, and may be of interest to those intolerant of the rates charged by companies for the use of electric dials.

FROM an article in the *Boston Journal* of February 7 we see that preparations are being made in the United States to observe the partial eclipse which will be visible there on March 16. Nearly 11/12ths of the sun's surface will be obscured at Washington, Baltimore, Philadelphia, New York, Boston, and Portland.

THE University of Glasgow having accepted the resignation of Dr. Bayley Balfour, the Chair of Botany in that University is now vacant. The patronage belongs to the Crown.

A PARLIAMENTARY paper published during the week (Corea, No. 1) contains, besides the trade report for Corea in the usual form, the account of a journey made by the Consul-General of Great Britain in the Peninsula. As for trade, the reports may be summed up much like the chapter on the snakes of Ireland: there is no trade, and there is no probability of there being any. The journey was from Seoul, the capital, to Songdo, to the north-east, the ancient capital of one of the three kingdoms into which Corea was divided. Some interesting information is given with regard to the production of the famous drug ginseng, so prized as a tonic by the Chinese. It is grown from a seed which is sown in March. The seedlings are planted out in beds raised a foot above the level of the surrounding soil, bordered with upright slates, and covered in from sun and rain by sheds of reeds, well closed in except towards the north side, where they are left to open. In the first or second year the ginseng plant is only two or three inches high, and has only two leaves. It is transplanted frequently during this period. In the fourth year the stem is about six inches high, with four horizontal leaves standing out from it at right angles, and in the fifth year a strong healthy plant has reached maturity, though it is more usual not to take it up until it has reached the sixth season. Ordinary ginseng is prepared by simply drying the root in the sun, or over a charcoal fire. To make red or clarified ginseng, the root is placed in wicker baskets, which are put in a large earthenware vessel with a closely-fitting cover, and pierced as the bottom with holes. It is then placed over boiling water and steamed for about four hours. Ginseng was for centuries regarded as a very elixir of life all over the East; and especially in China and Japan. Its properties were supposed to be miraculous, but they were generally supposed to be confined to the Corean ginseng. But its enormous price put it out of the reach of the poorer classes. The wild ginseng of Corea has frequently fetched twenty times its weight in silver in China. The export from Corea is a strict monopoly, which affords a considerable revenue, and is said to be the king's personal perquisite. Death is the punishment for smuggling it out of the country. The total export is only about 27,000 pounds avoirdupois.

ON February 8 died, near Hamburg, Johann Cæsar Godeffroy, until lately head of the great German firm of traders to the South Sea Islands. He was, however, much more than a merchant. Besides captains and supercargoes, he sent to Micronesia, Melanesia, Polynesia, and especially to Samoa, men of science, whose duty it was to make collections and send them to

Hamburg, to form there an exhaustive museum of natural history. The first whom he sent out on a mission of this kind was Dr. Graefe, of Zurich, now inspector of the zoological station at Trieste, who went to Samoa in 1861, and from this as a centre visited the Fiji, Tonga, and other groups in the region. He returned to Europe after eleven years, bringing with him important collections, and he undertook the editorship of a "Journal of the Godeffroy Museum." Amongst others thus despatched to the South Seas was a lady who spent ten years studying the botany of Northern Queensland, and a Polish surgeon, who lived for five years in the Marshall and Caroline Islands, then returned to Europe; returning again to the Carolines, where he is at present. A list of the men employed by Herr Godeffroy to travel in the South Seas to study the various islands, make collections for his museum, and report to him would embrace all nationalities, all departments of study, and every portion of the Southern Pacific. Eight catalogues of the Museum were published between 1864 and 1881, several of them containing zoological and geographical monographs as well. The *Journal*, which commenced in 1871, contained not only papers on the Museum and its contents, but was open to the discussion of any scientific subject connected with the South Sea Islands. Its most important feature was formed by the papers by specialists on sections of the collections sent home for the Museum. Fourteen parts were published in all, the most remarkable being on the fishes, which contained 140 plates and 312 illustrations. Through financial reverses this princely merchant died poor, and no purchaser was found for his museum, which will probably be broken up.

ACCORDING to a writer in the *North China Herald* on Chinese worship, it is certain that a great amount of fetichism prevails in that country. Near Peking, a few miles from the walls, on the east, is an enormous tree which fell more than two centuries ago, and which has been there ever since. It is called the Divine tree, and a temple has been erected for its worship. The people believe that a spirit lives in or near the tree, and should be worshipped from motives of prudence. The immense size of the tree is the result of the spirit's energy. It is believed it could not have grown so large without a present divinity. At Hantan, five or six days south from Peking, there are some iron bars in a well. In times of drought they are taken all the way to Peking to be prayed to for rain. They are placed in one temple after another, and prayers are offered to them till the showers fall. The bars are then reverently escorted back to Hantan, and placed in the well till they are again needed. In such a case the Chinese believe that there is a powerful spirit or genius in the well and in the bars, and that this spirit accompanies the bars to Peking and back again. This is Chinese contemporary fetichism, but in the ancient books there is no trace of fetichism. The objects of worship were either individual spirits or parts of nature. The ruling powers of the universe, from the highest to the lowest, were divided into four great classes—God, the subordinate heavenly powers, the higher earthly powers, and the numberless spirits that people earth and air. The subordinate heavenly powers were the seasons, the sun, moon, stars, cold and heat, floods and drought. The earthly powers were the gods of the mountains and rivers, and the last named are the spirits still remaining. Nothing is said of human spirits, though these were worshipped, then, as now, in the ancestral temples. But the worship in this instance consisted only of kneeling, prayer, and offerings.

DURING the late Health Exhibition at South Kensington the building and grounds were overrun with rats, food being plentiful and access to it comparatively easy. When the Exhibition closed, however, this ample source of provisions ceased to exist, and starvation seized upon the hosts of rodents who had for six months increased and multiplied upon the fat of the land. For a long time they were to be observed scampering here and there for food with abnormal temerity, often fighting fiercely over fragments of refuse, which evidenced their extreme voracity; and the officials on duty in the building have stated that the rats abounded in such large numbers that the noise of their movements resembled the "sound of wind." By degrees, however, they disappeared, some dying of starvation, whilst the majority emigrated to the houses in the neighbourhood; and at the present time there is scarcely one in the building.

IN connection with the Italian occupation of Massowah, materials for a meteorological station are being sent to that place.

IN the report of the Berlin Physiological Society for February 26 (NATURE, vol. xxxi. p. 404) the name of Dr. Kossel appears as Dr. Rossel.

IN the corrections in Sir William Thomson's Baltimore lecture given in last week's NATURE (p. 407), that for p. 296 should be π and π instead of ϖ and ϖ. Sir William Thomson also asks us to state that in his Bangor address (p. 410, 2nd col. line 12 from bottom) he has inadvertently given the date of his coming to Glasgow as 1845 instead of 1846.

THE additions to the Zoological Society's Gardens during the past week include a Dwarf Common Ass (*Equus asinus* δ) from Tripoli, presented by Mr. J. Skelding; a Bonnet Monkey (*Macacus sinicus* δ), a Macaque Monkey (*Macacus cynomolgus* ♀) from India, presented by Mrs. M. Strachan Carnegie; an Alexandrine Parrakeet (*Palæornis alexandri* δ) from India, presented by Mrs. Abbott; two Common Gulls (*Larus canus*), two Black-headed Gulls (*Larus ridibundus*), British, presented by Mr. F. S. Mosely, F.Z.S.; a Roan Kangaroo (*Macropus erubescens* ♀) from South Australia, three Coal Tits (*Parus ater*), British, purchased.

OUR ASTRONOMICAL COLUMN

VARIABLE STARS.—Prof. Schönfeld, in the notes to his second catalogue of variable stars, which was published in 1875, refers to the singular circumstance that R Serpentis had not been observed at its minimum, though he doubted if it descended below the twelfth magnitude. Considering that the variability of this star was detected by Harding in 1826, the want of satisfactory determinations of the times of minima might hardly have been expected; it does not appear that our knowledge in this direction has advanced during the last ten years. Schönfeld's formula assigns for dates of maxima January 27, 1885, and January 19, 1886; the middle date is July 25, somewhere about which we may look for a minimum, though it is to be remarked that the increase of light has been observed to be more rapid than the decrease, especially near maximum. Observations made during the approaching summer, and continued as long as practicable, may perhaps lead to a well-determined minimum being put on record. The position of R Serpentis for the commencement of the present year is in right ascension 15h. 45m. 23·6s., declination +15° 29′ 3″.

A star in R.A. 14h. 8m. 0s., decl. −11° 15′·2 for 1885·0 is probably variable from at least 7·5m. to 10m. On April 18, 1854, it was estimated a tenth magnitude, at a subsequent date 8·5, and on March 18, 1874, it was as bright as 7·5. It is not in Lalande, Bessel, Santini, Lamont, nor in the Bonn Observations, vol. vi. It is entered on Harding's Atlas as a seventh magnitude.

THE OCCULTATION OF ALDEBARAN ON MARCH 21.—The disappearance of Aldebaran at its next occultation by the moon takes place while the star is yet above the horizon at Greenwich, but its altitude there will be less than 2½°. At Exeter the star disappears at 11h. 45m. 19s., Greenwich time, at an altitude of 4½°, so that there is a possibility of observations in the west of England.

THE NAVAL OBSERVATORY, WASHINGTON.—In accordance with an intention notified several months since, Commodore

Franklin, U.S.N., Superintendent of the Observatory at Washington, issued a programme of work which it was proposed to undertake in that establishment during the present year. With the great equatorial, measures of a selected list of double stars, showing rapid motion or other peculiarity, are to be continued; the conjunctions of the inner satellites of Saturn will be observed, and a complete micrometrical measurement of the rings executed; observations which have been commenced for stellar parallax will be finished. The Transit Circle is to be employed on observations of the sun, moon, and larger planets, the latter being observed from fifteen to twenty times near opposition, and in addition each minor planet will be observed at least five times, if practicable, near opposition. The 9·6-inch equatorial will be utilised for observations of all the minor planets whose brightness at opposition is greater than their mean brightness, for positions of comets, and for occultations. The prime-vertical transit instrument is to be used in observing a selected list of stars, in conjunction with the Royal Observatory at Lisbon, in pursuance of a plan recommended by the International Geodetic Association, for the determination of variability of latitude. With the mural circle observations will be made of stars down to the seventh magnitude, south of 10° north declination, the positions of which have not been recently determined at any northern observatory, the observatory list including stars in Gould's *Uranometria Argentina* not found in Yarnall's catalogue, the transit circle list of B.A.C. stars, or the recent catalogue of the Glasgow Observatory. These principal items in the programme prove that it is not intended that the Naval Observatory shall fall short of its usual activity during the year 1885.

ASTRONOMICAL PHENOMENA FOR THE WEEK, 1885, MARCH 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 March 15

Sun rises, 6h. 16m.; souths, 12h. 8m. 58·1s.; sets, 18h. 3m.; decl. on meridian, 1° 57′ S.: Sidereal Time at Sunset, 5h. 37m.

Moon (New on March 16) rises, 5h. 34m.; souths, 11h. 9m.; sets, 16h. 52m.; decl. on meridian, 5° 51′ S.

Planet	Rises	Souths	Sets	Decl. on Meridian
	h. m.	h. m.	h. m.	° ′
Mercury ...	6 25 ...	12 17 ...	18 9 ...	2 29 S.
Venus ...	6 2 ...	11 23 ...	16 45 ...	8 17 S.
Mars ...	6 10 ...	11 45 ...	17 20 ...	5 34 S.
Jupiter ...	15 14 ...	22 27 ...	5 40* ...	13 24 N.
Saturn ...	9 30 ...	17 34 ...	1 38* ...	21 44 N.

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

Occultations of Stars by the Moon

March	Star	Mag.	Disap.	Reap.	Corresponding angles from vertex to right for inverted image
			h. m.	h. m.	° °
18 ...	B.A.C. 481 ...	6½ ...	18 58 ...	19 54 ...	153 314
21 ...	B.A.C. 1351 ...	6½ ...	18 30 ...	18 58 ...	193 242
21 ...	75 Tauri ...	6 ...	20 37 ..	21 34 ...	111 336
21 ...	B.A.C. 1391 ...	5 ...	22 0 near approach		43 —
21 ...	Aldebaran ...	1 ...	23 43 ...	0 32† ...	128 305

† Occurs on the following day; is below horizon at Greenwich.

Phenomena of Jupiter's Satellites

March	h. m.		March	h. m.	
15 ...	1 21	II. occ. disap.	20 ...	2 12	I. occ. disap.
	5 22	II. ecl. reap.		5 9	I. ecl. reap.
	18 31	I. tr. egr.		22 24	III. tr. ing.
16 ...	19 28	II. tr. ing.		23 31	I. tr. ing.
	22 24	II. tr. egr.	21 ...	1 51	I. tr. egr.
18 ...	18 40	II. ecl. reap.		2 2	III. tr. egr.
19 ..	5 4	I. tr. ing.		20 38	I. occ. disap.
				23 37	I. ecl. reap.

The Occultations of Stars and Phenomena of Jupiter's Satellites are such as are visible at Greenwich.

March	h.	
15 ...	19 ...	Venus in conjunction with and 3° 32′ south of the Moon.
16 ...	6 ...	Mars in conjunction with and 2° 32′ south of the Moon.
16 ...	... ...	Annular eclipse of Sun; not visible in England. In Ireland the commencement of the eclipse may be seen, the sun setting very shortly afterwards.
17 ...	1 ...	Mercury in conjunction with and 1° 37′ south of the Moon.
20 ...	.. ...	Sun in equator.

GEOGRAPHICAL NOTES

The Australian journals which have arrived by the last mail contain full reports of the four days' conference of the Geographical Society of Australasia at Melbourne. Gen. Sir Edward Strickland was elected President, and Baron F. von Müller, Vice-President. The first resolution proposed that the term "Australasia" should be strictly defined. The expression was first used by Mr. Wallace, but it appears to have already had various inconsistent meanings applied to it. The proposer suggested that the following definition would serve all purposes: Australasia is that part of Oceania of which Australia is the geographical, commercial, and political centre. Limits: on the west and part of the north the 100° of longitude; east, to the point of its intersection with the 20° south latitude, thence by a line running in approximate parallelism to the western and northern coast of New Guinea, and around its north-western extremity to the equator; thence on the north, by the equator, to its intersection with the 120° of longitude west, and on the east by the 120° to the south pole, including groups of islands on the equatorial line. The question was ultimately referred to a strong committee. The next resolution affirmed the desirability of a scientific exploration of New Guinea under the auspices of the Society. A corollary calling on the Government to define the boundaries of the British possessions in that island was rejected in favour of one for complete annexation. The compilation of standard works on the geography of Australasia, as well as of school maps, was also discussed. After much discussion it was decided that the consideration of the aptest means for discovery of the fate of Leichhardt and his party should be left to the Colonial Councils of the Society, with a suggestion that a circular should be addressed to pastoral tenants in Western Queensland and Central Australia, requesting information on the subject. The formation of geographical societies, and their affiliation with the central body, in South Australia, Queensland, Western Australia, New Zealand, and Tasmania was also recommended. The next Conference will meet at Sydney.

At the meeting of the Geographical Society of Paris on February 20 a communication was read from Dr. Gustave Le Bon, the author of a work on Arab civilisation, who is at present travelling in Nepaul. For the purpose of measuring the ancient monuments of various native states he has employed certain new instruments, which he will explain to the Society on his return a few months hence. Nepaul is closed to Europeans, and Dr. Le Bon is said to have been the first who has been permitted to travel through it.—M. de Lavigne spoke on the French law protecting cartographers from piracy, which he held to be ample. A method of discovering counterfeits, adopted by certain French cartographers, is said to be the insertion of some street, town, or place with an imaginary name.—M. Pinart described a journey which he made in Chiriqui, in Panama, to study the manners, language, and monuments of the inhabitants.—M. Potel discussed the present situation of French trade in the River Plate.

From *Science* we learn that several expeditions to Alaska are projected during the coming season. Gen. Miles, commanding the military district of which the territory forms a part, desires to acquire a knowledge of the unexplored region between the head of Cook's Inlet and the Tananah watershed. The course of the Tananah is likewise unmapped, except from hearsay, though often traversed by traders in the last fifteen years; so that the opportunity exists here for a fruitful expedition. It is hoped that arrangements may be practicable by which Lieut. Ray, well known for his successful direction of the Point-Barrow party, may be able to command such an exploration. The plan contemplates work either from the Yukon as a base, with a steam-launch and a small party, ascending in June and July, and returning before navigation closes, or an expedition by way of Cook's Inlet, making the portage to the Tananah, and then descending; but a final decision is not yet reached. The party under Lieut. Abercrombie did not succeed in obtaining native assistance,

as expected, and were unable to pass beyond the glacier alleged to obstruct the Copper or Atna River, about sixty miles from the sea. Meanwhile, a party has actually started, under Gen. Miles's orders, January 30, for the Copper River, consisting of Sergeant Robinson and F. W. Ficket, signal-observer U.S.A., and commanded by Lieut. Allen. They intend to go to the mouth of the Atna or Copper River by steamer, and ascend as far as possible on the ice, pushing on by water as soon as the ice breaks up and the freshets are over. They hope to cross the divide from the Upper Atna, and descend by one of the Yukon tributaries to the mouth of the latter river, and rejoin civilisation at St. Michael's. They may be fortunate enough to make the journey in one season, but are prepared to stay two years. They will add a number of Indians to the party at Sitka, and carry various peace-offerings for the Atna Indians. Lieut. Stoney, of the navy, is reported to have a new expedition nearly organised to continue his investigations of the Kowak River. The plan adopted, so far as yet decided upon, is to take a steam-launch, ascend the river as far as possible, and pursue the explorations to its source, and winter in the region if necessary. It is stated that the party is to be composed of sixteen men, which is dangerously large, considering the limited food-resources of the region, and might be advantageously diminished by one-half for explorations in the interior. If the party were to pass over the divide, and investigate the course of the Colville, returning *viâ* Point Barrow next summer, it would accomplish a praiseworthy and much-needed investigation.

We have received from Messrs. W. and A. K. Johnston a school physical wall map of England and Wales, in which the altitudes above sea-level are shown by varieties of tint. Of its kind this map is good, though we should prefer to see the method of tints combined with the graphic method, in order that pupils may be taught to read the maps with which they have to deal when they become men and women. Accompanying the map is a little hand-book of the physical geography of England and Wales.

THE SCOPE AND METHOD OF PETROGRAPHY[1]

In considering the history of geology we are struck by the fact that towards the close of the last and during the commencement of the present century, when the science was taking rank as an important branch of human knowledge, petrography occupied a much higher position than it has at any subsequent period.

Werner, whose influence was almost unrivalled at the time to which I have referred, was a mineralogist, and his formations were therefore naturally based on the mineralogical characters of the different rocks. His observations were limited for the most part to his own district of Saxony, but he regarded his formations as sediments or precipitates from a universal ocean, and his numerous pupils, fired by his love of science and his intense enthusiasm, rejoiced in extending his classification to the districts with which they were severally acquainted.

The magnificent work of those who devoted special attention to the organic remains in the sedimentary deposits, and especially that of William Smith, the "Father of British Geology," had the effect of deposing petrography from the position which it held under the influence of Werner and his followers. It was clearly shown that the fossil contents of the strata were far more reliable as evidence of chronological relations than their lithological characters, and as soon as this became generally recognised, the reduction of the fossil-bearing rocks all over the world to something like definite order followed as a natural consequence.

The principle that strata may be identified by means of their fossil contents has not only proved applicable to the Secondary and Tertiary formations to which it was originally applied by Smith, Cuvier, and others, but it has been extended by Murchison, Sedgwick, Barrande, and others to the older rocks. Speaking broadly, there can be no doubt that over large areas the succession of the forms of marine life has been remarkably uniform from the Cambrian times down to the present, so that we have in the fossil contents of the different strata by far the most reliable means of determining chronological relations.

It is not surprising, then, that petrography has been comparatively neglected by geologists, for their main object during the present century has been to classify the stratified rocks which form so large a portion of the existing land surfaces.

At the present time, however, we are witnessing a great revival of interest in petrography, not only in this country but all over the globe. This is due in part, no doubt, to the introduction of new methods of research; but it seems to me that there are other and more general causes. The clear recognition of the great principle with which the name of William Smith is so indissolubly united at once made it possible for a host of observers to do excellent work in every quarter of the globe. The interest awakened by the study of the geological structure of the most densely populated regions was akin to that which is felt by the geographical explorer of unknown lands. Until the main features of the geology of fossiliferous regions were described, it was not to be expected that observers would turn aside from a field of research in which they were certain to meet with success for the purpose of attacking problems which, after all, might prove to be insoluble. As time went on, the unexplored tracts in which fossiliferous rocks occur became more and more restricted, or more and more inaccessible, and when the old chaos of Grauwacke fell into order before the brilliant researches of Sedgwick, Murchison, and Barrande, geologists were placed in an entirely new position. They had conquered that portion of the world which was open to their special method of attack. A number of fortresses still held out, it is true, and many of these remain unsubdued at the present day. They will doubtless occupy the attention of those who are most skilled in the old methods of warfare for many years to come. At the same time I think it will be admitted on all hands that the brilliant successes of the old generals have left a large portion of the army with little to do. We must, therefore, look for other worlds to conquer.

Now, on taking a general survey of the subject-matter of geology it will be seen at once that we are profoundly ignorant on questions relating to the origin and sequence of volcanic rocks, the cause or causes of volcanic action, the mode of formation of the crystalline schists, and the origin of mountains. That these questions are really unsolved is proved by the difference of opinion which exists between competent observers. Another point which strikes one is, that if a solution of these problems be ever realised, it will be due in a great measure to the combination of field geology and petrography. This, it seems to me, will explain the great interest which is taken in the latter branch of science at the present day. If I am right in my opinion as to the present state of things, then we may safely predict that petrography will occupy as prominent a position in the immediate future of geology as palæontology has done in the past. In making this statement I trust it will not be thought that I am claiming too high a position for that branch of geology with which I am most intimately acquainted.

Let us turn now to a more detailed consideration of the scope and method of petrography. The rocks of the earth's crust form the subject-matter of the science. Now these may be studied from two more or less distinct points of view—the descriptive and the ætiological. We may set to work to describe the rocks, that is, to ascertain and record every possible fact with regard to them; or we may endeavour to trace the succession of events which has culminated in the state of things which we actually observe. It is perfectly obvious that we cannot hope to attain any considerable success in the second branch of the subject until we have devoted a considerable amount of attention to the first.

Descriptive petrography then concerns itself with the chemical, mineralogical and physical characters of the individual rocks, and also with the distribution and mutual relations of the different varieties. The last-mentioned branch of the subject occupies the same position in petrography as comparative anatomy does in zoology. It may therefore be termed comparative petrography.

When the history of the science comes to be written, it will be recognised that it is to the Germans we are especially indebted for our knowledge of descriptive petrography. The amount of work which has been done in Germany is immeasurably greater than that produced by other nations. For years past they have been steadily improving their methods of observation, as well as observing and recording facts. Moreover, they have been training petrographers who are now scattered all over the world. The Americans especially have availed themselves of the laboratories of Rosenbusch and Zirkel, and almost every Annual Report of the American Survey now bears witness to the influence of

[1] Lecture delivered in the Woodwardian Museum, Cambridge, by J. J. H. Teale, M.A., F.G.S.

Germany from a teaching point of view on the growth of petrographical science. In this sketch, of course, I am only calling attention to the broad facts of history as far as regards the special branch of descriptive petrography. Many observers in France, England, and America have done independent work of the very highest order, and to England especially belongs the credit of having, in the person of Sorby, determined to a very large extent the introduction of the modern methods of microscopical research.

Consider now what is involved in the description of any particular rock, and take, for example, a specimen of the Whin Sill, that mass of basic igneous rock which plays such an important part in the Carboniferous region of the North of England.

The rock is dark gray or bluish-gray when freshly exposed. In texture it varies from compact to coarsely crystalline, the most common variety being one in which the individual constituents are just recognisable by the naked eye. Its specific gravity varies from 2·90 to 2·95. Its chemical composition is shown on this table. (Table referred to.) We have now to consider its mineralogical composition. In the determination of minerals in rocks we use physical and chemical methods. Colour, general appearance, hardness, cleavages, specific gravity, crystalline form, fusibility, and flame coloration are some of the most important physical properties available for the determination of minerals in rocks when they can be examined macroscopically. In thin sections we can use colour, general appearance, cleavages, form, and also the many properties which are brought out by the use of parallel and convergent rays of polarised light. Chemical tests may be applied both to macroscopically recognisable minerals and also to those which can only be observed by the use of thin sections or minute particles and the microscope. The latter are generally referred to as microchemical tests.

By applying these methods, some of which will be more fully explained in the subsequent lectures, we can prove that the rock of the Whin Sill is composed of felspar, pyroxene, titaniferous magnetic iron ore, quartz in the form of grains and also as a constituent of micro-pegmatite, apatite, pyrite, brown hornblende, mica, and some green decomposition products. Apatite, pyrite, hornblende, and mica occur only in very small quantity, and cannot be said to form any appreciable portion of the rock.

In order to give a complete petrographical description, however, it is necessary that we should not only know what minerals are present, but also that we should know the precise composition of each and the relative abundance of the different species. Information on these points can only be obtained by isolating the different constituents of a rock and analysing them separately. Methods of isolation will be described in subsequent lectures. The most important are those which depend on the use of heavy solutions, the magnet and electro-magnet, and various chemical reagents, especially hydrochloric and hydrofluoric acids. The chemical composition of each of the three principal constituents of the Whin Sill is represented on these tables. (Tables referred to.) Now, having obtained a knowledge of the composition of the principal constituents of the rock, it becomes possible to determine with a very fair amount of accuracy the relative proportions of these constituents by calculations based on the bulk analysis of the rock.

There is yet another point of great importance to which attention should be paid in subjecting a rock to an exhaustive examination. Owing to the brilliant researches of Sandberger, it is beginning to be recognised that many of the heavy and so-called rare metals are present in ordinary rocks in minute quantities. Until recently we have been disposed to regard these substances as occurring only in mineral veins and in the deeper portions of the earth from which the mineral veins have been supposed to derive their supply of material. Now it is beginning to be clearly recognised that these substances are very widely distributed even in the superficial crust of the globe. As an illustration of the interest and practical importance of the subject above referred to I may call attention to the important work by Dr. Becker, on the "Geology of the Comstock Lode," recently published by the U.S. Geological Survey. This lode, the yield of which is supposed to have sensibly affected the bullion markets of the world, occurs in a region which is remarkable for the extreme development of igneous rocks (diabase, diorite, andesites, &c.), and for the widespread alteration to which these rocks have been subjected. The bisilicates, especially, have been affected by this alteration, and for immense distances they have been entirely replaced by a green chloritic mineral.

Most careful assays have been executed, under the supervision of Dr. Becker, for the purpose of determining the amount of bullion in the fresh and unaltered rocks, and the relative amounts of gold and silver. He says: "By comparison of the different assays it appears that decomposed diabase carries somewhat less than half as much silver as the fresh rock. When the decomposed rocks are pyritous, the experiments made do not indicate any essential diminution of the gold contents. This fact, however, is quite possibly due to irregularity in distribution and the minuteness of the quantities of gold to be determined. As the decomposition of the rock in question has proceeded at a great depth beneath the surface, it is highly unlikely that silver should have been extracted unaccompanied by gold. Much of the decomposed rock, too, is nearly free from pyrite, and had the gold contents of such specimens been determined, a smaller percentage would probably have been found. The omission [to select specimens free from pyrite] was not detected until it was too late to resume the investigation. So far as quantitative relations are concerned, the silver only can be relied on, though the qualitative detection of gold as well is both interesting and important."

Another point of great interest was determined by Dr. Becker. He isolated the felspar and the augite of the diabase and tested both from silver. He found that for equal weights the augite was eight times as rich as the felspar substance, and as the latter contained some augite, this appears to furnish substantial proo that the silver is a constituent of the augite.

Having subjected a rock to exhaustive chemical and mineralogical examination, it next becomes necessary to compare it with other rocks, and to give it a name. The subject of nomenclature is a very difficult one. It is much to be regretted that notwithstanding all that has been done in descriptive and comparative petrography, we are still far from having any system of classification which is capable of general acceptance. Indeed, we are not agreed as to the first principles on which a classification of rocks should be based. The German petrographers, in most cases, adopt at the outset a principle which we cannot accept. They divide igneous rocks into older and younger: the former including all those which they regard as pre-Tertiary, the latter all those which are of post-Cretaceous age. The division is based, of course, on the assumption that the conditions of eruption in pre-Tertiary times were essentially different from those which have prevailed since. There seems, so far as we can judge, little or no ground for this assumption. The few facts which do at first sight lend support to it appear to be equally capable of explanation on the other hypothesis. The typical pre-Tertiary rocks of the German system are the granites, diorites, gabbros, diabases, and syenites. Now there is reason to believe that these are all plutonic rocks; in other words, that they are the result of slow consolidation beneath the surface, and therefore under great pressure. If this view be correct then their exposure at the surface can only occur long after their formation, and the fact that the majority of those known to us should be of pre-Tertiary age, as Lyell long ago pointed out, need occasion no surprise.

Again, it must be remembered that the mere association of eruptive rocks with pre-Tertiary deposits is no proof in itself that the former are of pre-Tertiary age, and also that many competent observers believe that these are clear cases of Tertiary granite, diorite, diabase, and gabbro.

The igneous rocks, which are regarded by the German petrographers as especially characteristic of the post-Cretaceous period, are the basalts, andesites, trachytes, and rhyolites; in other words, the surface-products of volcanic action. That these should be mainly Tertiary, and that they should differ to a certain extent from their pre-Tertiary equivalents in consequence of alteration, is only what might be naturally expected. This, however, is not sufficient to justify the refusal to give the same name to different specimens of one and the same rock merely because they have been produced at different periods; and the work of Allport, Bonney, Geikie, and others has proved that there are basalts, andesites, and rhyolites of Palæozoic age which are identical in structure, composition, and mode of occurrence with modern rocks.

In the absence of any generally recognised system of nomenclature it becomes difficult to assign a name to the rock of the Whin Sill. It is a holo-crystalline rock composed essentially of plagioclase, pyroxene, titaniferous and magnetic iron ore. In sections the felspar occurs in lath-shaped forms. To such a rock, provided it be of pre-Tertiary age, Rosenbusch would

give the name diabase. We are inclined, on the other hand, to call the rock a dolerite. The important point for the student to remember, however, is that in the present unsettled state of nomenclature his primary duty is to make himself familiar with the structure and composition of the various rock types. The question of names is, after all, only of secondary importance, provided we remember that in looking at the facts through the medium of an unphilosophical nomenclature we may so distort them as to fail to realise their true forms and relations.

Consider now the ætiological aspect of petrography. Most of us are so constituted that we cannot rest satisfied with a mere description of facts; we almost instinctively endeavour to discover what we call the origin of things. This, after all, merely consists in tracing back as far as possible the chain of events of which the object or phenomenon in question represents the last link. The search after causal relations in the organic world has led to the introduction of a principle which is now recognised as one of the greatest importance in almost every branch of human knowledge. Changes in the characters of organisms are now admitted to be determined by two factors—the inherent properties of the organism and the influence of surrounding circumstances. A very little consideration will serve to show that the changes which occur during and subsequent to the development of minerals and rocks are determined by two allied factors.

Take the case of crystallogenesis. It is not difficult to see in a general kind of way that the characters which a crystal possesses have been determined (1) by the inherent properties of the crystallising substance, and (2) by the influence of surrounding circumstances—of the environment. When we examine thin sections of rocks, furnace-slags, or the refuse products of glass-works, we frequently find a number of bodies which are intermediate as it were between glass and true crystals. These have been carefully examined and admirably described by Hermann Vogelsang, who has also succeeded in producing many of them by artificial means. As they serve to illustrate in a very striking way the principle above referred to, a short description of Vogelsang's experiments will not be out of place.

The crystallising substance finally selected by Vogelsang for the purpose of his experiments was sulphur. This substance is readily soluble in bisulphide of carbon, out of which it crystallises in the rhombic form. If the process of crystallisation be followed under the microscope, nothing definite as to the nature of crystalline growth can be made out. The first objects which appear are definite crystals, and these grow by accretion. If, however, the solution of sulphur be thickened with Canada balsam then, provided the proper proportions of the different substances have been employed, some very interesting phenomena may be observed by the aid of the microscope as the bisulphide of carbon evaporates. Minute fluid spheres arise in the medium and grow by mutual absorption. They finally consolidate as clear, transparent, isotropic bodies, and to them Vogelsang has applied the term globulites. It is impossible to determine absolutely the composition of these globulites, but there seems no reason to doubt the conclusion of Vogelsang that they are portions of the Canada balsam which are richer in sulphur than the surrounding mass, and that they arise in consequence of the attempt of sulphur to crystallise under unfavourable circumstances. Similar bodies may be observed in certain rocks, slags, and blow-pipe beads, although the crystallising compounds must be very different in the different cases.

Under certain circumstances the mass of sulphur and Canada balsam solidifies with the formation of globulites, but under other circumstances additional phenomena may be observed. When the resistance of the medium is too great to prevent the union of the globulites, but not too great to prevent their approach, they become united into various more or less definite forms. The mode of union depends partly on the way in which the globulites attract each other, and partly on the movements in the mass. A linear arrangement of the globulites is very common, and to the form arising in this way Vogelsang has given the name margarite. A rectangular grouping is also not uncommon. From a study of the various forms arising in consequence of the union of globulites, Vogelsang concludes that in the case of sulphur there are in each globulite, as it were, three directions at right angles to each other, in which the attraction is considerable, and that in one of these the attraction is decidedly greater than in the other two.

The building up of the compound forms naturally leaves the surrounding space free from globulites.

Under certain circumstances the globulites become fused, as it were, at the points of contact. This occurs when the resistance is sufficient to prevent the assumption of the spherical form, but not sufficient to resist the destruction of the pellicle at the point of contact. In this way rod-like bodies, termed longulites, arise.

It must be remembered that all these forms are strictly isotropic. They are not, therefore, in any sense of the word, crystals. The moment a true crystal of sulphur appears, it can be recognised by its doubly-refracting properties. They have been termed crystallites, wherever they occur, by Vogelsang, and they evidently arise in consequence of the attempts of some definite chemical compound to crystallise under conditions which do not admit of the free approach of the molecules.

Between crystallites and perfect crystals showing definite external faces there are numerous intermediate forms, such as microlites and skeleton crystals. As further illustrations of the influence of the environment we have only to consider the facts that no two crystals of the same substance are precisely alike in all their characters, and that some substances, like sulphur and carbonate of lime, may be made to crystallise in two different systems by varying the conditions under which the crystallisation is effected.

There can be no doubt, then, that two factors are involved in the determination of the properties which crystals present: the inherent forces of the crystallising substance and the influence of surrounding substances.

So far we have referred only to the birth and growth of crystals. But the history of a crystal does not cease with its formation. With a change in the surrounding circumstances the crystal may be modified or destroyed. Thus we see that crystals have a kind of life-history: they are born, they grow in size by accretion, and finally they cease to exist as distinct individuals.

As an illustration of the influence of a change of physical condition on the character of a crystal, consider the case of leucite. At ordinary temperatures this mineral is generally regarded as tetragonal, and it certainly shows double refraction in thin sections. Klein has shown that by heating leucite to a point far short of its fusibility it may be rendered perfectly isotropic, and hence follows the conclusion that leucite is really isotropic when subject to the conditions under which it is formed. That crystals should be in a state of stable equilibrium, so far as molecular forces are concerned, when subject to the physical conditions under which they are formed, is exactly what we should expect, and that this equilibrium may be disturbed by a change in these conditions is also very easy to understand.

As further illustrations of the principle here referred to, consider the various cases of paramorphosis, such as the change from arragonite to calcite, or from calcite to arragonite; or, again, the corresponding changes in sulphur.

Illustrations of the changes which arise in crystals in consequence of changes in the chemical conditions to which they are subjected, need not here be referred to in detail; the destruction of crystalline rocks by denudation is of course a consequence of these changes.

Consider, now, the rocks of which the earth's crust is composed. They also have a life-history. They are formed and destroyed, and it is the business of the petrographer not only to describe and classify them, but also to trace out the cycle of change. For the purpose of illustrating this branch of petrography let us consider certain facts with reference to the genesis of crystalline igneous rocks. It will be admitted on all hands that such rocks as granite, syenite, diabase, rhyolite, trachyte, andesite, and basalt have originated by the consolidation of an intensely heated silicate-magma under different conditions as to temperature and pressure. The consolidation has been accompanied—except in those cases where the magma has consolidated as a homogeneous glass, and these will be left out of account for the present—by the development of crystals. If, then, we would understand the manner in which crystalline igneous rocks have been formed, we must consider the subject of crystallogenesis in silicate-magmas. Numberless facts which need not here be referred to prove that the process of consolidation is not a sudden one. As the surrounding circumstances (environment) become more and more favourable to crystallisation, the minerals separate out one after the other, and at last the whole mass becomes solid, and the rock is formed. The temperature at which any given mineral forms is not determined by its own fusibility. The laws of the formation of minerals in

igneous rocks are analogous to those which determine the formation of salts from concentrated aqueous solutions. Cooling influences the separation of the different minerals only in so far as it affects the solubility of the constituents of the minerals in the silicate-magma. The point at which a mineral forms from a silicate solution has, then, no more connection with its fusibility than the point at which graphite forms in molten iron has with *its* fusibility.

Another point of very great importance is this: the differentiation of crystals in an originally homogeneous magma must necessarily be accompanied by a variation in the composition of that magma. It becomes, then, of great interest to determine the general order of the formation of crystals in igneous magmas. On this subject we have a most valuable and suggestive paper by Rosenbusch, entitled "Ueber das Wesen der körnigen und porphyrischen Structur bei Massengesteinen" (*Neues Jahrbuch*, 1882, ii. p. 1). Before proceeding to give an account of the portion of this paper which bears more particularly on the subject we are now discussing, it may be well to call attention to the methods available for the purpose of determining the order of the formation of the minerals in a rock. There are two. In the first place we may observe the phenomena of inclusions, and in the second place we may observe the extent to which crystalline form has been developed. If one mineral is seen to be included in another, then we may safely infer, subject to certain precautions, that the included mineral is the earlier of the two, and if one mineral shows a more perfect form than another with which it is associated, then we may infer—again subject to certain precautions—that the mineral with the more perfect form is the earlier.

Now in the paper above referred to, Rosenbusch divides the constituents of igneous rocks into four groups:—

(1) The ores and accessory constituents (magnetite, hematite, ilmenite, apatite, zircon, spinel, sphene).

(2) The ferro-magnesian silicates (biotite, amphibole, pyroxene, olivine).

(3) The felspathic constituents (felspar, nepheline, leucite, melilite, sodalite, haüyn).

(4) Free quartz.

He then calls attention to the contrast which is presented by the granites and syenites on the one hand, and the diabases on the other. In the former the following law is adhered to with a very great amount of persistence:—The order of formation is that of increasing basicity: the ores and accessory constituents are first formed, and the quartz is the final product of consolidation. In the diabases and gabbros there is apparently an exception to this law of increasing basicity, the augite consolidating after the felspar. Rosenbusch proposes to divide the granular holo-crystalline rocks into two classes: (1) those in which the minerals of the 2nd group in the above classification consolidate before those of the 3rd, and (2) those in which the reverse relation holds. He then calls attention to cases illustrative of the law of increasing basicity which are furnished by the order of separation in the individual groups. Thus in the ferro-magnesian group, olivine is older than biotite, amphibole and pyroxene; and biotite is older than the bisilicates. In the felspathic group triclinic felspars are older than monoclinic [there are exceptions to this rule, as, for instance, in the porphyroid of Mairus in the Ardennes, where orthoclase crystals are seen to be surrounded by a narrow zone of oligoclase], and the basic triclinic felspars are older than those which contain a large percentage of silica.

The views of Rosenbusch are based on the assumption that the order of formation of crystals in igneous magmas is determined solely by chemical conditions. That these conditions are the more potent seems quite clear, but there are facts which appear to show that physical conditions are not altogether without influence on the result.

The law of increasing basicity may be accepted without hesitation as expressing in a general way the truth as regards the order of separation of the different constituents of igneous rocks.

Now a very interesting conclusion follows as a natural consequence of this law. The effect of progressive crystallisation in a magma must be to increase the percentage of silica, to decrease the amount of lime, iron, and magnesia, to increase the total amount of alkalies, and to increase the potash relatively to the soda in the part which remains liquid. It is always satisfactory to find independent evidence confirmatory of any conclusion at which one may have arrived. Now I think we have confirmatory evidence of this kind in the present case. It will be admitted on all hands that the crystals in porphyritic rocks, such as hypersthene-andesite, have been formed in a magma the composition of which is represented by the bulk analysis of the rock. If, then, we compare the bulk analysis with the analysis of the ground-mass deprived of its crystals, we ought to find confirmation of the above conclusion.

Dr. Petersen has isolated and analysed the ground-masses of two of the Cheviot porphyritic rocks, and by comparing these with the bulk analyses of the rock the truth of the conclusion is most strikingly illustrated. The effect of progressive crystallisation in the andesitic magma has led unquestionably to an increase in the amount of silica, a decrease in the amounts of lime, iron, and magnesia, an increase in the amount of alkalies generally, and an increase in the potash relatively to the soda. In the rock itself soda is in excess of potash; in the ground-mass potash is in excess of soda.

There is yet another piece of independent confirmatory evidence. Every geologist is familiar with the phenomenon of contemporaneous veins. The general view held with regard to them is that they represent portions of material which remained fluid after consolidation had progressed to a considerable extent. If this view be correct, then they should hold the same chemical relation to the main mass of the rock as the ground-mass of the Cheviot andesite does to the main mass of the andesite. Mr. Waller has recently analysed certain contemporaneous veins which occur in the bronzite-diabase of Penmænmawr. He finds that they contain about 7 per cent. more silica than the normal rock, less lime and magnesia, more alkalies, and more potash than soda, although in the normal rock soda is in excess. Contemporaneous veins in the Rowley rag dolerite have also been investigated by Mr. Waller, with the same result as far as increase in silica and total alkalies is concerned. The relation of potash to soda has not yet been determined.

I believe it is admitted to be a general rule that contemporaneous veins contain more silica than the rock with which they are associated. It will be seen that there is abundant evidence of an independent character to confirm the general truth of the conclusion which follows from a consideration of the facts brought forward by Rosenbusch.

I should not have treated this subject at such length did it not appear to have an important bearing on the origin and sequence of volcanic rocks. I can best explain this by referring to the Cheviot district, with which I am slightly acquainted.

Andesitic lavas and tuffs cover large tracts of this district. These are unquestionably the products of surface volcanic action. In the central portion of the volcanic area there is a mass of augitic granite. A consideration of the mineralogical composition of this granite shows that it cannot belong to the acid group of rocks, and this conclusion is confirmed by an examination of the chemical composition of allied rocks from the Vosges. So far as we can judge in the absence of analyses there appears to be a very close connection between the composition of the plutonic and that of the volcanic rocks of the Cheviot district, and we therefore seem justified in concluding that the plutonic masses differ in character from the andesitic lavas merely in consequence of differences in the conditions of consolidation. The plutonic rocks represent the consolidation of the andesitic magma beneath the surface, and therefore under great pressure; the lavas and tuffs represent the consolidation of the same magma at the surface.

I now come to the point to which I wish to direct special attention. The andesitic lavas and tuffs are traversed by quartz-felsite dykes in such a way as to show that a magma of rhyolitic composition must have been erupted by the Cheviot volcanoes subsequently to the period characterised by the eruption of the andesitic magma. Contemporaneous veins similar in character to the quartz-felsite dykes also occur in the plutonic rocks. Again, an analysis of one of the quartz-felsite dykes by Mr. Waller agrees almost exactly with the analyses of the ground-mass of the hypersthene-andesite by Dr. Petersen.

Putting all these facts together, we conclude that the eruption of an andesitic magma was followed, in the history of the Cheviot volcanoes, by that of a rhyolitic magma in consequence of progressive crystallisation in the deep-seated plutonic source. The rhyolitic magma is, so to speak, the mother liquor out of which various basic minerals have crystallised. Suppose a half-consolidated plutonic mass, originally of andesitic composition, to become subjected to a powerful crush such as that which unquestionably arises in the earth's crust under certain circumstances. The mother liquor will be squeezed out of the mass,

like whey out of cheese, and it may finally consolidate as contemporaneous veins in the plutonic rock, as dykes in the surrounding volcanic rocks, or as rhyolitic lavas and tuffs at the surface. The ideas here thrown out appear to me to be capable of extension to other volcanic regions; but as the sequence in these regions is generally complicated by the coming in of basic rocks during the later phases of volcanic activity, it will not be advisable to enter more fully into the subject on the present occasion.

The special characters which igneous rocks present, then, are to be traced to the chemical and physical properties of the original magma and to the influence of surrounding circumstances. Rocks, like minerals, are in a state of stable equilibrium when subjected to the conditions of their formation. When subjected to other conditions, whether physical or chemical, they usually undergo a change. The destruction and disintegration of igneous rocks by the various agents of denudation are familiar to every student of geology, and need not therefore be described on the present occasion.

I trust I have now said sufficient to show that the science of petrography is one of the greatest importance to the geologist of the present day. The remarks on ætiological petrography are, of course, only intended to illustrate the nature of this branch of the subject, and to show that conclusions of the greatest theoretical interest may be expected to follow from a careful consideration of the facts acquired by work in the other branch of the science.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—A Report recently issued gives particulars of the successful raising of the roof of the Mineralogical Museum to form a Morphological Laboratory on the new floor thus created. The firm of builders who had furnished estimates ultimately declined the work, and the Department of Mechanism undertook it. Under the continual superintendence of Prof. Stuart and Mr. Lyon the work was so skilfully done that not a crack was occasioned in the ceiling of the Mineralogical Museum, and the deflection of the new timbers was so well calculated that no timber moved upwards or downwards more than the eighth of an inch when the load came upon it. The cost was several hundred pounds less than the estimate. The roof raised was 110 feet long, and the weight fifty tons. A special vote of thanks is to be given to the Department of Mechanism for the care, skill, and economy with which the building operations were conducted.

The Botanical Laboratory has cost a little over 800*l.*; the Morphological Laboratory has cost about 2500*l.*

In the Natural Science "Special" Examinations for the ordinary B.A. degree during the past year, the great majority of candidates chose Chemistry, and showed that they had bestowed considerable pains on laboratory work while yet they were only imperfectly acquainted with the *rationale* of the processes they employed. The candidates in Botany had neglected systematic, and especially descriptive, botany. In June the descriptions of easy, well-marked specimens of flowering-plants were so worthless, that it was difficult to find out, from some descriptions, to which of the specimens they were intended to apply.

In Mechanism and Applied Science book-work was satisfactorily done, but deductions and numerical applications were very imperfect. Drawing was well done, and the candidates also showed a practical acquaintance with the use of tools; but they did not sufficiently connect their mathematical with their practical knowledge.

In the previous examination or little-go, Jevons's logic was set as an alternative subject to Paley with considerable success last year. Out of forty-four candidates only six failed. In arithmetic a knowledge of decimals and the use of common sense were strikingly wanting. The gradual elevation of standard in Euclid and Algebra of late years appears to have produced beneficial results. The papers in Mechanics in the October examination (on entrance) were unsatisfactorily answered; the candidates had for the most part read treatises dealing with the subject incompletely and popularly.

The proposal to discontinue entirely the additional examination in Mathematics for Honours Candidates has been rejected by a large majority, it having been found impossible to provide any substitute which would command general assent.

Mr. M. C. Potter, Assistant Curator of the Herbarium, has been approved as a Teacher of Botany.

The Physiological class-rooms having again become seriously overcrowded, owing to the increase of the medical school, a scheme for building new class-rooms with a large lecture-room is put forward by the Museums and Lecture Rooms Syndicate. The lecture-room is to be 45 feet by 40, and 32 feet high, and is calculated to accommodate 247 students comfortably. A new class-room 80 feet long to accommodate 100 students working at one time is an important feature, and rooms will also be provided for Prof. Roy's temporary Pathological Laboratory. The estimate cost is 9000*l.*

SCIENTIFIC SERIALS

Journal of Anatomy and Physiology, January, contains:—Diseases of the reproductive organs in frogs, birds, and mammals, by J. B. Sutton (plate 8).—Oviduct in an adult male skate, by J. D. Matthews (plate 9).—On the influences of some conditions on the metamorphosis of the blow-fly, by J. Davidson.—On the sources and the excretion of carbonic acid at the liver, by J. J. Charles.—On a method of maceration, by A. M. Paterson (plate 10).—Floating kidney, by D. Hepburn.—The movements of the ulna in rotation of the fore-arm, by Thos. Dwight.—Dissection of a double monster, by A. Hill.—Relation of the alveolar form of cleft palate to the incisor teeth and the intermaxillary bones.—The dumb-bell-shaped bone in the palate of Ornithorhynchus compared with the pre-nasal bone of the pig.—The infra-orbital suture; and an additional note on the oviducts of the Greenland shark, by W. Turner.—Anatomical notes.

Quarterly Journal of Microscopical Science, January, contains:—On the significance of Kupffer's vesicle, with remarks on other questions of vertebrate morphology (plate 1), by J. T. Cunningham.—Blastopore, mesoderm, and metameric segmentation, by W. H. Caldwell (plate 2).—On the origin of the hypoblast in pelagic teleostean ova, by G. Brook.—On the presence of eyes in the shells of certain Chitonidæ, and on the structure of these organs, by H. N. Moseley (plates 4, 5, 6).—*Archerina boltoni*, nov. gen. et sp., chlorophyllogenous protozoon allied to Vampyrella, by E. Ray Lankester (plate 7).—On the apex of the root in Osmunda and Todea, by F. O. Bower (plates 7 and 8).—Correction of an error as to the morphology of *Welwitschia mirabilis*, by F. O. Bower.—E. Van Beneden's researches on the maturation and fecundation of the ovum, by J. T. Cunningham (plate 10).—On the suprarenal bodies of vertebrata, by W. F. R. Weldon (plates 11 and 12).—On the life-history of certain British heterœcismal uredines, by C. Plowright.—On the occurrence of chitin as a constituent of the cartilages of Limulus and Sepia, by W. D. Halliburton.

Journal of the Royal Microscopical Society, February, contains:—On the apparatus for differentiating the sexes in bees and wasps. An anatomical investigation into the structure of the receptaculum seminis and adjacent parts, by F. R. Cheshire (plates 1 and 2).—On the occurrence of variations in the development of a Saccharomyces, by G. F. Dowdeswell.—Notes on the life-histories of some little-known Tyroglyphidæ, by A. D. Michael (plate 3).—The usual summary of current researches in zoology, botany, and microscopy.

THE *American Naturalist*, February, contains:—On the habits of some Arvicolinæ, by E. R. Quick and A. W. Butler.—On a parasitic copepod of the clam, by R. R. Wright.—On the rudimentary hind-limb of Megaptera, and on the finger-muscles in *M. longimana* and in other whales, by J. Struthers.—The structure and development of the suspensory ligament of the fetlock in the horse, by J. D. Cunningham.—The Winooski or Wakefield marble of Vermont, by G. H. Perkins.—A botanical study of the mite-gall found in the black walnut, by Lillie J. Martin.—On the evolution of the Vertebrata, progressive and retrogressive, by E. D. Cope.

Rendiconti del Reale Istituto Lombardo, January 8.—Annual report on the work of the Institute in the various branches of science and letters during the past year, by the Secretary.—Biographical notice of Baldassare Poli, by Prof. Carlo Cantoni.

January 15.—On the secular variations in the elements of terrestrial magnetism at Venice, by Ciro Chistoni.—On a rare case of congenital malformation of the bladder, by Dr. G. Fiorani.—Extent of the diurnal oscillation of the magnet of declination at Milan in the year 1884, by Prof. G. V. Schiaparelli.—On the anatomy of the human brain, by Dr. Casimiro Mondino.—On

the appearance of Halley's comet in the year 1456, by Prof. G. Celoria.

Rivista Scientifico-Industriale, January 15.—Influence of static electricity on lightning conductors, by Prof. Eugenio Canestrini.—On Trouvé's universal incandescent electric lamps (four illustrations), by the Editor.—On the various forms of *Scleranthus marginatus*, Gussone, by Dr. Leopoldo Nicotra.

Zeitschrift für wissenschaftliche Zoologie, December 1884, contains:—Observations on the origin of the sexual cells in Obelia, by Dr. C. Hartlaub (plates 11 and 12).—Studies among the Amœbæ, by Dr. A. Gruber (plates 13 and 14).—On the propagation and development of *Rotifer vulgaris*, by Dr. O. Zacharias (plate 16).—On the amœboid movements of the Spermatozoa of *Polyphemus pediculus*, by Dr. O. Zacharius.—On the uropneustic system in Helicinæ, by Dr. H. v. Ihering (plate 17).—On the metamorphosis in Nephelis, by Dr. R. S. Bergh (plates 18 and 19).—On the intercellular spaces and bridges in epithelia, by P. Mitrophanow.

Morphologisches Jahrbuch, Band x. Heft 3, contains:—On the occurrence of spindle-shaped bodies in the yolk of young frog eggs, by Prof. O. Hertwig (plate 14).—Researches upon the *Pori abdominales*, by H. Ayers (plate 15).—Contribution to a knowledge of the eye in gastropods, by C. Hilger (plates 16 and 17), and a postscript by Dr. O. Bütschli.—Studies on the development of the medullary cord in bony fish, with observations on the first appendages of the germinal vesicle and the chorda dorsalis in Salmonidæ, by N. Goronowitsch (plates 18 to 21).—Dinosaurs and birds: a reply to Prof. W. Dames, by Dr. G. Baur.—On the carpi centrale, and on the morphology of the tarsus in the Mammalia, by Dr. G. Baur.—Remarks on the abdominal pores in fish, by Prof. C. Gegenbaur.

SOCIETIES AND ACADEMIES

LONDON

Royal Society; January 13.—"On the Constant of Electromagnetic Rotation of Light in Bisulphide of Carbon." By Lord Rayleigh, F.R.S.

A complete account is here given of the experiments briefly referred to in the Preliminary Note,[1] and of others on the same plan of more recent date. As regards the method, it may be sufficient to add to what was there said, that the electric currents were estimated by comparing the difference of potential generated by the current in traversing a known resistance with that of a standard Clark cell, the value of the cell being known by converse operations, in which the current was measured by a special electro-magnetic apparatus.[2] Allowance being made for temperature, the determination of the currents by this method was abundantly accurate and very simple.

The results are grouped in three series, of which the first two were considered in the Preliminary Note. In both of them the same tube was used, the principal difference being that in the first the light traversed the tube three times, and in the second but once. In the third series another tube was employed, and some improvements in respect to thermal insulation were introduced. The readings were taken with a double-image prism in place of the ordinary analysing Nicol, a substitution by which it is believed some advantages were obtained.

From the fifteen sets of observations of Series I. we find as the rotation of sodium light in bisulphide of carbon at 18° corresponding to a difference of potential equal to unity C.G.S. the value ·04203 minute. From the four observations of Series II. we get in like manner ·04198 minute, and from the seven observations of Series III. ·04202 minute. The last value is adopted as the most probable.

In an appendix some remarks are made upon polarimetry in general, especially in relation to the half-shade method. A device proposed by M. Becquerel for augmenting the precision with which rotations can be determined with the aid of a half-wave plate is considered, and the conclusion is arrived at that no advantage can thus be obtained.

February 19.—"Note on a Preliminary Comparison between the Dates of Cyclonic Storms in Great Britain and those of Magnetic Disturbances at the Kew Observatory." By Balfour Stewart, F.R.S., and Wm. Lant Carpenter.

The authors had made this comparison, through the kindness of Mr. Whipple, in the case of about thirty storms, the dates of which were taken haphazard from those given by Mr. R. H. Scott in his paper on the cyclonic storms of the last ten years, in the *Quarterly Journal* of the Meteorological Society for October, 1884. Out of these thirty cases, in twenty-three there war a distinct magnetic disturbance, for the most part preceding the storm by somewhat more than a day. The authors intend to pursue the subject, considering that there is a *primâ facie* case for investigation.

Geological Society, February 20.—Annual General Meeting.—Prof. T. G. Bonney, F.R.S., President, in the chair.—The Council's Report announced the awards of the various medals and of the proceeds of the Donation Funds in the gift of the Society.—In handing the Wollaston Gold Medal to Dr. W. T. Blanford, F.R.S., for transmission to Mr. George Busk, F.R.S., F.G.S., the President addressed him as follows:—The Council of the Geological Society has awarded to Mr. George Busk the Wollaston Medal in recognition of the value of his researches in more than one branch of palæontology. Polyzoa, not only fossil, but also recent, he has made peculiarly his own, and his numerous separate papers, his British Museum Catalogue, and his memoir on the Polyzoa of the Crag, have entitled him to the lasting gratitude of workers at this class of the Molluscoida. But, perhaps as a relief to the study of these minute invertebrates, he has occupied himself, not less successfully, with the larger vertebrata, so that to him we are indebted for much information on the fauna of Post-tertiary deposits, especially from the caves of Malta and of Brixham. Permit me, in handing you this medal for transmission to Mr. Busk, to express my pleasure at having such a duty to discharge, and my earnest hope, in which I am sure all present will share, that restored health may enable him to continue his work in the cause of our science.—The President then presented the balance of the proceeds of the Wollaston Donation Fund to Dr. Charles Gallaway, F.G.S., and addressed him as follows:—The Council of the Geological Society has awarded to you the balance of the proceeds of the Wollaston Donation Fund, in recognition of the value of your researches among the older British rocks. By your identification of Upper Cambrian rocks in Shropshire you have placed beyond question the antiquity of the Rhyolitic Group of the Wrekin, our knowledge of which and of yet older rocks in that district you have greatly augmented. Your contributions also to the geology of Anglesey and to unravelling the stratigraphy of the Scotch Highlands have been of great value, and we look forward to the results of further researches, in aid of which I have great pleasure in placing in your hands the amount of the award. That you receive it from a fellow-labourer will, I hope, make it not the less welcome. The President then handed the Murchison Medal to Dr. Henry Woodward, F.R.S., for transmission to Dr. Ferdinand Römer, F.M.G.S., of Breslau, and addressed him as follows:—The Council has awarded to Dr. Ferdinand Römer the Murchison Medal and a sum of ten guineas from the Donation Fund. His life-long and unwearied labours in the service of our science have long since made his name familiar to his fellow-workers. When I state that the Royal Society Catalogue, published now more than eleven years since, records the titles of 122 separate memoirs written by him, when I mention his other important works, such as that on "The Chalk Formation of Texas," on "The Silurian Fauna of Tennessee," on "The Geology of Upper Silesia," and the "Lethæa Geognostica," I have said enough to prove that this memorial of an illustrious geologist could not well have been bestowed on a more illustrious recipient. In transmitting it to Dr. Römer, be so kind as to express our regret that the distance and the season of the year have deprived us of the pleasure of his presence on this occasion. In presenting the balance of the proceeds of the Murchison Geological Fund to Mr. Horace B. Woodward, F.G.S., the President addressed him as follows:—The balance of the proceeds of the Murchison Donation Fund has been awarded to you in recognition of the good service which you have already rendered to geology, especially by your work among the later deposits of the eastern counties, and to aid you in further researches. But the excellent papers which you have written, in addition to the work done by you as a member of the Geological Survey, do not constitute your only claim to our recognition. You have made use of the opportunity of your official position to promote a love of science among those who live in our eastern counties, and we are indebted to you for that admirable volume, "The Geology of England and Wales," which, though in one sense a compilation, is such a one as only

[1] *Proc. Roy. Soc.* vol. xxxvii. p. 146.

[2] "On the Electro-chemical Equivalent of Silver, and on the Absolute electromotive Force of Clark Cells." *Proc. Roy. Soc.*, vol. xxxvii. p. 142.

a skilled geologist could produce. The President next presented the Lyell Medal to Prof. H. G. Seeley, F.R.S., F.G.S., and addressed him as follows:—The Council has awarded to you the Lyell Medal and a grant of 40*l.* in recognition of your investigations into the anatomy and classification of the Fossil Reptilia, especially the Dinosauria. Not that you have limited yourself to this field of research; your papers on *Emys* and *Psephophorus*, on *Megalornis* and British Fossil Cretaceous Birds, on *Zeuglodon*, and on remains of Mammalia from Stonesfield, prove your extensive knowledge of vertebrate palæontology, as your proficiency in invertebrate is evidenced by your earlier work, both stratigraphical and directly palæontological. Furthermore, your excellent edition of the first volume of Phillip's "Manual of Geology" indicates an exceptional familiarity with the literature of our science. Since our acquaintance first began, some twenty years since, at Cambridge, we have both had our disappointments and our successes; you, undiscouraged by the one, unelated by the other, have pushed on to your present high position in science, making no enemies, winning many friends. I trust that your future career may be even more prosperous than your past, and that this medal may be an augury of many good gifts of fortune. You will, I know, believe me when I say that I feel an exceptional pleasure in being commissioned to place in your hands this medal, commemorative of the great geologist whose philosophic spirit you so well appreciate, and whose memory, I know, you so greatly revere. The President then handed the balance of the proceeds of the Lyell Geological Fund to Mr. J. J. H. Teall, F.G.S., for transmission to Mr. A. J. Jukes-Browne, F.G.S., and addressed him as follows:—The balance of the Lyell Donation Fund has been awarded to Mr. A. J. Jukes-Browne in recognition of the excellent work that he has done on the Cretaceous formation and on glacial geology, and to aid him in further researches. His papers on the Cambridge greensand cleared up many difficulties connected with that interesting formation; and in his Sedgwick prize essay on the Post-tertiary deposits of Cambridgeshire he commenced those investigations which have since brought us more than one valuable contribution on glacial and later deposits. You can tell him that his old college tutor feels a little pardonable pride and much real pleasure in being the instrument of placing this award in your hands for transmission to him. In presenting the Bigsby Gold Medal to Prof. Renard, of Brussels, the President addressed him as follows:—When to a familiarity with geology in the field and a love of nature are united the skill of a finished chemist and the experience of a practised worker with the microscope, the results cannot fail to be of the utmost importance to our science. These qualifications, rarely united in any one man, are in yourself combined with an untiring industry and a love of science for its own sake. Thus we are indebted to you for many important contributions to our knowledge in geology. Your early memoir, "Sur les Roches Plutoniennes de la Belgique et de l'Ardenne Française," written in conjunction with M. de la Vallée Poussin, will long be classic; your papers on various subjects connected with the Carboniferous limestone, on the coticule, the phyllites, and other altered rocks of Belgium, and on the deep-sea deposits, are too well known to need more than mention, and in recognition of these the Council has awarded you the Bigsby Medal. In placing it in your hands may I be allowed to express for myself and others the hope that it will be always a pleasant *souvenir* of your many friends on this side of the Channel, some of whom, myself included, will not soon forget the pleasant and, to us, most profitable days spent under your guidance in geological studies by the limestone cliffs of the winding Meuse and the wooded crags of the Ardennes. The President then read his Anniversary Address, in which, after giving obituary notices of some of the members lost by the Society during the year 1884, he referred to the principal contributions to geological knowledge which have been made during the past year, both in the publications of the Society and elsewhere in Britain, concluding with a notice of the new views which have been adopted with regard to the structure of the Western Highlands, and a brief history of the steps by which they have been arrived at. The concluding portion of the address was devoted to a discussion of the principles of nomenclature which should be followed in petrology, with remarks on the classification of igneous rocks, and on the significance of certain structures, especially the more minute.—Officers and Council, 1885:—President: Prof. T. G. Bonney, F.R.S.; Vice-Presidents: W. Carruthers, F.R.S., John Evans, F.R.S., J. W. Hulke, F.R.S., J. A. Phillips, F.R.S.; Secretaries: W. T. Blanford, F.R.S., Prof. J. W. Judd, F.R.S.; Foreign Secretary: Warington W. Smyth, F.R.S.; Treasurer: Prof. T. Wiltshire, F.L.S.; Council: H. Bauerman, W. T. Blanford, F.R.S., Prof. T. G. Bonney, F.R.S., W. Carruthers, F.R.S., Prof. W. Boyd Dawkins, F.R.S., John Evans, F.R.S., A. Geikie, F.R.S., Henry Hicks, M.D., Rev. Edwin Hill, M.A., G. J. Hinde, Ph.D., John Hopkinson, W. H. Hudleston, F.R.S., J. W. Hulke, F.R.S., Prof. T. Rupert, F.R.S., Prof. J. W. Judd, F.R.S., J. E. Marr, M.A., J. A. Phillips, F.R.S., Prof. J. Prestwich, F.R.S., Warington W. Smyth, F.R.S., J. J. H. Teall, M.A., W. Topley, Prof. T. Wiltshire, F.L.S., Rev. H. H. Winwood, M.A., Henry Woodward, F.R.S.; Assistant-Secretary, Librarian, and Curator: W. S. Dallas, F.L.S.; Clerk: W. W. Leighton; Library and Museum Assistant: W. Rupert Jones.

Physical Society, February 28.—Prof. Guthrie, President, in the chair.—Messrs. G. R. Begley and O. Chadwick were elected Members of the Society.—Mr. J. C. McConnel presented two notes on the use of Nicol's prism. The first note related to the error in measuring a rotation of the plane of polarisation due to the axis of rotation of the prism not being parallel to the emergent light. After pointing out that this error was, to a first approximation, eliminated by taking the mean of the readings in the two opposite positions of the Nicol, the author proceed to push the calculation to a second approximation, so as to get a measure of the residual error. This is given by the equation—

$$\frac{\theta+\theta_1}{2} - \psi = \text{const.} + .24r^2 \sin\psi\cos\psi,$$

where θ and $180 + \theta_1$ are the two readings of the circle; ψ the angle between the plane of polarisation and a fixed plane, and r the angle between the axis of rotation and the incident light. This equation is practically correct for a flat-ended as well as an ordinary Nicol. The residual error cannot amount to 1′ in a rotation of 60° if r is less than 2°. The optical properties of the Nicol tend to neutralise the geometrical error due to the rotation taking place about one axis and being measured about another. The second note dealt with a new method of obtaining the zero reading of a Nicol circle. This is often defined as the reading when the plane of polarisation is parallel to the axis of rotation of the table of a spectrometer. A Nicol is fixed on the table, the light quenched by turning the Nicol circle, and the reading taken. The table is then rotated through 180°, the light quenched, and the reading taken again. The mean of the two readings gives the result required. It was described how the error due to the want of symmetry of the Nicol might be found and eliminated.—Mr. H. G. Madan exhibited and described some new forms of polarising prisms. The first of these is by M. Bertrand, and has been described by him (*Comptes Rendus*, September 29, 1884). The prism consists of a parallelopiped of dense flint glass of refractive index 1·658, the same as that of Iceland spar for the ordinary ray. The glass prism is cut like the spar of a Nicol's prism, a cleavage plate of spar being cemented between the two halves by an organic cement of refractive power slightly greater than 1·658. A beam of light traversing the prism is incident upon the spar at an angle of 76° 44′. The ordinary ray passes through without change, but the extraordinary ray is totally reflected at the first surface. The prism gives a field of 40°. M. Bertrand's prism has the great advantage of requiring only a very small quantity of Iceland spar, a substance that is becoming very scarce and expensive. The other prisms shown were:—a similar one by M. Bertrand, described in the same paper; a double-image prism by Ahrens, described in the *Phil. Mag.* for January, 1885; and a modification of the latter by Mr. Madan, described in NATURE for February 19. Mr. Lewis Wright pointed out as a practical objection to M. Bertrand's prism that it was very doubtful whether a glass could be obtained of so high a density as to possess a refractive index of 1·658 and at the same time be colourless and unaffected by the atmosphere. He also remarked that the principle of the prism was by no means new.—Prof. W. E. Ayrton read a paper by himself and Prof. J. Perry on "The most economical potential difference to employ with incandescent lamps." The authors commenced by pointing out the importance of experiments being made on the lives of incandescent lamps, in addition to experiments on efficiencies. Referring to the experiments on life given by M. Foussat in *The Electrician* for January 31, they showed that if p be the price of a lamp in pounds, n the number of hours per year that it burns, $f(v)$ the

life of the lamp in hours, and $\theta(v)$ the number of candles equivalent to the lamp, $f(v)$ and $\theta(v)$ being expressed as a function of the potential difference in volts $\frac{f \times n}{f(v) \times \theta(v)}$ stands for the cost per year per candle, as far as the renewal of lamps is concerned. Also, if H stands for the cost of an electric horse-power per year for the number of hours electric force is employed, and $p(v)$ the number of watts per candle, $\frac{H}{746} \times p(v)$ stands for the cost per year per candle as far as the production of power is concerned. The sum of these two represents the total cost per candle per year, and the value of v that makes this a minimum may be found either graphically or analytically. Solving the problem graphically for the 108 volt Edison lamps used at the Finsbury Technical College, where n may be taken as 560 and $H = 5l.$, they find that the minimum value of the total cost is given by $v = 106$. The curve connecting total yearly cost per candle with v they found to be very flat at this point, showing that the lamps may be burnt with a potential difference varying as much as 4 volts, with only 5 per cent. addition to the annual cost. It is found that with certain types of incandescent lamps the candle-power of the lamp varies as the potential difference minus a constant. The authors also find that in rough photometric experiments No. 8 sperm candles may be substituted for standard ones.—Mr. Macfarlane Gray gave an account of a most extended investigation upon the second law of thermodynamics. From considerations connected with the specific heats of liquids and gases the author comes to the conclusion that the second law is not true. The experimental results used are chiefly those of Regnault, to which, however, Mr. Gray has applied some corrections.

EDINBURGH

Royal Physical Society, February 18.—The Rev. Prof. J. Duns, D.D., F.R.S.E., President, in the chair.—The following communications were read, viz.:—Prof. W. Turner, F.R.S., exhibited and described a collection of fossil bones of mammals obtained in excavating the new dock and a gas-holding tank at Silloth. He was indebted for these to Dr. Leitch, Mr. Charles Boyd, and Mr. J. T. Middleton. The specimens consisted of antlers and a humerus of the Red Deer, vertebræ of two whales and two skulls and some of the bones of the limbs of the great extinct ox of Britain, *Bos primigenius*. Those found in excavating the dock were within a short distance of each other, lying in a bed of wet gravel and shingle, mixed with oyster, mussel, and cockle beds, the material overlying the bones being twenty-six feet in thickness. One of the antlers contained eight points, and it is doubtful if a finer specimen could be found on any existing red deer. The lower jaw of one skull of the *Bos primigenius* was obtained, and it is apparently the only specimen that had been seen in Britain, and, comparing it with the wild cattle in Cadzow Forest, he found that the extreme length of the jaw of the fossil ox was 18¼ inches, as against 15⅞ inches in the Hamilton cattle, being a difference of nearly 3 inches. The leg bones also showed the massive character of the Great Ox, and enabled the Society to realise its magnitude.—Dr. R. Milne Murray, M.A., M.R.C.P.E., described and exhibited some new modifications of recording apparatus.—Dr. Ramsay Traquair, F.R.S., described and exhibited a new fossil fish, *Elonichthys multistriatus*, found in the black-band ironstone at Gilmerton.—Mr. George Brook, F.L.S., described a new method for the aëration of marine aquaria.—Mr. John Hunter, F.C.S., read a paper on a new modification of Lunge's nitrometer.—Prof. A. G. Nathorst and Prof. Gustav Lindström, of Stockholm, have been elected Corresponding Fellows of the Society.

Institution of Civil Engineers, February 19.—Sir Frederick J. Bramwell, F.R.S., President, in the chair.—The second of a course of lectures on "The Theory and Practice of Hydromechanics" was delivered by Dr. William Pole, F.R.SS., L. and E., M.Inst.C.E., Honorary Secretary of the Institution, the subject being "Water Supply."

CAMBRIDGE

Philosophical Society, February 16.—Prof. Foster, President, in the chair.—The following communications were made to the Society:—Some remarks on the urea-ferment, by Mr. A. S. Lea.—On the occurrence of reproductive organs on the root of *Laminaria bulbosa*, by Mr. Walter Gardiner.—On the types of excretory system found in the Enteropneusta, by Mr. W. Bateson.

SYDNEY

Linnean Society of New South Wales, December 31, 1884.—C. S. Wilkinson, F.L.S., President, in the chair.—The following gentlemen were present as visitors:—Messrs. W. H. Caldwell, B.A., C. E. Smith, James Mosely, Alex. Hamilton.—The following papers were read:—Occasional notes on plants indigenous in the immediate neighbourhood of Sydney, No. 8, by Edwin Haviland.—The geology and physical geography of the State of Perak, by the Rev. J. E. Tenison-Woods, F.G.S., &c.—Note on an apparently new parasite affecting sheep, by R. von Lendenfeld. In several localities sheep were affected by a disease similar in appearance to epithelial cancer, which appeared on the feet behind the hoofs and on the lips. The histological investigation shows that the rete malphigii is inflamed and the Papillæ attain a very large and abnormal size; the outer layer of the skin and the horny epithelium are very much thickened, and it is apparent that between the horny layer granular masses, apparently parasites, are disposed, in which nuclei can be detected. The author supposes these to be an Amœba, and to cause by irritation the hypertrophy of the epithelium. The sections were exhibited under the microscope; the specimens were hardened with chromic acid and stained with picric acid carmin.—On the temperature of the body of *Ornithorhynchus paradoxus*, by N. de Miklouho-Maclay. The result of some observations on the temperature of the *Ornithorhynchus* is here given, showing it not to exceed 40° C. or 76° Fahr. Previous observations made by the Baron had shown that the temperature of the body of the Echidna was at least 5° Fahr. higher than that of the other Monotreme.—Mr. W. H. Caldwell, B.A., exhibited several specimens which he had recently obtained in Queensland, showing the stages in the development of the Monotremes from the laying of the egg to the hatching.—Mr. J. Mitchell, of Bowning, exhibited a large number of Silurian fossils collected by him in the neighbourhood of Bowning. They consisted of a variety of mollusks, corals, and about sixteen species of trilobites. Among the trilobites are *Phacops caudatus*, *P. longicaudatus*, *P. encrinurus punctatus*, and *P. Jamesii* (?), *Calymene* (*Lenaria* ?), *Harpes ungula*, *Staurocephalus Murchisonii*, *Bronteus*, and several of the genus *Acidaspis*, one of which attained a considerable size. The mollusks included representatives of *Pentamerus*, *Orthoceras*, *Avicula*, *Strophomena*, &c.

PARIS

Academy of Sciences, March 2.—M. Bouley, President, in the chair.—Note on "Les Origines de l'Alchimie," by the author, M. Berthelot. In this work the origin of alchemy, forerunner of the modern science of chemistry, is traced back by means of Greek manuscripts and Egyptian papyruses to the remotest historic times.—Researches on isomery in the aromatic series; heat of neutralisation of the polyatomic phenols, by MM. Berthelot and Werner.—Observations of the small planets and of Wolff's comet made with the great meridian at the Paris Observatory during the last quarter of the year 1884, communicated by M. Mouchez.—On the periodicity of the solar spots, and the anomaly of their last maximum, by M. Faye. The periodicity is regarded as established, and the irregularity in the last maximum is referred to a possible quasi independence of the northern and southern solar hemispheres, in virtue of which the epochs of their respective greatest activity may not coincide exactly.—First explorations of the mission sent by the Academy to study the recent earthquakes in the south of Spain, by M. Fouqué. The mission, consisting of MM. Fouqué, Lévy, Bertrand, Barrois, Offret, Kilian, and Bergeron, arrived at Malaga on February 7, and from that point visited Periana, Zaffararia, Venta de Zaffararia, Alhama, Arenas del Rey, and Albuñuelas, which places suffered most during the disturbances.—On a characteristic reaction of the secondary alcohols, by M. G. Chancel.—Action of oxygenated water on the oxides of cerium and thorium, by M. Lecoq de Boisbaudran.—Correction of a previous communication (*Comptes Rendus*, February, 1879, p. 322) regarding the spectrum of Samarium, by M. Lecoq de Boisbaudran.—On the prevailing winds of North Persia, and on the south wind of the province of Ghilan, by M. J. D. Tholozan.—Report of the International Commission for the widening and deepening of the Suez Canal, presented by M. de Lesseps.—Election of M. Grand' Eury as Corresponding Member for the Section of Botany in place

of the late M. Duval-Jouve.—Reply to some of the criticisms, formulated in connection with the note of January 5, on the reproduction of phylloxera and the employment of the sulphate of carbon for its destruction, by M. P. Boiteau.—On the spectrum and formation of the tail of Encke's comet, by M. Ch. Trépied.—On a theorem of M. Darboux in mathematical analysis, by M. E. Picard.—The poles of the gyroscope and rotating solids in connection with Coriolis's theorem, by M. Henry.—On the maxim phase in the diurnal variations of terrestrial magnetism in 1882, according to the results obtained at the Montsouris Observatory, by M. L. Descroix.—Claim of priority in respect of the process of annulation of the extra current employed by M. d'Arsonval to avoid the dangers of mechanical generators of electricity, by M. A. Doussin.—On the means of counteracting or diminishing the dangers of the extra current in dynamo-electric machines in case of rupture in the exterior circuit, by M. J. Raynaud.—On the limit of density and atomic value of the gases, and especially of oxygen and hydrogen, by M. E. H. Amagat.—Composition of the gaseous products of the combustion of iron pyrites, and influence of Glover's tower on the production of sulphuric acid, by M. Scheurer-Kestner.—On the separation of alumina and the sesquioxide of iron, by M. P. Vignon.—On some basic and ammoniac nitrates, by M. G. André.—On the composition of the glyoxal-bisulphate of ammonia ($C_4H_2O_4$, $2(AzH_4O$, $S_2O_4)$, $2HO$), by M. de Forcrand.—Action of the sulphate of cinchonamine on the circulation and secretions, by MM. G. Sée and Bochefontaine.—On the substitution of quinine for creosote and phenic acid in the treatment of typhoid fever, by M. G. Pécholier.—Measure of the pressure necessary to determine the rupture of blood-vessels, by MM. Gréhant and Quinquaud.—On some peculiarities relative to the connections of the cervical ganglia of the sympathic nerve and the distribution of their afferent and efferent branches in *Anas boschas*, by M. F. Rochas.—On the nature of the placental neo-formation, and on the unity maintained in the development of the placenta, by M. Laulanie.—Note on the fœtus and placenta of a gibbon, by M. J. Deniker.—On some points in the physiology of the muscular system of the invertebrates, by M. H. de Varigny.—On *Bos triceros*, Rochbr., and on preventive inoculation against epizootic peripneumonia as practised by the Moors and Fulahs of Senegambia, by Dr. A. T. de Rochebrune. This variety of domestic ox, peculiar to Senegambia, is characterised by a third horn growing from the nasal process and identical in its constitution and development to the two frontal horns. The variety, which is of unknown origin, is thoroughly established, and from time immemorial has been inoculated by the natives with the virus of epizootic peripneumonia, a disease prevalent in the country.—On the mosses of the Carboniferous epoch, by MM. B. Renault and R. Zeiller.—Origin of the iron, magnesia, and zinc ores in and at the foot of the Jurassic Limestone hills on the periphery of the central plateau in France, by M. Dieulafait.—On a remarkable deposit of running water in the mines of Carmaux, Tarn, by M. Stan. Meunier.—Destructive effects of a waterspout which recently passed over the Argentan district, Orne, by M. E. Vimont.—A new method of observing stars during their transit across the meridian, by M. Ch. V. Zenger.

BERLIN

Physiological Society, February 13.—Prof. Fritsch produced a few specimens of *Lophius piscatorius*, and drew special attention to the two rays situated above the wide gape, and ending in flap-like appendages, which in some had the shape of a fly, in others that of a worm, and were used by the fish as bait to attract its prey. The jaws and fins were likewise covered with flap-like appendages, excrescences of the skin, which rendered the animal, especially in mud, completely irrecognisable. The peculiar development of the skin of this fish induced the speaker to search for corresponding peculiarities in its nervous system—peculiarities which he soon discovered in its medulla oblongata. He found there, on the posterior side of the medulla, and quite superficially situated, a group of huge ganglion-cells, recognisable by means of a lens, such as had hitherto been found only in Malapterurus. While, however, this latter fish possessed but two such gigantic cells, Lophius had a larger number of them, and these offered for study a series of general problems on the structure of ganglion cells. The protoplasm of these colossal nerve-cells was not fibrous, but granular, the nucleus large and bladder-like. The nutriment was provided by a close capillary net which closed tightly around the protoplasm and sent loops into its recesses. The cells were multipolar, yet one process, which in every case was the peripherical, preponderated in size over all the others. From these cells there branched off gigantic nervous fibres consisting of powerful fibrous axis cylinders and sheaths. Such gigantic nerves were found partly also in the roots of the vagus and trigeminus, and probably spread to the peculiar cuticular appendages of Lophius. Altogether Prof. Fritsch believed he was justified in concluding from what he had observed in his investigations of the ganglion-cells of Lophius, that there were neither apolar nor unipolar ganglion-cells, but only bipolar and multipolar, and that the processes of the ganglion-cells might unite, so that frequently an axis-cylinder would be produced from two ganglia.—Dr. Uhthoff spoke in detail of the experiments carried out by him in the Physical Institute regarding the dependence of visual acuteness on light intensity. By way of supplement to the report on the subject given by Dr. König at a recent meeting of the Physical Society, be it here observed that differences among the eyes examined showed themselves specially under weak light intensities, and that the minimum of visual acuteness (1-1000th of the normal value) was, in particular cases, still observable under an illumination corresponding with the removal of the petroleum lamp to a distance of 360 m. The visual acuteness was further examined under a changing intensity with red and blue light. Red light, just as much as white, showed with increasing intensity a very rapid increase of visual force. The curve in the case of red light was, however, different from that in the case of white light. Under a blue light the visual sharpness very slowly declined with increasing light intensity. Dr. Uhthoff next described an apparatus he had constructed for the purpose of measuring the angle of the visual line with the line perpendicular to the cornea, without the use of the ophthalmometer. The principle of the apparatus was based on measuring the angular displacement of a plane paralleled glass plate, the glass plate standing perpendicular first to the normal and then to the (actual) visual line. Both the apparatus of Dr. Uhthoff and the microscopical preparations of the gigantic ganglion-cells and fibres of Lophius were shown to the Society in the demonstrating hall.

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THURSDAY, JUNE 11, 1885

THE DARWIN MEMORIAL

IT is not often that the unveiling of a statue is attended with an interest at all comparable with that which characterised this ceremony as performed last Tuesday in the Great Hall of the Natural History Museum. If the greatness of a man is to be estimated by the measure in which he has influenced the thoughts of men it is scarcely open to question that the greatest man of our century is Charles Darwin. As Prof. Huxley remarked in the course of his singularly judicious and well-balanced address, Mr. Darwin's work has not only reconstructed the science of biology, but has spread with an organising influence through almost every department of philosophical thought. Yet it was not merely the greatness of the naturalist which invested the proceedings in the Natural History Museum with an interest so unique. It was known to the whole assembly that the man whom they delighted to honour was one whose moral nature had been cast in the same lines of simple grandeur as those which belonged to his intellectual nature. It therefore only needed a passing allusion from Prof. Huxley to enable the whole assembly to reflect that it was due as much to massiveness of character as to massiveness of work that within three years of his death Mr. Darwin's name should constitute a new centre of gravity in every system of thought. And it was this reflection which gave to the ceremony so unusual a measure of interest. Around the statue were congregated the most representative men of every branch of culture, from the Prince of Wales and the Archbishop of Canterbury, to the opposite extremes of Radicalism and free-thought. Indeed, it is not too much to say that there can scarcely ever have been an occasion on which so many illustrious men of opposite ways of thinking have met to express a common agreement upon a man to whom they have felt that honour is due. The international memorial could not in any nation have found a more worthy site than the one in which it has been placed; but if anything could have added to the "solemn gladness" with which the personal friends of Mr. Darwin witnessed the presentation of this memorial, it must have been the evidence which the assembly yielded that among the innumerable differences of opinion which it represented, his memory must henceforth be always and universally regarded as a changeless monument of all that is greatest in human nature, as well as of all that is greatest in human achievement.

Concerning the statue itself, we have only to speak in terms of almost unqualified praise. It is, in the truest sense of the phrase, a noble work of art. The attitude is not only easy and dignified, but also natural and characteristic; the modelling of the head and face is unexceptionable; and the portrait is admirable. The only criticism we have to advance has reference to the hands, which not only do not bear the smallest resemblance to those of Mr. Darwin, but are of a kind which, had they been possessed by him, would have rendered impossible the accomplishment of much of his work. Although this misrepresentation is a matter to be deplored, it is not one for which the artist can be justly held responsible. Never having had the advantage of seeing Mr. Darwin, Mr. Boehm has only to be congratulated upon the wonderful success which has attended his portraiture of the face and figure; the hands were no doubt supplied by guess-work, and therefore we have only to regret that the guess did not happen to have been more fortunate.

The following is the address made by Prof. Huxley, in the name of the Darwin Memorial Committee, on handing over the statue to H.R.H. the Prince of Wales, as representative of the Trustees of the British Museum:—

YOUR ROYAL HIGHNESS,—It is now three years since the announcement of the death of our famous countryman, Charles Darwin, gave rise to a manifestation of public feeling, not only in these realms, but throughout the civilised world, which, if I mistake not, is without precedent in the modest annals of scientific biography.

The causes of this deep and wide outburst of emotion are not far to seek. We had lost one of those rare ministers and interpreters of Nature whose names mark epochs in the advance of natural knowledge. For, whatever be the ultimate verdict of posterity upon this or that opinion which Mr. Darwin has propounded; whatever adumbrations or anticipations of his doctrines may be found in the writings of his predecessors; the broad fact remains that since the publication, and by reason of the publication, of the "Origin of Species" the fundamental conceptions and the aims of the students of living Nature have been completely changed. From that work has sprung a great renewal, a true "instauratio magna" of the zoological and botanical sciences.

But the impulse thus given to scientific thought rapidly spread beyond the ordinarily recognised limits of biology. Psychology, Ethics, Cosmology were stirred to their foundations, and the "Origin of Species" proved itself to be the fixed point which the general doctrine of evolution needed in order to move the world. "Darwinism," in one form or another, sometimes strangely distorted and mutilated, became an everyday topic of men's speech, the object of an abundance both of vituperation and of praise, more often than of serious study.

It is curious now to remember how largely, at first, the objectors predominated; but, considering the usual fate of new views, it is still more curious to consider for how short a time the phase of vehement opposition lasted. Before twenty years had passed, not only had the importance of Mr. Darwin's work been fully recognised, but the world had discerned the simple, earnest, generous character of the man that shone through every page of his writings.

I imagine that reflections such as these swept through the minds alike of loving friends and of honourable antagonists when Mr. Darwin died; and that they were at one in the desire to honour the memory of the man who, without fear and without reproach, had successfully fought the hardest intellectual battle of these days.

It was in satisfaction of these just and generous impulses that our great naturalist's remains were deposited in Westminster Abbey; and that, immediately afterwards, a public meeting, presided over by my lamented predecessor Mr. Spottiswoode, was held in the rooms of the

Royal Society, for the purpose of considering what further steps should be taken towards the same end.

It was resolved to invite subscriptions, with the view of erecting a statue of Mr. Darwin in some suitable locality; and to devote any surplus to the advancement of the biological sciences.

Contributions at once flowed in from Austria, Belgium, Brazil, Denmark, France, Germany, Holland, Italy, Norway, Portugal, Russia, Spain, Sweden, Switzerland, the United States, and the British Colonies, no less than from all parts of the three kingdoms; and they came from all classes of the community. To mention one interesting case, Sweden sent in 2296 subscriptions "from all sorts of people," as the distinguished man of science who transmitted them wrote, "from the bishop to the seamstress, and in sums from five pounds to two pence."

The Executive Committee has thus been enabled to carry out the objects proposed. A "Darwin Fund" has been created, which is to be held in trust by the Royal Society, and is to be employed in the promotion of biological research.

The execution of the statue was entrusted to Mr. Boehm; and I think that those who had the good fortune to know Mr. Darwin personally will admire the power of artistic divination which has enabled the sculptor to place before us so very characteristic a likeness of one whom he had not seen.

It appeared to the Committee that, whether they regarded Mr. Darwin's career or the requirements of a work of art, no site could be so appropriate as this great hall, and they applied to the Trustees of the British Museum for permission to erect it in its present position.

That permission was most cordially granted, and I am desired to tender the best thanks of the Committee to the Trustees for their willingness to accede to our wishes.

I also beg leave to offer the expression of our gratitude to your Royal Highness for kindly consenting to represent the Trustees to-day.

It only remains for me, your Royal Highness, my Lords and Gentlemen, Trustees of the British Museum, in the name of the Darwin Memorial Committee, to request you to accept this statue of Charles Darwin.

We do not make this request for the mere sake of perpetuating a memory; for so long as men occupy themselves with the pursuit of truth, the name of Darwin runs no more risk of oblivion than does that of Copernicus or that of Harvey.

Nor, most assuredly, do we ask you to preserve the statue in its cynosural position in this entrance-hall of our National Museum of Natural History as evidence that Mr. Darwin's views have received your official sanction; for science does not recognise such sanctions, and commits suicide when it adopts a creed.

No; we beg you to cherish this Memorial as a symbol by which, as generation after generation of students of Nature enter yonder door, they shall be reminded of the ideal according to which they must shape their lives, if they would turn to the best account the opportunities offered by the great institution under your charge.

The following reply was made by H.R.H. the Prince of Wales:—

PROF. HUXLEY AND GENTLEMEN,—I consider it to be a high privilege to have been deputed by the unanimous wish of my colleagues, the Trustees of the British Museum, to accept, in their name, the gift which you have offered us on behalf of the Committee of the Darwin Memorial. The Committee and subscribers may rest assured that we have most willingly assigned this honourable place to the statue of the great Englishman who has exerted so vast an influence upon the progress of those branches of natural knowledge the advancement of which is the object of the vast collections gathered here. It has given me much pleasure to learn that the memorial has received so much support in foreign countries that it may be regarded as cosmopolitan rather than as simply national; while the fact that persons of every condition of life have contributed to it affords remarkable evidence of the popular interest in the discussion of scientific problems. A memorial to which all nations and all classes of society have contributed cannot be more fitly lodged than in our Museum, which, though national, is open to all the world, and the resources of which are at the disposal of every student of nature, whatever his condition or his country, who enters our doors.

CLAUS'S "ELEMENTARY TEXT-BOOK OF ZOOLOGY"

Elementary Text-Book of Zoology. Special Part: Mollusca to Man. By Dr. C. Claus. Translated and edited by Adam Sedgwick, M.A., Fellow and Lecturer of Trinity College, Cambridge, with the assistance of F. G. Heathcote, B.A., Trinity College, Cambridge. (London: W. Swan Sonnenschein and Co., 1885.)

THE first 109 pages of this volume are devoted to the Mollusca and Tunicata, and the remarks offered in NATURE (vol. xxxi. p. 191) in criticism upon Vol. I. apply equally well here.

The information imparted is fully up to date, and the Tunicate section may be taken, on the whole, as a type of that well-balanced and succinct writing indispensable in a work of this order.

The unqualified statement on p. 9 that the mollusca are "*bilaterally symmetrical*" is unfortunate, and typical of a general insufficiency and sketchiness, evident throughout the entire work, in the diagnoses given of the great groups. No better instance of this can be quoted than those relating to the birds and mammals, where characters so vitally important as the modes of articulation of the jaw-apparatus upon the skull are omitted, and, although mentioned elsewhere, are inserted without that emphasis demanded of *primâ facie* characters applicable to both the living and extinct forms.

It is disappointing to find the invertebrate digestive-gland still spoken of as a "liver," no mention being made of the researches of Weber, Barfurth, and others, into its structure and functions. It is highly desirable in a book of this kind that any statements made concerning animals, such as are likely to fall into the hands of the average student, should be absolutely reliable. It cannot be said (p. 52) that the shell of Aplysia is "covered by two lobes of the foot," and the beginner would soon find that Limax and Arion are not the only common Gasteropods in which the pedal gland is present, while,

from the statements made on p. 27 he would never infer that the common Anodon shell is destitute of teeth. The Argonauta, although somewhat less commonplace than the aforenamed, is to be found in our museums, and no mention is made in this volume of the exceptional characters of its shell—in fact, the beginner would rather infer from the descriptions given that it is a normal Cephalopod shell. Less pardonable are the inadequate remarks devoted to the rest of the Cephalopod group, which are especially unfortunate in their reference to connecting-links with the extinct forms. The anomalous but characteristic Aptychi go without a mention.

Viewed in the light of Prof. Moseley's recent discoveries, the reasons adduced on p. 44 for the absence of the cerebral ganglia in Chiton are of some interest, as a caution against making too sweeping generalisations.

Under the head of Molluscoidea there is a bare mention of the genus Rhabdopleura, and we are at a loss to conceive why the reference to this important form printed in the original index should have been omitted in the translation.

Turning now to that portion of the work which follows, the fact that but 231 pages are devoted to the Vertebrata, exclusive of Tunicates, is sufficient in itself to raise suspicion, especially when we reflect that 115 pages of Vol. I. are given up to Tracheates alone. When Mr. Sedgwick published the first volume of this work it was patent to any one familiar with the original that nothing short of a complete revision of the Vertebrate section could justify that claim set up by him in his translator's preface. Having admitted his willingness to supplement the original where he "thought it necessary"—thereby, we presume, countenancing the weakness of the volume now before us—it is surprising to find how little he has carried that resolve into execution, the more so as he acknowledges the assistance and advice of others, some of whom are authorities. That this defect is not due to any want of intention on the translator's part is clear from insertions such as that on p. 167; but we look in vain for dozens of other similar modifications, connected with matters of infinitely greater importance than that just referred to. Similarly, why should the recent discovery of the meroblastic segmentation of the Monotreme's egg be inserted by the translators and referred to some two or three times when there is no mention whatever of the far more weighty characters of the skull of that group? Even were defects such as the above-named rectified, the book would still remain wholly insufficient and incompetent. The exclusive use of the old classification of birds—the dogmatic statements made concerning many of the most involved fields of Vertebrate morphology; for example, that of the auditory ossicles, where Reichert's views are alone given—the entire omission of any description of such a characteristic structure as the lizard's hind-limb and ankle-joint—the feeble and confused descriptions of the vertebrate skull, obvious throughout the entire work and ushered in on p. 118 by the barbarous "*os linguale*" and "*copulæ*"—the ambiguous statements made on p. 124 concerning the vertebrate diaphragm, which still (p. 250) finds its place among the respiratory organs of birds, are, to say nothing of other similar defects, sufficient in themselves to stamp the vertebrate portion of the Text-book as little short of a failure. That that section of the work falls short of the needs of the English-speaking student is certain, especially as it is so far behind other manuals current in the tongue. Errors, the bare enumeration of which would be superfluous, are predominant on all hands, and the retention of the "Cetacea Carnivora" and "Cetacea Herbivora or Sirenia" (*sic*) of the ancients, is, leaving the Hydrosauria with its sub-classes aside, certainly not creditable to any one concerned. We heartily recommend the invertebrate portion of the work to the student. He may find that which follows useful, but he need be no specialist to see that it is insufficient on all points, and absolutely inaccurate and misleading on many of vital importance. It but remains to enumerate certain of the more conspicuous defects, respecting which at least, should a second edition of the work be demanded, it is to be hoped that the translators will see fit to effect an alteration.

The cumbrous and fanciful method of accounting (p. 113) for the characters of the thoracic region of the vertebrate body is to be regretted, leading the beginner, as it does to suppose this to be the most modified region of the trunk—a conception the precise reverse of that which the properly-trained student will soon form for himself. The exclusion of the teeth from the list (p. 119) of dermal derivatives and the complete confusion between scutes and scales evident throughout, are but slight faults compared with such as we have already enumerated. On p. 127 we are introduced to a thorough mixing up of the urinary receptacle of fishes with the allantoic bladder of Amniotes—a serious error, and one which the translator ought to have been expected to rectify.

The above remarks apply more especially to the general part of the vertebrate section of the work; but, on passing to that treating of the special groups, we find a general feebleness nowhere more evident than in that portion devoted to fishes. The diagnoses of that group are meagre in the extreme, and descriptions of even their tails such as are given on p. 164 are wanting in accuracy. No wonder, then, that the "jugular" pelvic fin should be once more to the front, that there is a disregard of characters so important as are those of the maxillary apparatus of Teleostei, and that such genera as Albula, Cheirocentrus, Megalops, &c., go unnoticed. The treatment of the Sauropsida is no less unfortunate than the above. Reference has already been made to some of the more conspicuous defects of this section, barely less pardonable than which are the bad descriptions of the bird's manus (p. 237) and the bare mention of the structure of the avian lung.

We are told on p. 243 that birds possess a rudimentary "corpus callosum," no mention being made of that tract which may probably answer to it in Amphibia. The treatment of the Sauropsidian pelvis and of the bird's shoulder-girdle are miserably poor, and the student is informed on p. 196 that Crocodiles possess an "*abdominal* sternum," which is "composed of a number of ventral ribs (without dorsal part)"; he will learn a valuable lesson who—Prof. Claus's manual in hand—discovers for himself that the ventral sternal ribs and these abdominal splints coexist in Hatteria, skeletons of which are now to be found in our museums. Considering the above facts, it is not surprising that nearly all reference to important

matters of affinity between living birds and reptiles should be overlooked. The characters of the mesotarsal joint and of the tarso-metatarsus are imperfectly defined, and those of the pelvis of Apteryx ignored; while among the extinct forms, the Dinosauria—several of whose features we are told on p. 220 "recall mammals, especially the Pachydermata"—the Ornithoscelida, and the Odontornithes, are all dismissed in a few lines. Little would the student, taking his text from this work, dream of the noble array of direct affinities to be found among even living birds and reptiles.

The translators have evidently realised that the statements reproduced on pp. 198 and 215, concerning the lizard's quadrato-jugal arcade are contradictory, and a supplemental paragraph of their own on p. 198 only serves to increase the perplexity. Chapter IX. is devoted to the Mammalia, but 69 pages of it starting with the assertion (p. 282) that the Monotremes' hemispheres are "still smooth," is poor fare. The cutting down of every group of mammals to a minimum would be in a sense pardonable, if only concise diagnoses were given such as should cover the broad lines of modification; but when, bearing in mind certain of the more glaring defects of this chapter referred to at the outset, we read (p. 306) that the Whales approach the Ungulates "through the Sirenia," and that the "Sirenia are intermediate, so far as their form is concerned, between the whales and seals" (p. 309), our faith is shaken in that which remains. There is the usual confusion concerning the position and movements of the hind-limbs of the Pinnipedia, the condition of the parts in the eared seals being entirely overlooked. In diagnosing a group of animals for purposes such as are here required, where the living and the extinct are both under consideration, it is but fair to assume that special attention should be paid to the hard parts, the teeth not excepted; but we look in vain for statements such as shall embody the extremes of modification of these parts in any one group of living mammals—for example, in dealing with the Rodents the utmost sketchiness prevails, the modifications of even the fibula are not hinted at, and while Hydromys is placed among the mice with grinders $\frac{3}{3}$, Heliophobius is not mentioned. No wonder, then, that Hyœmoschus should go unnoticed, that Hyrax should here be found under the order Proboscidea (with a caution, it is true), and that the Carnivora, Cheiroptera, Lemurs, and Primates should be treated with disrespect. We are told (p. 301) that the epipubes support the marsupial pouch, and there is no reference at all to the most important facts concerning the marsupial dentition. There is something so specifically English about gross vertebrate anatomy that we search in vain for bare mention, not to say recognition, of discoveries bearing upon the above, and many similar matters of first importance.

From what has been said it will be obvious to English students that the vertebrate section of Prof. Claus's manual is weakest where works on the subject already current in our language are strong; and, with all respect to our Continental cousins, we are of opinion that the market is becoming overstocked with translations such as that before us. Their period is past; the English student in earnest must sooner or later fit himself for access to the originals, and the repeated production of English versions serves only to prolong the fatal day. We cannot but regret, though reluctantly, the publication of this work in its present form, the more so as it threatens to encourage the growing tendency to under-estimate the value of gross vertebrate anatomy, a field of labour essentially English, but still the very backbone of zoological science.

Mr. Sedgwick has performed the task of translation with a thoroughness and skill deserving the thanks of his countrymen. Some few passages in the original, at best clumsy, might have been better rendered than they are; and settings such as the "above together," on p. 16, might be advantageously modified. The translators give in Vol. I. a list of English synonyms for the geological terms employed in the original, but these are not always adopted in Vol. II.; thus we find the Jurassic beds referred to again and again as the "Jura," a rendering certainly not that of English geologists. The original illustrations are for the most part excellent, and those which remain are admirably selected. That on p. 284, however, certainly does not illustrate the anatomy of the human ear, and the figures selected from the classic of Johannes Müller, in illustration of the anatomy of the lamprey's skull (p. 154) do scant justice to the work of a great genius, and he a German. G. B. H.

CLIFFORD'S EXACT SCIENCES

The Common Sense of the Exact Sciences. By the late W. K. Clifford. (London: Kegan Paul, Trench, and Co., 1885.)

ONCE more a characteristic record of the work of a most remarkable, but too brief, life lies before us. In rapidity of accurate thinking, even on abstruse matters, Clifford had few equals; in clearness of exposition, on subjects which suited the peculiar bent of his genius and on which he could be persuaded to bestow sufficient attention, still fewer. But the ease with which he mastered the more prominent features of a subject often led him to dispense with important steps which had been taken by some of his less agile concurrents. These steps, however, he was obliged to take when he was engaged in exposition; and he consequently gave them (of course in perfect good faith) without indicating that they were not his own. Thus, especially in matters connected with the development of recent mathematical and kinematical methods, his statements were by no means satisfactory (from the historical point of view) to those who recognised, as their own, some of the best "nuggets" that shine here and there in his pages. His A*inematic* was, throughout, specially open to this objection:—and it applies, though by no means to the same extent, to the present work. On the other hand, the specially important and distinctive features of this work, viz. the homely, yet apt and often complete, illustrations of matters intrinsically difficult, are entirely due to the Author himself.

The Editor, in his *Preface*, tells us the whole story of the difficulties he had to face in completing the volume for press. All will sympathise with him when they find that he had to furnish one entire chapter, and large portions of two others, in addition to thorough revisal of the whole. For Clifford's style is here entirely *sui generis*. The track to his homely yet hardy expositions often lay in regions where but a single careless step would have led

to the Inconsequent or the Ridiculous. And one who tries to imitate him successfully must possess not only his nerve, but also his wonderful agility and resource of every kind. We shall therefore say no more on the subject of the Editor's additions to the volume, than that his daring has met with comparative immunity from the more obvious dangers of his course.

The original title of the work was, we are told, *The First Principles of the Mathematical Sciences Explained to the Non-Mathematical*. There can be no doubt that the new title is much to be preferred. We do *not* believe that the Mathematical Sciences, even in their first principles, can be explained to the Non-Mathematical. Whosoever understands the explanation has, to that extent at least, *become* Mathematical in the very act of understanding. But this observation is made on the assumption that Non-Mathematical means "uninstructed in mathematics." There is another sense which the term may bear:—viz. "incapable of understanding mathematics." Among mankind there are none who more persistently claim the almost exclusive possession of the highest grade of human intelligence than do the (so-called) Metaphysicians. How many of these self-accredited possessors of all but superhuman acuteness have been able to cross the *Pons Asinorum?* How many have been able to understand even the *objects* (not the *processes*) of mathematical investigation? When the answer comes (it probably will not come, as it *can not* come in a favourable form) it will be time to comment on it.

The chief good of this book, and in many respects it is very good, lies in the fact that the versatility of its gifted author has enabled him to present to his readers many trite things, simple as well as complex, from so novel a point of view that they acquire a perfectly fresh and unexpected interest in the eyes of those to whom they had become commonplace. Surely this was an object worthy of attainment! But it is altogether thrown away on the non-mathematical, to whom neither new nor old points of view are accessible.

Considering the circumstances under which the book has been produced, it would be unfair to comment on the smaller errors. But there are a few very awkward statements, and one or two grave errors, which ought not to have escaped correction. We give an example of each class. Thus, p. 16, the following statement is quite unnecessarily puzzling:—

"If we can fill a box with cubes whose height, length, and breadth are all equal to one another, the shape of the box will be itself a cube."

This out-germans German itself in the displacement of the words from their natural position in English; and, at first sight, seems to be nonsense. Read it, however, thus:—

"If we can fill with cubes a box whose height, &c. . . . the shape of the box itself will be a cube,"

and the absurdity, suggested by the collocation, disappears.

Again, p. 66, what are we to make of the following, standing, as it does, without comment or explanation of any kind?—

"The statement that a thing can be moved about without altering its shape may be shown to amount only to this, that two angles which fit in one place will fit also in another, no matter how they have been brought from the one place to the other."

Several most serious qualifications must be imposed upon this statement before it can possibly be accepted as true.

The chapter on *Motion* properly forms a part of this work, so far at least as kinematics is concerned. But it seems to be a mistake to conclude it with a few editorial sentences on the *Laws of Motion*. For here we have a perfectly new subject, and one which would require at least a full chapter to itself. It is probable enough that, at some period of his life, Clifford imagined that it might be possible to get rid of the idea of matter as well as of that of force, and so to reduce Dynamics to mere Kinematics. He never so expressed himself to me. But purely physical subjects were, properly speaking, beyond his sphere; his ideas about them were always more or less vague, because always of a somewhat transitional character, and were much modified at times by the momentary turn of his philosophical speculations. We are told in a foot-note to the first page of the *Preface* that Clifford left his *Kinetic* (a companion volume to his Kinematic) *in a completed state*. Surely, keeping this in view, the introduction of Laws of Motion into the present work was superfluous.

This foot-note unfortunately strikes a jarring chord at the very first opening of the book. We are told that "more serious delay seems likely to attend the publication" of Clifford's *completed* MS.; this is followed by a mysterious species of protest or remonstrance. Clifford could never have written in this vein. He would either have kept silence, or have blurted out the whole truth. Mystery and insinuation were not weapons of his, and should not be employed in connection with his name.[1]

P. G. TAIT

OUR BOOK SHELF

New Commercial Plants and Drugs. No. 8. By Thos. Christy, F.L.S., &c. (London: Christy and Co., 155, Fenchurch Street, 1885.)

THE eighth number of Mr. Thos. Christy's "New Commercial Plants and Drugs" has recently appeared, and the contents are of a similar character to those that have preceded it, the most recently introduced commercial products derived from the vegetable kingdom being enumerated and what has been written about them brought together. The first plant referred to in the book is of course the Kola nut (*Cola acuminata*), as being one of the most important, or at least one that has attracted a very large share of attention during the past year. This article is illustrated by a coloured plate of the fruit and seeds of this species, as well as of the Guttiferous plant known as the Bitter Kola. Besides having the property of cleansing or purifying and thus rendering wholesome stagnant or foul water, it has also been used for clarifying beer and spirits. One of its most remarkable properties is in restoring the senses after partaking to excess of intoxicating drinks. The most recent application of the Kola nut, however, is in the preparation of a paste for mixing with cocoa or chocolate, which it is said to improve "both in strength and flavour to an astonishing degree." It is considerably more nutritious and strengthening; so much so indeed "that a workman can, on a single cup taken at breakfast time, go on with his work through the day without feeling fatigued."

In consequence of this and many other medicinal

[1] In NATURE, vol. xxxii. p. 4, Mr. Tucker intimated that Messrs. Macmillan and Co. would publish the remaining mathematical papers of the late Prof. Clifford.—ED.

virtues the Kola nut is considered to have a great future before it in European commerce, and is consequently strongly recommended to the notice of planters in our colonies for extensive cultivation. With regard to the preservation of the germinating properties of the seeds, Mr. Christy says he has received them in good condition, both in baskets and barrels lined with the leathery leaves of a tree known as the "bal tree." Some received in dry loam arrived as fresh as when they were gathered, and of some that arrived eighteen months since, the bulk is stated to be perfectly fresh and retaining still their beautiful red colour.

From a list of fifteen species of *Myristica*, the fruits or seeds of which are described, the value of the nutmeg genus is shown, especially as oil seeds. Seeds new to commerce are frequently arriving in the Liverpool and London markets, intended for the expression of oil and for the preparation of oil cake. Such seeds are of a very varied character and belong to widely different natural orders, and not long since those of *Myristica surinamensis* came into Liverpool under the name of African nuts. Upon analysis they were found to contain a large quantity of solid oil or fat with an agreeable taste, and but little, if any, odour, and when fairly pure it is said to resemble cocoa butter.

Amongst other important economic plants or drugs mentioned are the Coca (*Erythroxylon coca*), the medical effects of which have attracted so much attention of late; the Jamaica Chewstick (*Gouania domingensis*), which, it is stated, "has recently been introduced into this country by one of our leading London dentists for use in tooth powder and mouth wash," and also in the form of a fluid extract as a gargle for relaxed throat.

Of Papaine, the active principle of the Papaw (*Carica papaya*), some interesting records are given regarding its effects in treatment of diphtheria, croup, indigestion, dyspepsia, &c.

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.*]

Ocular After-Images and Lightning

In reply to Mr. Shelford Bidwell's query whether the quiver of the lightning flash is a purely subjective phenomenon or not, I send the following extract from my note-book, made October, 1873:—"A flash of lightning consists of several separate flashes all occurring within a fraction of a second of each other. There was a very severe thunder storm at night, the thunder almost continuous. Drawing the curtain across the window so as to expose only a narrow slit of skylight, I observed this slit in the looking-glass which I kept moving rapidly backwards and forwards on its axis. Whenever a flash occurred, several images of the slit appeared, showing that there were several successive illuminations of the slit."

This was not the result I had expected, the experiment having been suggested to my mind in consequence of some experiments I had been making on the phenomenon of recurrent vision. The results of these experiments were published in the *Phil. Mag.*, December (supplement), 1872. One object of my experiments was to determine in what way the colour of the recurrent image depends upon the colour of the light producing it. By using a sliding shutter and a small window covered with different coloured glasses, I found that the colour of the recurrent image tends to be of a tint complementary to that of the light causing it, being, however, in all cases bluer than the complementary tint. I add the following extract from my paper:—"A recurrent image of an object may be produced without any apparatus whatever. To do this, place the right hand over the eyes so that the palm of the hand covers the right eye, and the fingers the left eye. If the middle finger be then raised for a moment, so as to admit light for as short a time as possible into the eye, a recurrent image of any light-coloured object held against a dark background may be seen. The effect is much better seen by twilight or gaslight than in full daylight. This method of producing a recurrent image is, however, much inferior to that in which a sliding shutter is used, owing probably to the illumination of the retina not being sufficiently instantaneous.

Cheltenham College, June 6 A. S. Davis

A Quinquefoliate Strawberry

In your issue for April 30 (vol. xxxi. p. 601) is an account of a quinquefoliate strawberry. In the garden of the New York Agricultural Experiment Station at Geneva we have some second year seedling strawberries, some of which are bearing three, four, and five leaflets on the same plant, the leaves all large and perfect. We have other plants in which the two extra leaves are borne half way down the petiole, and which attain fair size, and yet others where these stipulary-like appendages are reduced to hair-like bracts. The variety of strawberry introduced under the name "Mrs. Garfield" frequently has these bract-like appendages. While speaking of the strawberry, I would remark that seedling strawberries very frequently are unifoliate during their early growth, and it appears as if Duchesne's *Fragaria monophylla* may be regarded as an instance of arrested development in one of these one-leaved younglings.

E. Lewis Sturtevant

New York Agricultural Experiment Station,
Geneva, N.Y., May 28

OBSERVATIONS OF THE TEMPERATURE OF THE SEA AND AIR, MADE DURING A VOYAGE FROM ENGLAND TO THE RIVER PLATE IN THE S.S. "LEIBNITZ"

Being obliged to proceed to South America at the beginning of this year, I took with me a thermometer and a hydrometer in order, if circumstances were favourable, to provide myself with occupation during the somewhat long and monotonous voyage. Thanks to the kindness and courtesy of Capt. Brown, of the s.s. *Leibnitz*, who took a lively interest, and assisted me greatly in carrying out my observations, the voyage was neither long nor tedious.

The *Leibnitz* sailed from Southampton on January 16, 1885, and made the passage direct, without touching at intermediate ports, to Monte Video, where she arrived on February 8, after a very favourable voyage. The route lay through the most interesting meteorological districts of the Atlantic, and my principal object at starting was to make as many observations of the temperature and the density of the surface-water along the route as possible. With these I combined observations of the temperature of the air, and frequently also of the wet-bulb thermometer. Observations were begun on January 21 in lat. 34° N., and continued up to the morning of arrival in the River Plate.

I have put together the simultaneous observations of the temperature of the air and the water with those of the wet-bulb thermometer, as they possess some interest of their own; the observations of density are kept for a future opportunity, as the reductions in connection with them are not quite finished.

The *thermometer* used for all the observations was divided into simple degrees of the Centigrade scale, and was of the ordinary form of German manufacture, with a paper scale. The degrees were 1·6 mm. apart, so that there was no difficulty in estimating tenths of a degree. Its zero was verified on board by immersing it in pounded ice, and found correct. The ice was well pounded in a clean towel, and a soda-water tumbler filled with it; the thermometer was then thrust into it and allowed to remain till sufficient ice had melted to fill up the interstices, producing a perfect magma of ice and water down to the

bottom. The mercury remained constant on the zero line. The temperature of the air was 25° C.[1]

Temperature of the Water.—The water was collected in a small bucket, well clear of the side of the ship, and on the opposite side from that through which the condensing water of the engine is discharged. Its temperature was determined as soon as the sample was brought on board.

As the ship left the Channel in the middle of winter, and proceeded nearly due south, the temperature of the water rose rapidly at first. Observations were begun on January 21, in lat. 34° N., and between this latitude and lat. 10° N. the rate of rise was very steady, averaging 0·36° C. per degree of latitude. From lat. 5° N. to 15° S. the temperature is very uniform and high, averaging 26·86° C. After passing lat. 15° S. the temperature falls, and begins to show greater variations, as the shallow water on the Abrothes Bank is approached. The average temperature of the water over this bank was 25·56° C. After passing Cape Frio, and between the parallels of 25° and 30° of south latitude, the variations of temperature are considerable and often abrupt; the maximum observed in this part was 26°·7 C., and the minimum 24°·3 C. As the higher temperature generally accompanies a greater salinity, it is probable that these variations are due, not to any terrestrial source, such as large rivers, but to an oceanic cause, the less salt and colder water of the deeper ocean strata being thrown up against the coast, and mixing imperfectly with the hot and dense surface-water. In lat 30° S. the influence of the River Plate makes itself distinctly felt by a general rapid fall of temperature. As the ship got into soundings, with the change in colour and other properties of the water, the temperature fell rapidly to between 23° and 24° C., and to 22° C. in six fathoms off Flores Island close to Monte Video. The minimum temperature observed in this part was 20° C. at 2 a.m. between Lobos Island and Maldonado Point.

Excluding the latter part of the voyage between the River Plate and lat. 15° S., where the conditions are a good deal affected by purely local causes, the surface-water shows well-marked diurnal maxima and minima of temperature. From lat. 9° N. to lat. 2° N. the ship passed through the equatorial belt of calms and rains, which separates the regions of the north-east and the south-east trade-winds from each other. It is characterised by a calm sea, a cloudy sky, and heavy rains. Here the temperature was subject to very little diurnal variation (0°·3 C.) On approaching St. Paul's Rocks, a few miles north of the equator, the clouds cleared away completely, and there was a calm sea, a clear sky, and a very powerful sun. The result was a comparatively great rise of temperature in the afternoon; and yet the greatest difference between any neighbouring maximum and minimum in this region was only 1°·1 C.

The maximum temperature of the sea-surface observed during the voyage was 27°·4 C. (81°·3 F.) at 2 p.m. on January 31, in lat. 7° 35′ S., the Brazilian coast being about 100 miles distant. The temperature of the water will be further considered in connection with its density; at present its connection with the temperature of the air will be more particularly considered.

Temperature of the Air.—Along with the temperature of the water, that of the air during daylight was determined. It is probably very rare, in any part of the ocean, to find the mean temperature of the air agreeing accurately with that of the surface water, and in many places the differences are considerable. In order to be able to compare the temperature of the air with that of the water, it is necessary that both should be determined with equal accuracy. The temperature of the water is easily and accurately determined by agitating the thermometer in a bucket of it freshly collected. With the air it is somewhat different. Having only one thermometer with me, I was obliged to use it for all purposes, and I could not hang it up in a thermometer-box, even if I had had one, and had deemed it advisable to do so. On board ship, however, I am convinced that it is quite impossible to fix a thermometer-box in such a position as always to secure such an air-pressure as to justify the assumption that the indications of the thermometer may be taken as the true temperature of the air. Even on shore and under the most advantageous circumstances, the temperature of the thermometer in the atmosphere of the best constructed box is too much dependent on the temperature and capacity for heat of the material of the box for it to be assumed always to be identical with that of the air outside, at the moment of reading. I was obliged, therefore, to adopt the method of whirling the thermometer, at the end of a short string, in the air, in whatever part of the ship happened at the moment to afford the most favourable conditions, and reading it when it had assumed a constant temperature. The temperature of the air is thus determined in mostly the same way as that of the water, namely, by agitating a thermometer in it, and the comparison of the two is therefore likely to lead to trustworthy conclusions.

Temperature of Wet-bulb Thermometer.—The series of observations with this instrument is not so complete as that with the dry thermometer, but they possess some interest. The method of observation was the following:—The temperature of the air having been determined by whirling the thermometer in it, a bucket of sea-water was fetched and its temperature taken; the thermometer was then exposed, with its bulb still wet with sea-water, to the breeze in a proper part of the ship, and its temperature observed when it became constant. The exposure of the instrument requires some care. The bulb must be quite free from grease, which can be readily secured by washing it with soap and water. It is then dipped into the water and allowed to drip for a second. It is then held somewhat inclined to the direction of the wind and to the horizon, and rotated gently on its axis so that the bulb be kept covered with a continuous film of water which is locally thickened by gravity, which tends to form a drop on the lower side of the bulb. The reading of the thermometer is observed while it is being rotated. Had I intended from the beginning to make a series of wet and dry bulb observations, I should probably have used fresh water from the first. I began to expose the thermometer, merely in order to have an indication whether the atmosphere were saturated or not, and I expected, in the damp equatorial regions, to find the atmosphere so heavily saturated as to be incapable of producing any sensible lowering of the thermometer with damped bulb. For this purpose it seemed to be quite sufficient to expose the thermometer wet with sea-water. Having begun with

[1] Having plenty of pounded ice at my disposal, I poured off the water which had formed by melting, and replaced it by sea-water, containing 35·65 grammes salt per kilogramme, and then immersed the thermometer; it fell rapidly below zero, and remained constant at −1°·0. I then strained away the sea water from the ice and replaced it by a mixture of equal volumes sea-water and distilled water: the thermometer fell to −0°·45, and remained constant for some time at that temperature. When the ice was mixed with distilled water alone, the thermometer again stood at 0° C. These experiments were made to verify some observations of Pettersson, quoted in his investigations into the nature of ice formed from waters of different degrees of salinity, in connection with the voyage of the *Vega*. He there says, referring to the melting temperature of different kinds of ice, that pure fresh-water ice, when immersed in sea water, melts at a temperature considerably below 0° C. Writing from memory, I think he puts the melting-point at from −1° to −2° C. Having both the ice and the sea-water ready at hand, I repeated this remarkable experiment. The result showed that Pettersson's observation is quite correct, and that the lowering of the melting-point is roughly proportional to the salt held in solution. When equal volumes of the sea-water and distilled water of the same temperature were mixed, there was no change of temperature. I do not remember if Dr. Pettersson furnished an explanation of this remarkable phenomenon, and I am unable to supply one myself, but it must necessarily affect the validity of conclusions as to the composition of sea-water ice drawn from its melting-point. When the *Challenger* was in Antarctic waters I made a number of observations on the melting-point of ice collected from broken pieces of the pack, and found it begin to melt a little below −1° C. I concluded that either it was one solid substance or a mixture of several solids. But if pure ice melts at a different temperature according to the medium in which it is placed, then this reasoning is faulty, for inclosed brine would have much the same effect as inclosed salt or crystalline hydrate.

sea-water the observations were continued with it. A few comparative observations were made in order to determine the effect of replacing the sea-water by fresh water. On February 2, after a shower, the temperature of the air was 25°·0 C. When wet with sea-water the temperature of the thermometer was 23°·5 C., and with rain-water 23°·1 C. Similarly, at noon on the same day, the following temperatures were observed: dry bulb, 26°·1 C.; wet bulb (sea), 24°·5 C.; wet bulb (rain), 24°·2 C. The air, at this time, appeared, to the sensation, to be damper than at any other time, and yet, when suitably exposed, there was a difference of nearly 2° C. between the wet and dry thermometers.

There is an advantage in having the bulb of the thermometer wet with a continuous film of water, instead of being surrounded with damp muslin, namely, that it more nearly resembles the surface of the sea, which is exposed to the influence of the atmosphere. Observations with the wet thermometer were not made as regularly as those with the dry instrument, and no observations were made with either of them after dark, owing to the difficulty of securing proper exposure and reading the instrument with a lantern, without heating it.

The temperature of the air and of the water were taken generally every two hours from 6 a.m. to 6 p.m., but the intervals between the observations were not always the same. These observations showed that only on two days, January 31 and February 1, between lat. 6° S. and 12° S., did the mean *day* temperature of the air exceed that of the surface-water. On these days the temperatures were taken every two hours from 6 a.m. to 6 p.m., and the means of the groups of seven observations gave, on January 31: air, 27°·13 C.; sea, 26°·90 C.; difference, 0°·23 C.; and on February 1, air, 27°·26 C.; sea, 26°·96 C.; difference, 0°·30 C. These differences would have been reduced in amount if the observations had been carried on through the night, though, from the very high temperature of the air just before sunrise on February 1 and 2, they would not have been reduced to zero.

In the table (p. 129) all the simultaneous observations of temperature of air and water made during the voyage, except those of the last day, when approaching the mouth of the River Plate, are collected in small tables for each day. The time of day is given in hours, from 0 to 24; the temperatures are in Centigrade degrees; t denotes the temperature of the sea-surface, $t-T$ the difference between that of the temperature of the air, and $T-T'$ the difference between the readings of the thermometer in air with its bulb dry and when it is wet with sea-water. At the head of each table is given the meteorological district of the ocean through which the ship was passing, as "north-east trade-winds," "equatorial calms," and the like; also the day of the month (1885) and the latitude and longitude at noon of the day. The means at the foot of each table are simply the arithmetical means of the numbers in each column; and their meaning and value are at once apparent on inspecting the column.

With the two exceptions above-named, the temperature of the sea was always found higher than that of the air, over the day, and only very seldom was it exceeded by that of the air at the hottest time of the day. Had the observations been carried on through the night, the contrast between the two temperatures would have been much greater. On January 31 and February 1 the conditions were somewhat exceptional. On the former of these days the ship passed into the northerly monsoon, which prevails all down the Brazilian coast during the southern summer. Like the similar monsoons in the northern hemisphere, it is caused by the proximity of a large mass of land, which gets intensely heated by the vertical rays of the sun. On January 30 the wind had been light south-easterly; during the night it fell calm, and at sunrise a light easterly wind sprang up, which gradually drew around towards the north and blew all day, with just sufficient force to travel exactly at the same rate as the ship (11½ knots); consequently, during the whole of the day the atmosphere on the deck was motionless, with a very powerful sun beating on it and heating up every thing, so that it was impossible to find any place where the air could be got, coming fresh on board, without having been exposed to the influence of the highly-heated deck and fittings. It is therefore certain that the air-temperatures are somewhat above the water.

It is probable that, when the true temperature of the air can be ascertained, it will be found to be usually below that of the sea-surface. The cause of this is, I think, to be found in the relative dryness of the atmosphere over the ocean. If the observations with the wet-bulb thermometer be considered, it will be seen that the least difference of reading between the dry- and the wet-bulb thermometers was 1°·0 C. on January 28, when the ship was in the middle of the equatorial belt of calms and rains. In this region perfectly saturated air might be expected, and with instruments exposed in the usual form of box I have no doubt that here, and in the very oppressive weather of the northerly monsoon, the two instruments would have given identical readings. The readings of the air-temperature on January 28 were perfectly trustworthy, as the sky was thickly overcast with dense rain-clouds all day; there was thus no risk of overheating; the readings with the wetted bulb were equally satisfactory, so that the results of the observations on that day may be taken to represent fairly the normal state of things in the "Doldrums." The temperature of the sea varied from 26°·3 to 26°·6 C., the mean of five observations during the day being 26°·42 C. The mean temperature of the air during the day was 0°·92 lower than that of the sea, or 25°·5 C., and the temperature of the wet-bulb thermometer 1°·3 lower still, or 24°·2 C. It will be seen that, on the two exceptional days, January 31 and February 1, the difference between the wet- and the dry-bulb thermometer is greater than would be expected from the oppressive damp feeling of the air; it is therefore all the more likely that the dry-bulb readings are too high as indicated above. However, it is important to observe that in all the regions passed through, whether in the westerly winds of the North Atlantic or the equatorial calms, or the monsoon of the South Atlantic, the temperature of the wet-bulb thermometer is always very markedly below that of the dry-bulb thermometer. In fact, such is the mobility of the atmosphere that it rarely has the opportunity of saturating itself; and if the effect which must be produced when this air meets the surface of the water be considered, it will, I think, afford some explanation of why at sea the temperature of the air, even by day alone, is usually markedly below that of the sea-surface.

If we consider the film of water immediately at the surface of the sea, having the atmosphere on the one side of it and the bulk of the water on the other, it is strictly comparable with the film of water surrounding the bulb of the thermometer, when exposed to the atmosphere in the way described above; and the air playing upon it must produce exactly the same effect in the one case as in the other. The evaporation lowers the temperature of the aqueous film, which proceeds to extract heat from the neighbouring bodies—namely, in the one case the air and the bulb of the thermometer and in the other case the air and the layer of water immediately below the surface film. If we imagine for a moment the surface film separated from the bulk of the water below it by a diaphragm impervious to heat, then exposed to the atmosphere so as to suffer evaporation and lowering of temperature, then on the removal of the diaphragm it would immediately sink away from the surface and its place would be taken by warmer, and therefore less dense, water from below. In the case of sea-water this effect would be slightly intensified by the concentration produced by evaporation. But

TABLE GIVING THE TEMPERATURE OF THE SEA SURFACE (t), THE DIFFERENCE BETWEEN IT AND THE TEMPERATURE OF THE AIR ($t - T$), AND THE DIFFERENCE BETWEEN THE READINGS OF THE DRY BULB AND THE WET BULB THERMOMETERS IN AIR ($T - T'$), AT DIFFERENT HOURS OF THE DAY

N.W. Winds

Jan. 23, Lat. 26° 24′ N. Long. 21° 21′ W.

Hours	t °C	$t-T$ °C	$T-T'$ °C
8¼	18·9	2·1	
10	19·3	1·1	
12	19·2	0·7	
14	19·3	0·8	
16½	19·7	1·7	
17½	19·6	1·9	
Mean	19·33	1·38	

N.E. Trade Wind

Jan. 24, Lat. 22° 5′ N. Long. 23° 6′ W.

Hours	t °C	$t-T$ °C	$T-T'$ °C
8½	20·5	1·5	
10½	20·7	1·0	
12	20·9	0·8	
14	21·1	1·1	
16	21·2	1·2	
17½	21·2	1·3	
	20·93	1·15	

N.E. Trade Wind

Jan. 25, Lat. 18° 6′ N. Long. 24° 39′ W.

Hours	t °C	$t-T$ °C	$T-T'$ °C
8¼	22·0	1·4	1·6
10	22·0	0·8	
12	22·2	0·7	
14	22·2	1·0	
16	22·7	1·7	
17½	22·3	1·2	
	22·23	1·13	

N.E. Trade Wind

Jan. 26, Lat. 13° 46′ N. Long. 26° 6′ W.

Hours	t °C	$t-T$ °C	$T-T'$ °C
8	23·2	1·0	3·0
10	23·8	0·8	—
12	24·0	0·7	1·8
14	24·0	0·9	2·1
16	24·2	1·1	
17¼	24·2	1·0	
	23·90	0·92	

N.E. Trade Wind

Jan. 27, Lat. 9° 25′ N. Long. 27° 21′ W.

Hours	t °C	$t-T$ °C	$T-T'$ °C
6	25·4	1·5	
8	25·6	0·9	2·7
10	25·7	0·9	
13	26·0	1·0	3·0
16	26·0	1·0	
17½	26·0	1·0	
	25·79	1·05	

Equatorial Calms

Jan. 28, Lat. 5° 16′ N. Long. 28° 32′ W.

	t °C	$t-T$ °C	$T-T'$ °C
6	26·4	6·7	1·7
9	26·3	1·0	—
12	26·3	1·1	1·4
15	26·6	1·0	1·1
18	26·5	0·8	1·0
Mean	26·42	0·92	1·30

Equatorial Calms

Jan. 29, Lat. 1° 15′ N. Long. 29° 16′ W.

	t °C	$t-T$ °C	$T-T'$ °C
6	26·5	0·6	1·4
9	26·7	0·8	—
12	27·0	0·3	1·8
15	27·0	0·0	2·5
18	26·8	0·2	2·3
	26·80	0·38	2·00

S.E. Trade Wind

Jan. 30, Lat. 2° 53′ S. Long. 31° 5′ W.

	t °C	$t-T$ °C	$T-T'$ °C
6	26·3	0·3	1·6
9	26·4	−0·2	1·9
12	26·8	0·0	2·4
15	27·0	+0·4	2·2
18	26·8	0·7	1·8
	26·67	0·24	1·98

Northerly Monsoon

Jan. 31, Lat. 7° 5′ S. Long. 33° 2′ W.

	t °C	$t-T$ °C	$T-T'$ °C
6	26·5	0·5	1·7
8	26·5	−0·2	2·3
10	26·8	−0·6	2·6
12	27·1	−0·7	2·8
14	27·4	−0·3	2·6
16	27·1	−0·3	—
18	26·9	0·0	2·3
	26·90	−0·23	2·38

Northerly Monsoon

Feb. 1, Lat. 11° 18′ S. Long. 34° 53′ W.

	t °C	$t-T$ °C	$T-T'$ °C
6	26·8	0·1	2·4
8	26·9	−0·1	2·2
10	27·0	−0·3	2·7
12	27·0	−0·8	—
14	27·0	−0·7	2·8
16	27·0	−0·3	2·3
18	27·0	0·0	2·0
	26·96	−0·30	2·40

Northerly Monsoon

Feb. 2, Lat. 15° 30′ S. Long. 36° 53′ W.

	t °C	$t-T$ °C	$T-T'$ °C
6	26·9	−0·1	2·3
8	26·9	−0·1	2·0
10½	26·7	+1·7	1·5
12	26·9	0·8	1·6
16½	26·3	0·3	
18	25·5	−0·2	
Mean	26·54	0·40	1·85

Northerly Monsoon

Feb. 3, Lat. 19° 48′ S. Long. 38° 42′ W.

	t °C	$t-T$ °C	$T-T'$ °C
6	24·3	0·1	1·8
8	25·7	0·8	2·1
9	25·4	0·6	—
12	25·2	1·2	—
14	25·9	1·3	1·8
16	26·0	0·1	1·6
18	25·9	0·0	—
	25·48	0·60	1·82

S.E. Trade Wind

Feb. 4, Lat. 24° 0′ S. Long. 40° 33′ W.

	t °C	$t-T$ °C	$T-T'$ °C
7½	25·5	1·5	—
8	26·0	1·1	2·9
10	25·8	0·2	—
12	25·7	0·5	2·9
14	25·8	0·8	2·8
16	26·0	1·0	—
	25·80	0·85	2·87

S.E. Trade Wind

Feb. 5, Lat. 27° 8′ S. Long. 44° 1′ W.

	t °C	$t-T$ °C	$T-T'$ °C
5½	24·4	0·6	—
8	24·5	0·2	2·8
10	24·5	−0·3	3·7
12	25·2	−0·1	3·3
14	26·4	+1·4	4·7
16½	26·7	2·0	3·5
18	26·3	2·0	4·3
	25·43	0·97	3·72

S.E. Trade Wind

Feb. 6, Lat. 30° 13′ S. Long. 47° 52′ W.

	t °C	$t-T$ °C	$T-T'$ °C
6	24·7	0·6	2·8
8	25·0	0·7	2·7
10	24·8	1·1	2·7
14	25·2	0·9	3·0
16	24·7	0·7	2·9
18	24·8	1·1	3·7
	24·87	0·85	2·97

while the water below supplies some of the heat rendered latent by the evaporation of the water, the air above it supplies its share, and is cooled. In both cases the heat thus lost is made good by the direct radiation from the sun. Through a moderately dry atmosphere the rays pass with comparatively little heating effect, but are largely absorbed on entering the water. Consequently the less of heat which the water suffers by evaporation at the surface of separation is made good more abundantly than that sustained by the air; and the difference in power of absorption of radiant heat exhibited by these two substances is thus sufficient to keep up a permanent difference of temperature between the water and the air immediately above it.

Starting with air and water at the same temperature, we may imagine the process taking place in three acts. First, the water at the surface evaporates, and the air on the one side, and the water on the other, are cooled; second, in order to make up for the heat thus rendered latent and lost, the sun shines upon both alike, but the water absorbs a larger proportion of the heat of its rays than the air does; and finally, a portion of this excess is then removed from the water by the simple contact of the air at its surface. The nett effect of these causes is to produce a permanent excess of temperature of the surface-water of the sea over that of the air above it, provided that that air is not completely saturated with moisture.

From what I have seen and experienced in the regions visited by the south-west monsoon in the east, I cannot doubt that there are often cases where the most carefully exposed wet- and dry-bulb thermometers would show identical readings, and the atmosphere is completely saturated with vapour of water. Thus it is probable that the temperature of the air would not be inferior to that of the water. Further, when, on the eastern coasts of Asia, the south-west monsoon blows out of the China Sea and penetrates far into the North Pacific, off the coasts of Japan it attains a latitude of naturally lower temperature than that from which it proceeded, so that much of the water with which it was laden, and which is held diffused through it as a mere gas, is condensed and remains suspended in it, producing a visible haze, which obscures the horizon and condenses on all solid objects exposed to it. Here the conditions are reversed, and instead of the air losing heat to evaporate the water, it receives the heat liberated by the condensation of the steam removed from waters of lower latitudes. Such conditions are, however, certainly exceptional, and there can be little doubt that, as a rule, the temperature of the surface-water of the sea is higher than that of the air. The temperature of the air depends on that of the water which tends to warm it and the degree of its own dryness, by virtue of which the water has a tendency to evaporate into it and, by extracting heat from it for this purpose, to cool it.

It is obvious that local circumstances such as currents may produce differences between the temperature of the air and the water, but such cases are not here under consideration.

J. Y. BUCHANAN

Mendoza, March 18

THE REV. T. W. WEBB

BY the death of the Rev. Thomas William Webb, M.A., F.R.A.S., English astronomy has lost one of its most assiduous and accomplished votaries. Mr. Webb, who had reached the age of 79 years, passed a long life as the incumbent of two obscure Welsh livings, held by him in succession. At Tretire he may be said to have laid the foundations of those astronomical tastes which took their finished and best-known shape during the later years of his life whilst he was incumbent of Hardwick, in Breconshire. He was a genial and right-thinking parish priest, whose highest aim was the performance of his duty. For the sake of astronomy it was well perhaps that he obtained so little ecclesiastical advancement; for had things been otherwise it is probable that he would never have developed those scientific tastes which have made his name almost a household word. It was my privilege to make his acquaintance upwards of twenty years ago, and I look back with extreme pleasure to the many letters which have passed between us on practical matters connected with observational astronomy and the use of instruments. Whilst Mr. Webb in bygone years used to write a good deal in the current scientific magazines of the day, especially the *Intellectual Observer* and the *Student*, it was by his "Celestial Objects for Common Telescopes" that he became chiefly known in the astronomical world. This work, published in the year 1859, was designed to be a cheap popular abridgment in a modified form of Admiral Smyth's "Celestial Cycle," which had done right good service in providing English amateurs with information as to what to look for and how to find. By 1859 Smyth's work had become both out of print and somewhat out of date, and Mr. Webb's unpretending abridgment filled at once an undoubted void. It is indeed not wholly correct to speak of Webb's "Celestial Objects" as an abridgment of Smyth's older, larger, and more expensive volume. It was this; but it was also a good deal more, for whilst it offered to the possessors of small telescopes convenient lists of objects deserving of their attention, it also supplied an enormous amount of original information connected with the sun, moon, and planets, and the use of telescopes. This information, though no doubt suggested by Admiral Smyth's style, was no mere *rechauffé* of other people's work, but represented the personal experience of an intensely industrious and persevering man working under great difficulties through lack of instrumental means.

I shall never forget the feeling of blank astonishment which crept over my mind one day when (in, I think, the year 1864) Mr. Webb told me that the first edition of his book, and all his magazine articles up to that date describing double stars and clusters, were founded on studies pursued by means of a telescope set up in his garden and not equatorially mounted. This, I well remember, was not said in any spirit of boasting in the garb of mock modesty, but was the casual utterance of a simple truth disclosed without effort or intention. I do not think I ever came in the way of any student of nature of whom it could be so truly said that he was "without guile."

Mr. Webb was every inch a gentleman, and a philosopher in the highest sense of the word. Every line that he wrote contained either the record of some fact noticed by himself, or a sensible deduction from some other facts. When his facts had come to an end his pen ceased to pass over paper, and the result was that no one ever read a sentence written by him without learning something useful, set forth in the fewest possible words, often, indeed, in a form of concentration which erred on the side of inconvenient brevity; but in these days of penny-a-lining (and it may even be admitted that there is even such a thing as science penny-a-lining) Mr. Webb's habitual terseness cannot be described as a vice. His private letters show that, where necessary for the instruction of a young astronomer, he never grudged time and trouble for going into details. The highest praise that can be awarded him is that he not only did many useful things himself, but that he set an example of patient and industrious research which resulted in many young men all over the British Empire seeking to imitate his cheery and sensible style of work and thought.

G. F. CHAMBERS

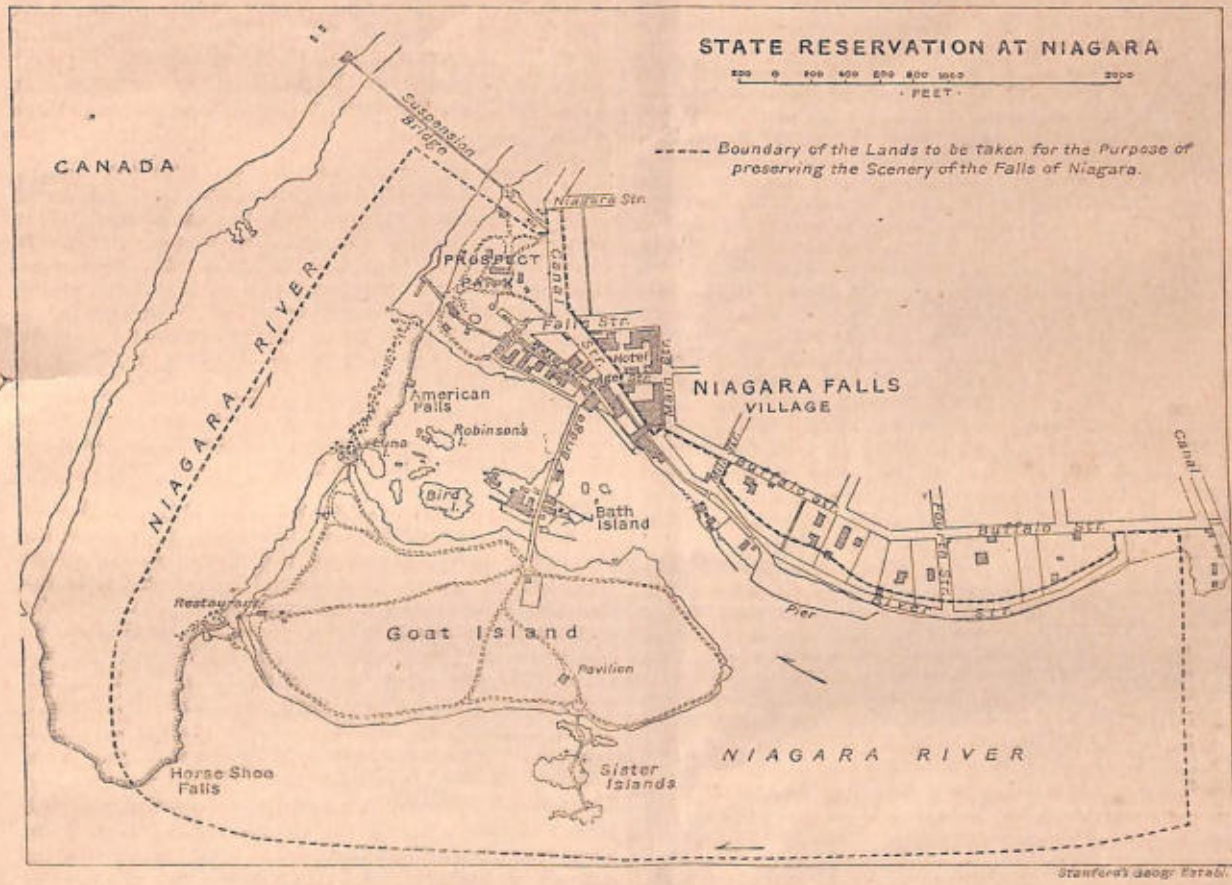
THE PRESERVATION OF NIAGARA[1]

NEARLY seven years ago Lord Dufferin, then governor-general of Canada, suggested to Gov. Robinson of New York that the governments of the province of Ontario and the state of New York should purchase such lands about Niagara Falls as would be required to give free access to the principal points of view, and serve to restore and preserve the natural scenery of the great cataract, beside securing to visitors freedom from those vexatious annoyances which now abound. Subsequently the governor-general called the attention of the government of Ontario to the matter, and recommended co-operation with the state of New York in accomplishing this purpose.

Later, in January, 1879, Gov. Robinson, in his annual message to the legislature of New York, presented this matter, and recommended the appointment of a commission to investigate the question, to confer with the Canadian authorities, to consider what measures were necessary, and to report the results to a succeeding legislature.

By resolution the commissioners of the State Survey were charged with the investigation. This commission included some of the most distinguished men of the state,—Ex-Gov. Horatio Seymour, Vice-President of the United States, W. A. Wheeler, Lieut.-Gov. Dorsheimer, President Barnard of Columbia College, and others.

With breadth of view worthy of such men, they state in their report that, "under this resolution, it became the duty of the commissioners to ascertain how far the private holding of land about Niagara Falls has worked to public



disadvantage through defacements of the scenery; to estimate the tendency to greater injury; and, lastly, to consider whether the proposed action by the state is necessary to arrest the process of destruction, and restore to the scenery its natural character." In pursuance of these objects, the commissioners instructed Mr. James T. Gardiner, director of the State Survey, to make an examination of the premises, and prepare for their consideration a project. He was assisted in this work by Mr. Frederick Law Olmsted, the distinguished landscape-architect.

The examination showed that the destruction of the natural scenery which forms the framework of the Falls was rapidly progressing: unsightly structures and mills were taking the place of the beautiful woods that once overhung the rapids; the fine piece of primeval forest remaining on Goat Island was in jeopardy from projects looking to making a showground of the island; and every point from which the Falls could be seen on the American side was fenced in, and a fee charged for admission. It was found that, owing to the topography of the main shore, it was practicable to restore its natural aspect by clearing away the buildings from a narrow strip of land 100 to 800 feet broad and a mile long, and planting it with trees which would screen out from view the buildings of the village. When these trees should be grown, and the mills removed from Bath Island, and trees planted there, the falls and rapids would be again seen in the setting of natural foliage which formed so important an element in their original beauty. Every point from which the Falls could be seen would also become free of access by the plan proposed. A map was made showing just what lands should be taken to carry out these purposes. The commissioners adopted the plan of Mr. Gardiner

[1] From *Science*.

and Mr. Olmsted, and recommended to the legislature of 1880 the passage of an Act to provide for acquiring title to the necessary lands by the exercise of the right of eminent domain, leaving it to a future legislature to consummate the purchase by appropriating the amount for the payment of the awards, if the sum should seem a reasonable price for the property. Such an Act passed the Assembly, but was defeated in the Senate, although the movement was supported by petitions signed by the most distinguished men of this and other countries. The report of the State Survey, with its complete descriptions, illustrations, and maps, then became the basis of a systematic effort on the part of a few determined friends of the Falls to educate and arouse public opinion to save the scenery of Niagara. Early in 1883 this movement ripened into the organisation of an association to promote legislation for preserving the scenery of the Falls of Niagara, Mr. Howard Potter of New York being president, and Hon. J. Hampden Robb, chairman of the executive committee.

Through the efforts of this Niagara Falls association an Act was passed, in 1883, providing for a commission, entitled "The commissioners of the state reservation at Niagara," and giving them power to proceed through the courts to condemn the lands needed. Ex-Lieut.-Gov. William Dorsheimer is the president of this board; and the other members are President Anderson of Rochester University, Hon. J. Hampden Robb, Hon. Sherman S. Rogers, and Andrew H. Green. With some modifications made necessary by changed conditions, they adopted the plan proposed by the State Survey. The lands selected were then surveyed, and their value appraised by a commission of very high character, appointed by the court, the total value of the lands being $1,433,429.50. The report of the commissioners of the reservation was made to the present legislature, and a Bill to appropriate this sum was introduced. The Niagara Falls association worked in every part of the state to arouse public opinion to the importance of making this appropriation, and the commissioners laboured most earnestly among the legislators and the people. The battle was a hard one against ignorance and narrow-minded selfishness; but the victory is complete. The legislature, by more than a two-thirds majority, has appropriated the $1,433,429.50, and the governor has approved the Act.

After six years of almost continuous effort on the part of the active friends of this enlightened project, it is secured by a law which declares that the lands are purchased by the state in order that they may be "restored to, and preserved in, a *state of nature*," and that every part of them shall be for ever free of access to all mankind.

NOTES

We understand that on the receipt by the Science and Art Department from the Foreign Office of a despatch from Her Majesty's Minister at Washington forwarding communications concerning the proposed change in the time for beginning the astronomical day, as recommended by the recent International Meridian Conference at Washington, the Lords of the Committee of Council on Education requested the following Committee to advise them as to what steps should be taken in the matter. Prof. J. C. Adams, F.R.S., the Astronomer-Royal, Capt. Sir F. Evans, K.C.B., R.N., the Hydrographer of the Navy, Gen. Strachey, R.E., C.S.I., F.R.S., Dr. Hind, F.R.S., and Col. Donnelly, R.E. In accordance with their recommendations copies of the Report of the Delegates to the International Prime Meridian Conference at Washington, together with the resolutions adopted by that body, have been sent to various departments of the State, and to the following Societies, &c.: Society of Telegraphic Engineers, Royal Astronomical Society, Royal Society, Submarine Telegraph Company, Eastern Telegraph Company (Limited), Eastern and South African Telegraph Company (Limited), Eastern Extension, Australasia and China Telegraph Company (Limited), Railway Clearing House. They have been informed that these resolutions of the Prime Meridian Conference appear to my Lords of the Committee of Council to be such as commend themselves for adoption. But before informing the American Government to that effect their Lordships would be glad to receive the opinion of the various societies on the subject.

The annual meeting for the election of Fellows of the Royal Society was held at Burlington House on Thursday, June 4, the President in the chair. The following were elected:—Major A. W. Baird, R.E., Philip Herbert Carpenter, D.Sc., Sir Andrew Clark, Bart., M.D., Andrew Ainslie Common, F.R.A.S., Staff-Commander Ettrick William Creak, R.N., Prof. Edward Divers, Henry Hicks, M.D., William Mitchison Hicks, M.A., Francis R. Japp, Ph.D., Arthur Milnes Marshall, M.D., Prof. Henry Newell Martin, D.Sc., Cornelius O'Sullivan, Prof. John Perry, Prof. Sydney Ringer, Sidney Howard Vines, D.Sc.

The Davis lectures upon zoological subjects will be given in the Lecture Room in the Zoological Society's Gardens, Regent's Park, on Thursdays, at 5 p.m. The first was given on Thursday, June 4, the subject being "Rhinoceroses and their Extinct Allies," by Prof. Flower, LL.D., V.P.R.S. The others are:—Thursday, June 11, "Apes and Lemurs," by Dr. St. George Mivart, F.R.S.; Thursday, June 18, "The Structure of the Swan," by Prof. W. K. Parker, F.R.S.; Thursday, June 25, "The Domestic Cat," by J. E. Harting, F.L.S.; Thursday, July 2, "Recent Advances in Zoology," by Prof. F. Jeffrey Bell, M.A.; Thursday, July 9, "The Ancestors of Birds," by F. E. Beddard, M.A.; Thursday, July 16, "The Animals of New Guinea," by P. L. Sclater, F.R.S.

In the second edition of his work, "Sur l'Origine du Monde," M. Faye has promulgated the following hypothesis regarding the relations between the geological epochs and the stages of the terrestrial cosmogony. The history of the earth he divides into six stadia. The first is that in which the earth was a glowing ball. The second he calls the *Antezoic period*, in which total darkness supervened on the extinction of the earth's glow. The third is the *Primary period*, during which there was a feeble illumination from the sun, which was then just coming into existence. During the *Secondary period* the sunlight went on increasing as the sun itself grew larger and assumed its proper shape. In the fifth stadium, which is that of the *Tertiary period*, there was complete solar illumination, and the sun soon attained the maximum of its activity; while in the last stadium, that of the *Quaternary period*, there has been a slight diminution of the solar activity (rather surmised than demonstrated), accompanied by the disappearance of every cosmogonic influence and the establishment of perfect stability in almost all directions. Oscillations in the earth's crust and feeble volcanic manifestations are almost the only instances of cosmogonic change still observable.

We have received from MM. Fol et Sarasin a copy of a paper by them on the depth to which the light of the sun will penetrate into the sea. It will be remembered that in November last they recounted the results of their experiments on the same subject in the Lake of Geneva. The present paper describes similar experiments made in the Mediterranean off the zoological station and harbour of Villefranche. By means of photographic plates they have proved that in the month of March, in the middle of a sunny day, the rays of the sun do not penetrate beyond 400 metres below the surface of the Mediterranean. This is established by seven separate experiments, at varying

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Of Nature trusts the mind which builds for aye."—WORDSWORTH.

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depths and different hours of the morning. At 380 metres, shortly before 11 a.m., the impression on the plate was less than that which would have been left on exposure to the air on a clear night, without a moon. Between 1.20 and 1.30 p.m., at a depth of 405 to 420 metres, there was no trace of any impression whatever on the plate. Light clouds do not appear to cause any notable diminution in the depth to which the light penetrates. In the Lake of Geneva the writers also undertook a new series of investigations to determine the effect of the season on the penetration of light. They give 200 metres as the extreme limit for winter in the lake; but they found that there is as much light at 380 metres in the Mediterranean as at 192 metres in the Lake of Geneva; and by a comparison of these with previous experiments, it appears the light penetrates from 20 to 30 metres deeper in March than in September; in the month of August, perhaps the difference is a little more. Compared with the series of plates exposed in the lake, those of the Mediterranean are characterised by a slower and more regular gradation. This gives rise to the idea that while in the lake the light would be promptly intercepted by the deeper layers, more or less disturbed or muddy, in the Mediterranean the absorption proper to pure water would be the principal, if not the sole factor in arresting the luminous rays.

In a communication to *Ausland* on the causes of the Andalusian earthquakes, A. Rzehak, of Brünn, maintains that they are clearly referable to the "tectonic" class of terrestrial disturbances—that is, those which are connected with the process by which mountains are elevated. Evidence of this connection is furnished by the manner in which the disturbed areas are influenced by lines of fault. The entire area of disturbance in the case of the earthquakes of December last is divisible into three zones: (1) the littoral zone in the south, where the shock was most severe; (2) Andalusia proper, which was likewise the seat of pretty severe disturbances; and (3) the central plateau of Spain as far as the Carpetena chain (a section of the Sierra Guadarrama), where, as already pointed out by M. Noguès (NATURE, xxxi. p. 417), the shocks completely died out. These three zones are separated by lines of fault. A great fault can be traced not only along the northern slopes of the Serrania de Ronda, but also further eastwards to the district lying north of Malaga. To the north of this line scarcely any places suffered greatly from the earthquake—except those which, like Antequera, Loja, and Archedona, lie close to or immediately beside transverse faults. Elsewhere the degree of shock was tolerably uniform as far as the fault of the Guadalquivir, which bounds the central plateau on the south. A third great fault passes along the south of the Sierra Guadarrama, and there the disturbance seems to have ended.

The honour of C.I.E. has been conferred upon Mr. Francis Day, Deputy-Surgeon-General (Retired), Medical Department, Madras, and on Mr. J. B. N. Hennessey, late Deputy-Superintendent, Indian Survey Department.

The Meteorological Society of Vienna has resolved to erect a meteorological station on Mount Sonnenblick, near Tauern, in the central range of the Tyrolese Alps, 3100 metres above sea-level, and thus the highest station of the kind in Europe.

The Royal Institute of British Architects, on Monday evening, presented to Dr. Henry Schliemann, F.S.A., their Royal Gold Medal. In acknowledging the medal Dr. Schliemann said that our knowledge of prehistoric architecture was very deficient, for our sole informant was Homer, whose scanty information as to the construction and arrangement of the heroic palaces we did not even understand.

The latest official report of the earthquake in Cashmere states that much damage was occasioned in the north western portion of the valley. The ground opened, and the villages of Dubgaon, Jamalapar, and Ovan were swallowed up, while sulphurous dust and hot water issued from the cracks. The fort at Gurais and the grain store-houses were buried. A telegram sent from Serinagur on Friday last says:—"The shocks continue every three hours, with much preliminary noise, but a comparatively slight motion." The great shock appears to have travelled in a southerly direction, and to have been felt at several places in Northern India, although it did no damage there.

The death is announced, at the age of fifty-two, of Robert von Schlagintweit, Professor of Geography and Ethnology at the University of Giessen. He was the youngest of the three brothers Schlagintweit who, on the recommendation of Alexander von Humboldt, and under the special care of Lieut.-Col. Sykes, were sent by the British East India Company to explore that country, and especially the mountain regions in the north-west. The results of their researches, which lasted for several years, are recorded in comprehensive works of the highest scientific value.

Important experiments in aërial navigation are now being made by Mr. A. F. Gower, well known in connection with the Gower-Bell telephone. The operations being carried on are, it is understood, within the cognisance of the Government, and are more particularly directed towards the adaptation of balloons to war purposes. Several ascents have already been made, and in carrying out his arrangements Mr. Gower appears to have recognised the advantages offered by the position of the town of Hythe, which he has made the centre of his operations. On Sunday week the wind being favourable, one of the automatic pilot balloons invented by Mr. Gower, with appliances for giving out its own gas and ballast, one compensating for the loss of the other, was filled with 2300 feet of gas, and ascended at about 11 o'clock. In the car a written statement was, of course, placed, explaining the ownership of the machine and its object, with the result that it was next heard of at Dieppe, having made a rapid passage of about seventy-two miles in a straight direction and descended at 2.30 in the afternoon. On Monday, another pilot balloon, with a capacity of 4300 feet, was started, and immediately followed by Mr. Gower in his own balloon (containing 23,000 feet of gas). The object of Mr. Gower in ascending was to watch the action of the pilot; but the smaller machine made such rapid progress that it got out of his observation and came down in the vicinity of Paris. Meanwhile Mr. Gower, who ascended about noon, took the French coast at Boulogne at 2.15, and then taking a northerly curve travelled overland to Calais, where he made a smooth descent at 4 p.m. A still more important undertaking was, however, entered upon on Wednesday, when Mr. Gower, Capt. Lane, and Mr. Dale, the aëronaut, ascended in a balloon of 40,000 feet capacity. A good start was made, and the aërial voyagers sailed away in a northerly direction. After a journey of rather more than an hour, they were compelled to descend, owing to the wind taking a slight turn towards the North Sea, and with much difficulty landed on the Isle of Sheppey, having travelled twenty-three miles.

A very laudable effort at teaching the general public practical astronomy is being made in Christiania. An optician, Herr A. Olsen, has erected a great refractor in the Royal Park—in size said to be the fifth in the world—through which the celestial bodies can be observed by the public for a small fee, while explanations are given of their nature, &c. The interior of the pavilion in which it is mounted is hung with celestial charts and diagrams, as well as views of the planets, the sun, and the moon, for the purpose of facilitating the object in view. The cost of the instrument is very nearly 2000*l*.

Intelligence has been received at New York, June 9, stating that a waterspout has burst near Lagos, in Mexico. One

hundred persons are reported to have perished, and it is feared that the loss of life will prove even greater.

A WATERSPOUT passed over a portion of the town of Hagenau (Alsace) on May 23 last, doing very great damage to houses and trees.

AT Stendal (Prussian Saxony) a Committee for the erection of a monument in memory of Dr. Gustav Nachtigal has been formed, and contributions towards this object are solicited.

THE Austrian Central Tourist Club has addressed a petition to the Assemblies of all Austrian alpine provinces to pass a law prohibiting the wholesale uprooting of *Edelweiss* now carried on. The petitioners point out that hundreds of thousands of the plants are dug up and sent abroad, even to America, so that there is a fear that the favourite plant of all lovers of the Alps will be totally exterminated, except in a few remote places. In Switzerland, it is stated, for several years past there have been stringent laws in the several cantons against uprooting and selling the *Edelweiss*.

THE *rôle* of wind in fertilising the ground is remarkably illustrated, according to M. Alluard, by the very fertile valley of Limagne, in Auvergne. The prevalent winds there are west and south-west, and traverse the chain of the Dômes, where are vast deposits of volcanic ashes. Much of this dust is thus carried to the Limagne valley, and settles there of itself, or is carried down by rain or snow. As it contains a large amount of phosphoric acid, potash, and lime, it is highly fertilising, and its very fine state favours rapid assimilation. From observations on the Puy de Dôme, M. Alluard estimates the annual deposit at 348 to 400 grammes per square metre.

WE have received the Calendar of the University of Virginia for the academical year 1884-85. The science department appears to be exceptionally strong and well organised.

ONE result of the recen visit of the Ameer of Afghanistan to India is that his palace at Cabul is to be lit by the electric light. He ordered the necessary apparatus when at Rawul Pindi, and three Cabulese have for some time past been studying its manipulation at Bombay.

WE have received a copy of a lecture by Mr. Thomas Fletcher, delivered before the Parkes Museum of Hygiene, on "Smokeless Houses and Manufactories." It deals mainly with the lecturer's personal experiences of the employment of gaseous fuel in his private residence and manufactory at Warrington, the appliances which he has used, a comparison of the cost with that of coal, the work done, &c. In reply to a question, Mr. Fletcher expressed the opinion that radiant heat is the only possible comfortable way of heating a living-room, and that it is therefore better to mix gas with air to prevent smoke, and heat as large a surface as possible to incandescence.

ACCORDING to a report by the Director of Public Instruction in Tunis, there are at the present moment twenty primary schools in the Regency—eight in Tunis, and twelve in other towns—Susa, Monastir, Sfax, Goletta, &c. In this number are included three schools of the Israelite alliance at Susa, Tunis, and Mehdia. The number of pupils is 3974, composed of 2291 boys and 1683 girls. The report states that there are in addition a certain number of primary schools in which the instruction is religious. Of these there are 113 in Tunis, and about 500 in the whole Regency. For secondary instruction there are three establishments, all in Tunis. These contain 23 classes with 38 masters, giving instruction to 416 pupils, of whom 78 are French, 27 Italian, 26 Anglo-Maltese, 74 Jews, 193 Arabs, and 18 of various nationalities.

A MEETING of the National Fish Culture Association was held on Thurday last to consider the question of instituting sea temperature observations with a view to gaining independent and fresh knowledge with respect to our marine food-fishes. The subject of marine stations was discussed together with other matters relative to log-books to be issued to suitable investigators.

THE additions to the Zoological Society's Gardens during the past week include a Squirrel Monkey (*Chrysothrix sciurea*) from Demerara, presented by Mr. T. C. Edwards-Moss; a Common Badger (*Meles taxus*) from Derbyshire, presented by His Grace the Duke of Devonshire, K.G., F.Z.S.; a Common Badger (*Meles taxus*) from North Wales, presented by Mr. T. W. Proger; two Common Hedgehogs (*Erinaceus europæus*), a Common Viper (*Vipera berus*) from Norfolk, presented by Mr. T. E. Gunn; a Chattering Lory (*Lorius garrulus*) from Moluccas, presented by Mr. H. D. Astley, F.Z.S.; a Red-crested Cardinal (*Paroaria cucullata*) from South America, presented by Miss Hyrzan; a White-tailed Eagle (*Haliaetus albicilla*) from Perthshire, presented by Mr. H. Tennent Tennent; a Manx Shearwater (*Puffinus anglorum*), a Puffin (*Fratercula arctica*), British, presented by Mr. W. Graham, F.Z.S.; an Egyptian Monitor (*Varanus niloticus*) from West Africa, presented by Mr. H. Denny; an African Lepidosiren (*Protopterus annectens*) from African Rivers, presented by Mr. Cornelius Alfred Malony, C.M.G.; two Slowworms (*Anguis fragilis*), British, presented by Mr. F. J. Guy; a Sharp-nosed Crocodile (*Crocodilus acutus*) from Jamaica, deposited; a Collared Fruit Bat (*Cynonycteris collaris*), an Axis Deer (*Cervus axis* ♀), a Hybrid Luhdorf's Deer (between *Cervus luehdorfi* and *Cervus canadensis* ♂), a Burrhel Wild Sheep (*Ovis burrhel*), two Triangular-spotted Pigeons (*Columba guinea*), a Variegated Sheldrake (*Tadorna variegata*), a Herring Gull (*Larus argentatus*), twenty Spotted Salamanders (*Salamandra maculosa*), thirty Pleurodele Newts (*Molge waltl*), bred in the Gardens.

ASTRONOMICAL PHENOMENA FOR THE WEEK, 1885, JUNE 14-20

(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 14

Sun rises, 3h. 44m.; souths, 11h. 59m. 59·9s.; sets, 20h. 16m.; decl. on meridian, 23° 18′ N.: Sidereal Time at Sunset, 13h. 49m.

Moon (at First Quarter on June 19, 14h.) rises, 5h. 46m.; souths, 13h. 38m.; sets, 21h. 25m.; decl. on meridian, 17° 37′ N.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury ...	2 58	10 56	18 54	20 45 N.
Venus ...	4 26	12 48	21 10	24 11 N.
Mars ...	2 18	10 7	17 56	19 17 N.
Jupiter ...	9 28	16 37	23 46	12 32 N.
Saturn ...	4 7	12 16	20 25	22 28 N.

Phenomena of Jupiter's Satellites

June	h. m		June	h. m.	
14 ...	20 15	III. tr. ing.	18 ...	23 17	II. occ. disap.
	22 37	I. ecl. reap.	20 ...	20 33	II. tr. egr.
16 ...	22 24	IV. ecl. disap.			

The Eclipses of Jupiter's Satellites are such as are visible at Greenwich.

June	h.	
17 ...	15 ...	Jupiter in conjunction with and 3° 44′ north of the Moon.
18 ...	23 ...	Saturn in conjunction with the Sun.

GEOGRAPHICAL NOTES

AFTER having lost, in December last, their director, Prof. W. G. Erofeeff, and in January one of their most active members, W. A. Domzer, the Russian Geological Commission has again sustained a heavy loss in the death of the distinguished G. P. Helmersen. According to the notice in the last issue of the *Isvestia* of the Commission he began his scientific career more than sixty years ago, at the Dorpat University, and when

less than twenty-two years of age. Throughout his life he has had the opportunity of exploring nearly all the surface of Russia in Europe, from Olonetz to the Crimea and from Poland to the Ural, penetrating also into the Kirghiz Steppes in the Asiatic dominions of the empire. The results of his varied explorations are embodied in 130 monographs, some of which are bulky works. His first work of importance, the "Exploration of Southern U al," was published in 1831, in connection with Hofmann. Five years later it was followed by a description of the Kirghiz Steppes and by a short paper on the Ural and Altay Mountains. In 1838 he began to publish the results of his explorations of the Baltic provinces, which were thenceforth continued throughout his life. In 1840 he studied the lake region of North-west Russia and of the Valdai Hills, and next year made the first attempt to embody all that was known regarding the geological structure of Russia by publishing the first geological map of the country. The coal-fields of the Moscow basin then attracted his attention, and in 1845 he published the results of his researches into the structure of the Ust-Urt and its slopes towards the Sea of Aral. In 1850 he published an interesting sketch of the Devonian Rocks of Middle Russsa. In 1857 there appeared his notice as to the rising of the Baltic shore and the action of ice and water on it, being the first of a series which led him afterwards to investigate the subject of boulders. After having spent four years in the exploration of the Olonetz region, he embodied the results of his observations in a work published in 1860. His researches into the physical conditions of St. Petersburgh, the artesian well bored in that capital, and the Alexander monolith, made his name popular even among unscientific readers. A work on Lake Peipus and the Narova river appeared in 1864, and completed his researches in the lake region of North-west Russia. Next year a second revised edition of his geological map of Russia, including the Ural and Caucasus, and a map of the Russian coal-basins, were published by the indefatigable geologist. The supposed drying up of the Sea of Azov was the subject of several papers and reports presented by him to the Academy of Sciences, as also the extension of the coal-fields from the Don, through Tula and Kaluya, to Courland and Eastern Prussia. In 1870 he published his "Studies on Boulders," the second part of which appeared only three years ago. In 1879 he issued a geological and physico-geographical description of the Aralo-Caspian region. A paper, written together with M. Yakovleff on the same subject, in 1883, was his last contribution to the Memoirs of the Academy of Sciences. In all these works, Helmersen appeared as a follower of the school of geologists represented by Leopold von Buch and Alexander Humboldt. Instead of merely describing the fossils of a given formation, and minutely studying its various stratigraphical and palæontological horizons, he tried to discover the leading physical and geographical features of the country he explored, and devoted great attention to dynamical geology. His works are as valuable to the geographer as to the geologist. For twenty-five consecutive years Helmersen was Professor at the Mining Institute of St. Petersburg, and since 1844 he was one of the most active members of the Academy of Sciences. In 1851 he was elected a foreign member of the Geological Society of London – an honour well bestowed on one of the most industrious and distinguished geologists whom Russia has produced.

THE last issue of the *Izvestia* of the Russian Geographical Society contains a map showing M. Potanin's last journey in China, from Peking to Kookoo-koto and Lang-tcheou (73° 30' E. long.), to illustrate M. Potanin's letters dated Boro-balgasun and Lang-tcheou, September and November 13th, 1884. The Ordos, described with so dark features by Huc, looked more attractive than might have been expected. True, the whole of the country between the Yellow river and Boro-Balgasun is covered with sand; but moving sand is rare, the *barkhans* being usually fortified by vegetation. The *shiahyk*—a species of *Artemisia*—is the most frequent growth in the *barkhans*, the cavities between them being thickly covered with bushes of Caragana, *archa*, and *yashil*. Water is found wherever the subsoil appears from beneath the sand; numerous sweet water ponds make there their appearance, and they are surrounded with moist pasture-grounds. The dry grounds between the sands are covered with Steppe vegetation, the *Calimeris* colouring sometimes wide spaces in white. Sarrazin, millet, and hemp are cultivated on these dry grounds. Altogether, the eastern Ordos may be considered as a rich country for cattle breeding, if supported by some agriculture. Two old towns, now in ruins, were passed on the borders of the Ordos. Boro-balgasun, too, was formerly a town, within the ruined walls of which there are now but a few Mongolian huts, and the house of the Belgian missionaries. In the Van principality M. Potanin visited the Edjen-khoro place, on the Tchamkhak river; it consists of two tents where the bones of Chengiz-khan are said to be preserved. On Sept. 22, the expedition left Boro-balgasun. They visited the salt lake Baga-shikyr, and for five days crossed a region covered with low hills and almost uninhabited, notwithstanding the good pasturage which spread between the *barkhans*, these last becoming more thinly spread than in the east. Ruins of Mussulman villages destroyed during the last insurrection are not uncommon. Lin-tcheou, on the Hoang-ho, is surrounded by fruit-gardens. South of it numerous villages extend for some fifty miles along a canal which runs parallel to the Hoang-ho and crosses on aqueducts its tributaries. Its banks offer an uninterrupted fruit garden, with a few rice-fields. All this richness is, however, of recent origin, the former gardens having been all destroyed by Chinese after the last insurrection. Altogether, the region bears traces of desolation; whole towns have been quite destroyed. The town Tsin-tsi-pou was the centre of the insurrection. South of this town, M. Potanin left the valley of the Hoang-ho, and crossed the series of flat ridges which reach towards the south, 6,000 feet to 7,000 feet above the sea-level. Still they have gentle slopes, owing to their covering of Loess which reaches a thickness of from 200 to 300 feet. The hills are formed of red sandstone, with some layers of pudding-stone north of the Tao-tsoui river, while south of Tsin-youang the ridge consists of silicious and clay-slate. The sandstone contains beds of salt, which impregnates also the soil and is worked to some extent; it is raised also from a number of small lakes. The Loess covers the whole of the country from Ping-yang-sia to Lang-tcheou, spreading also over the summits of the higher ridges. The population is of Turk origin, and though it has assumed Chinese customs it maintains its Mussulman religion. In the hilly tracts dwellings, and even inns, are dug out in the Loess. Lang-tcheou is a great city, picturesquely built on the right bank of the Hoang-ho at the foot of a high mountain ridge. A floating bridge crosses the great river. The plants collected for the herbarium by the expedition were but few, owing to the late season; but altogether in the whole region there are no trees excepting those which are cultivated; even the higher ridges are devoid of trees and but scarcely clothed with grass. From Lang-tcheou, where the astronomer, M. Skassy, remained with the scientific collection, M. Potanin went to the west to visit the Salors and Shorongols, who inhabit that region, while M. Berezovsky proposed to advance further south to Hoy-sian, situated on the water-divide between the Yellow and the Blue Rivers. The scientific results of the expedition promise to be very interesting. The astronomer, M. Skassy, has determined the position of fifteen places and mapped the route. M. Berezovsky has collected 140 samples of birds, and M. Potanin brings back collections of plants, insects, and reptiles, as also a geological collection.

A RECENT number of the *Japan Gazette* contains a series of notes on each of the islands forming the Kurile group, which stretches from Jeso northward to Kamtschatka, and which for the past ten years have belonged to Japan. The notes are arranged by Prof. Milne, from his own notes and those of Mr. Snow, who has spent many consecutive summers amongst the islands. They refer mainly to the numerous volcanoes among the Kuriles, but much information on other points relating to this little-known group is given. The name applied by the Japanese to the chain is "Chishima," or "the thousand islands," but there are really not more than thirty or forty. Of these, Iturup and Kunashiri, the most southern members of the group, are the largest. They "form the first links of the chain which volcanic agencies have built up whilst attempting to join Japan and Asia." Iturup is 113 miles long and 77 in greatest width; Kunashiri is 62 miles by 17. They are all very desolate, and sparsely populated in summer by Japanese and Ainos, who come to fish. In Iturup, between the coast and the mountains, there is a kind of jungle composed mainly of bamboo grass, which is impassable. The explorer has therefore to follow the bed of a stream or the bear tracks. Prof. Milne thinks it not unlikely that the Iturup bear may be a species new to science. From the specimens seen in cages it seems to resemble the grizzly bear of North America.

ANNIVERSARY OF THE ROYAL GEOGRAPHICAL SOCIETY

THE Anniversary Meeting of the Royal Geographical Society was held in the theatre of London University on Thursday, the Right Hon. Lord Aberdare, F.R.S., President, in the chair. In his address, Lord Aberdare referred to Mr. Keltie's report on the position of geographical education in England and on the Continent. The Report, Lord Aberdare stated, contains statements and recommendations of the highest interest and importance. Of the state of geographical education in Great Britain Mr. Keltie draws a very dismal picture. "There is no encouragement to give the subject a prominent place in the school curriculum; no provision, except at elementary normal schools, for the training of teachers in the facts and principles of the subject, and in the best methods of teaching it; no inducement to publishers to produce maps, globes, pictures, reliefs, or other apparatus of the quality and in the variety to be found on the Continent; while our ordinary text-books are, as a rule, unskilful compilations by men who have no special knowledge of their subject." This neglect is attributed to the "exigencies of examination." Geography, as a class-subject, "does not pay." It is not recognised at the Universities by either professorship or readership; it does not find a real place at any of their examinations; while in the Army and Navy examinations it is at a discount; and such geography as is given is of a very partial character, and is merely left to crammers. These unsatisfactory statements are justified by a large amount of evidence. In striking contrast to this picture is that which Mr. Keltie presents of the state of geographical education in Germany, France, Italy, Switzerland, and several other countries of Europe. Germany, as might be expected, takes the lead, and does its work most thoroughly. But the systematic study of geography is even there of recent creation. It prevails in twelve out of the twenty-one universities of Germany; and nearly all the twelve existing professorships of geography have been founded within the last twelve years. "The ideal aimed at, and being rapidly carried out, is to have one continuous course of geographical instruction from the youngest school-year up to the university." And Mr. Keltie deals with these ascending courses, showing in detail the teaching from the elementary to the higher schools, and in the universities. His examples of lessons he himself heard at some of these schools are most graphic, and suggest their high value in any course of intelligent education.

Lord Aberdare then briefly referred to the conclusions at which Mr. Keltie arrives. These, he stated, are clear, sensible, practical, but by no means encouraging. In all these European countries the curriculum is defined and imposed by the State, which, keeping the purse-strings, dictates the course of instruction. Except over our elementary schools, the State in this country exercises no such power, direct or indirect. We must be content to bring the force of public opinion to bear upon our schools and universities; for with them, and especially with our universities, rests the solution of this great question. Mr. Keltie's Report will be duly considered by the Council; it will doubtless be published; and means, Lord Aberdare ventured to prophesy, will be taken to bring home to our educational authorities, with fresh power and urgency, the necessity for not allowing Great Britain to lag behind our political and commercial rivals, our rivals in human culture, in the systematic study of geography. In the meantime, during the course of the autumn, an exhibition will be formed of the results of Mr. Keltie's labours in collecting specimens of the best text-books, maps, globes, diagrams, models, and other apparatus used in teaching the various branches of geography. This done, it remains for me, Lord Aberdare said, only to express the fervent hope that this latest effort of the Society to promote the studies which it was founded to extend, may meet with a large measure of success and tend to lay the basis of a sound and thoroughly national system of instruction in geography in all its branches, physical, political, and historical.

Lord Aberdare then gave a brief *résumé* of exploring work since his address in November last. He specially referred to the four years' explorations in Eastern Tibet of the Pundit Krishna, and to the geographical work done in connection with the Afghan Boundary Commission.

The preliminary map sent home by Major Holdich rectifies in many important points the erroneous topography in all pre-existing maps, and gives us a clear idea of the surface-configuration and physical condition of one of the most interesting districts in Central Asia.

Further east the indefatigable Colonel Prjevalsky has been recently again heard of from the centre of the continent, at Lob Nor.

In and around the Zhob valley, areas of about 5500 square miles of reconnaissance on the ¼-inch scale, and of 400 square miles of topography in the ½-inch scale are reported to have been completed; thus going far to fill in a reproachful hiatus in our present maps of Afghanistan. The ascent of certain peaks in the Himalaya by a member of the Alpine Club, Mr. W. W. Graham, an account of which was read by him at one of the Society's meetings in June last, has attracted considerable attention in India. The classical lands of Asia Minor have again this year been the subject of topographical investigation. In the winter of 1882-3 a fund was raised by public subscription in order to effect explorations that might throw light on the antiquities and early history of the region. Mr. W. M. Ramsay was entrusted with the execution of this scheme, and travelled with this view, May to October, 1883. He invited a scholar of the American School of Athens, Mr. J. R. S. Sterrett, to accompany him during great part of the summer. During that year's work the conviction grew up that no adequate study of the history of Asia Minor was possible till the ancient topography was better known and that no advance in the study of the ancient topography could be made till a better map of the country had been compiled. It was therefore found necessary, week by week, to pay a growing attention to the natural features of the country, the natural routes of communication, and the natural boundaries separating district from district. Lord Aberdare referred to the work done in New Guinea by Mr. Van Braam Morris, Dutch Resident at Tidore, who has examined this part of the coast, and ascended the Amberno, which had always been reported by passing navigators, on account of its numerous supposed mouths, to be a large river with an extensive delta, and to the journeys into the interior of the Rev. James Chalmers. Mr. Chalmers has visited many parts of this coast along a line of about 500 miles, and penetrated, at various places further inland, by land, than any other European, and his descriptions of the country and the habits of the vivacious, excitable, and pugnacious race of savages with which it is peopled, merit careful attention at the present time. An attempt is about to be made by the experienced traveller Mr. H. O. Forbes to penetrate to the summit of the ranges, or plateaux, which extend along the centre of this part of the great island. Since he left England on this arduous mission some weeks ago we learn that the Sydney and Melbourne branches of the Geographical Society of Australasia have offered to contribute to the expenses of this expedition, which is supported by grants by our Society, the Scottish Geographical Society, and the British Association. In other parts of Australasia the chief additions to our knowledge have been a survey of a large tract of new country in Central Queensland by Mr. C. Winnecke, and the exploration of the King Country in the northern island of New Zealand by Mr. Kerry-Nicholls, of which the explorer himself gave us an account at one of our evening meetings.

In Africa Lord Aberdare referred to the work done by Mr. H. H. Johnston at Kilimanjaro. Since then the brothers Denhardt, who had previously done excellent work in surveying the course of the River Dana, which flows from the southern slopes of Mount Kenia, have left again for East Africa. They have been commissioned, as we are informed by the German African Society, to take up a line of exploration similar to that adopted with so much success by Mr. Joseph Thomson, but to follow it much further to the north than the point reached by our English traveller, namely, to the reported great lake Samburu, north of Lake Bahringo. Further north still the year has witnessed the accomplishment of what may be termed one of the most interesting and difficult feats of all recent African travel. This is the journey of Messrs. F. L. and W. D. James, the authors of the well-known book on the "Wild Tribes of the Soudan," who with three English companions, Messrs. G. P. V. Aylmer, E. Lort Phillips, and J. Godfrey Thrupp, organised an expedition and started last December to cross the north-eastern angle of Africa from Berbera to Mogadoxo. The hostile disposition and uncertain temper of the Somali tribes who inhabit this wide region have hitherto offered invincible obstacles to its exploration by Europeans. Mr. James and his party, however, succeeded in penetrating 400 miles to the south, as far as Barri on the River Webbe, a point about 215 miles distant from Mogadoxo. The interior was found to be a plateau of an average elevation of about 4000 feet.

With regard to the more southerly parts of Eastern Africa, and more especially the region between the Mozambique coast and Lake Nyassa, our knowledge has lately increased by leaps and bounds. The increase has been principally due to the systematic explorations of Mr. Consul O'Neill. The general remark may be permitted that, thanks chiefly to Mr. O'Neill, we now have for the first time a fairly satisfactory knowledge of a region varied in its physical configuration, well watered, and fertile, which has hitherto remained a blank on our maps, notwithstanding the occupation of the coast by the Portuguese for nearly four centuries.

M. Giraud has returned this spring from his exploration of Lake Bangweolo and its outlet, and his unsuccessful attempt to cross Africa by way of the Upper-Congo; Mr. Arnot has crossed from Natal to the Bihé plateau by way of the Upper Zambesi; Mr. Montagu Kerr has crossed Matabele-land and the Zambesi, and penetrated by a new route to the south-western shore of Lake Nyassa; and Mr. Richards has reached from Inhambane the southern districts of Umzila's kingdom. In Western Africa further additons have been made to our knowledge of the Congo, chiefly by the publication of Mr. Stanley's long-expected book and the maps which accompany it, and by Messrs. Grenfell and Comber's careful survey of the middle course of the Congo and the Bochini tributary to the junction of the great river Kwango.

The members of the French Expedition on the Ogowé and the northern tributaries of the Congo have also been doing good work in the survey of the territories newly acquired by France.

In South America a striking feat of exploration has been accomplished since my last address; the supposed inaccessible summit of Mount Roraima, on the confines of British Guiana and Brazil, was reached in December last by Mr. im Thurn and his companion, Mr. Perkins, accompanied by a small party of Indians.

In conclusion Lord Aberdare gave the following brief summary of the Admiralty surveys of the year 1884, for which he was indebted to the hydrographer, Capt. Wharton, R.N.: The continuous prosecutions of marine surveys in different quarters of the globe has been well maintained during the past year. The two home-surveying vessels have been employed, one on the west and the other on the east coast of Great Britain. On foreign surveys 60 officers and 500 men have been employed in four steam ships of war and five other smaller vessels. These ships have been at work in Newfoundland, the Bahama Islands, Magellan Straits, South Africa, Red Sea, Malay Peninsula, coasts of China and Korea, north-west coast of Australia, and amongst the Pacific islands. The most important additions to our hydrographical knowledge are as follows:—The survey of the Little Bahama Bank will be shortly finished, and the same may be said of the southern shore of Newfoundland. The survey of the main strait of Magellan, to which reference was made in the last address, was completed early in the year. Many useful additions have been made to ports and salient parts of the coast of south-east Africa. In the Red Sea the intricate approaches to Sawakin have been well laid down. On the west coast of the Malay Peninsula, Penang harbour has been re-surveyed and the positions of the islands lying to the north-west and forming the eastern boundary of the ordinary route of vessels to Malacca Strait have been accurately determined. The unknown western shores of Korea, south of the approach to Seoul, for two degrees of latitude have been explored, and the main features of this island-studded shore laid down. New rivers and harbours have been entered, notably, the large river Yeun-san-gang, at the entrance to which stands the considerable town of Mokfo. There appears, however, to be little chance of immediate trade with Korea, in consequence of the absence of any valuable products and the scanty needs of the population. The southern approach to Haitan Strait on the Chinese coast, much used by British trade, has been re-charted. On the difficult shores of Western Australia such progress has been made as the small means at the disposal of the surveyors has permitted. In the Solomon Islands the Bougainville Strait has been charted. This Channel will in the future be most probably a highway for traffic between Eastern Australia and Japan. Many additions have been also made to the charts of various groups of other Pacific islands. The survey of the coasts of India carried on by officers of the Royal Navy and India Marine has been actively progressing. Surveys of Rangoon, Cheduba, and other ports in the Bay of Bengal, as well as harbours on the west coast of Hindostan, have been made. A re-survey of the great Canadian lakes has been commenced in Georgian Bay, where trade by water is on the increase.

Lord Aberdare then intimated his resignation of the Presidency of the Society, the Marquis of Lorne having been elected to succeed him.

PROF. REYNOLDS ON THE STEAM INDICATOR[1]

THE object of this paper was to define the causes and extent of the disturbances in indicator diagrams. The theory, as given, had been taught for several years in Owens College; but the publication had been deferred to enable an extensive series of experiments to be made. These experiments had now been carried out by Mr. A. W. Brightmore, Stud. Inst. C.E., late Berkeley Fellow in Owens College. In the first place it was shown that there were five principal causes of disturbance, namely: the inertia of the piston of the indicator and its attached weights; the friction of the pencil on the paper, and its attached mechanism; varying action of the spring; inertia of the drum; friction of the drum.

The effect of the inertia of the pencil and its attached mechanism presented a mathematical problem, by the solution of which it was shown that there were two disturbances from this cause: one, a general enlargement of the mean indicated pressure, depending on the weight of the moving parts of the indicator, the stiffness of the spring, and the square of the speed. The other disturbance was a vibration of the pencil. Every indicator piston vibrated when disturbed, so that the period of vibration depended on the stiffness of the spring.

The error which these oscillations caused in the area of the diagram depended on their magnitude, and, to a greater extent, on the smallness of the number in a revolution. But the evil of these oscillations was not so much an effect on the area as in the disfigurement and the confusion they produced in the diagram. So long as there were thirty of these oscillations in a cycle, the necessary fluid friction of the indicator piston would so far reduce them as to render a fair diagram possible, but when the number was as low as ten it was all the pencil could do to prevent them upsetting the diagram.

The friction arising from the pressure of the pencil always acted to oppose the motion of the pencil, and therefore rendered it too large during expansion and exhaust and too small during compression and admission, and thus the general effect was to increase the size of the diagram. This friction consisted of that of the pencil on the paper; and that of the mechanism, caused by sustaining the pressure of the pencil. The effect of the friction of the pencil was greatly reduced by the motion of the paper. The magnitude of these effects taken together on the area of the diagram depended on the construction of the instrument and on pencil-pressure. From numerous experiments it would appear possible to make a difference of as much as five per cent. in a locomotive in mid-gear by pencil-friction.

The couclusions, as regarded the motion of the pencil, were that the general effect of inertia and friction were both to increase the size of the diagram; that so long as the speeds were such that the number of vibrations of the pencil during a revolution of the engine was not greater than fifteen, the effect of inertia was less than one per cent., but that, if the number was greater than thirty, oscillations would show themselves unless the pencil-friction was increased. They might, by this, be kept down till the number of vibrations was equal to fifteen, but not farther, and then the necessary friction would affect the area of the diagram about five per cent. For the diagrams to be sensibly accurate, and free from oscillation, the speeds must not be greater than would make the number of vibrations equal to thirty. These speeds were given in the paper for Richards' indicators.

The effect of the inertia of the drum with an elastic cord was shown to be a nearly uniform elongation of the diagram. The result of the varying stiffness of the drum spring was a nearly uniform contraction. With Richards' indicator these two latter disturbances neutralized each other at a speed of 150 revolutions per minute. At other speeds the effects were apparent in the length of the diagram; but, except when the expansion was great and the connecting rod short, they did not affect the indicated pressure. The friction of the drum with an elastic cord caused the cord to be longer during the forward stroke than during the

[1] A Paper read at the Institution of Civil Engineers, May 19, "On the Theory of the Indicator and the Errors in Indicator Diagrams," by Prof. Osborne Reynolds F.R.S.

backward stroke, so that the diagram was distorted and shortened, the drum being uniformly behind its proper position during the forward stroke, and before its position during the backward stroke. This distortion diminished the area of the diagram according to the rate of expansion and the length and elasticity of the cord used. This was definitely expressed by a formula. This disturbance, the influence of which was very great in cases of high expansion, large engines, and ordinary cords, appeared to have been unnoticed. The circumstances on which it depended were the elasticity of the cord and the friction of the drum, and the question was how far these existed in the ordinary indicators. It might be said that the diagrams which led to the discovery of this effect were taken with an indicator which had been in constant use for several years. It was in apparently perfect condition, and the diagrams did not differ essentially from those which had been previously taken. The cord was one which had been supplied by the maker. The manner of the discovery was described: For years the author had pursued in the class the method of testing the vibrations of the indicator pencil by projecting them on to the crank-circle, and he had noticed that the first oscillation fell short, and shorter in the back diagram than in the front. The cause of this was not obvious, and it was partly with a view to determine this cause that Mr. Brightmore's investigation was commenced. A slight error in the reducing rod, which had a fixed centre and a slot in which a stud in the slide-block worked, was altered. This, however, did not get rid of the effect. A new cord was substituted for the old one, and the effect was found to be much enhanced, the new cord being more elastic than the old one. This reduced it to the stretching of the cord, but it was only after carefully working out the effect of the inertia of the drum, and it was seen this was to lengthen the first oscillation at the back end that the friction was examined. The indicator was taken to pieces, cleaned and oiled; then the effect was much reduced. Several new wires and cords were used, and eventually steel wire was adopted as the best. The test supplied by the oscillations could only be applied to diagrams taken at high speeds, and the test furnished by the influence upon area was vague. What was wanted was an independent means of determining the simultaneous positions of the drum and the engine-piston. As the best method of meeting this, it was decided to arrange an electric circuit through the pencil to the drum, with sufficient electromotive force to prick the paper, making the engine-piston close this circuit at eleven definite equidistant points in the motion backwards and forwards. This was successfully carried out, and the stretching of the cord during the backward and forward strokes was definitely ascertained. Taking the smallest results obtained with a cord, it appeared from these experiments that the least difference of stretching was to make this difference in inches 5 per cent. of the length of the cord in feet. Examples of this effect in diminishing the mean indicated pressure were given. Thus, in a locomotive cutting off at one-quarter it was 8 per cent.; in a condensing engine having 3·5 feet stroke, cutting off at one-tenth, 20 per cent.; and the same compounded, 10 per cent.

These would seem to be the smallest results that could have occurred in ordinary practice. The conclusion, however, that hitherto the normal indicated power from engines had been from 10 to 20 per cent. too small must wait for verification. Yet there were not wanting independent evidences of such an effect. In diagrams taken from engines at high speeds the admission line would not but for this effect be vertical. It would show a certain amount of detail, and the first oscillation would not have a sharp top. Moreover, it was commonly found that the expansion line, allowing for clearance, was above the true expansion line for the steam. This apparent rise in the curve of expansion was exactly what would result if the apparent cut-off was too early, and this was the result of the effect that had been considered. The author had tried several diagrams, and found that after correction the expansion line came out very close to the true curve.

In making these comparisons the explanation of another feature of diagrams became apparent. When the two diagrams were traced on the same card, there was sometimes a want of symmetry about them, and in this case the cut-off was shorter on the back than on the front diagram. This the author attributed to the friction of the drum when the cord for the back diagram was longer than that for the front. When this was the case the relative lengths of the cord were about 1 to 1·8. These observations were illustrated in a diagram from "Richards' Indicator." To test this diagram a tracing was taken, and reversed so that the front diagram was superimposed on the back. It was observed that the diagrams were of different lengths, and the difference was about the same as the difference in cut-off; that notwithstanding the apparent cut-off in the back diagram was to that in the front in the ratio of 2 to 3, the expansion line of the back diagram was the same shape as that in the front; and that if the diagrams were restored, supposing the lengths of the cords used to have been 5 feet and 9 feet, the diagrams became exactly similar, and, allowing 2 per cent. clearance, the expansion line came to be the true expansion line for that cut-off. The mean pressure was 14 per cent. larger than from the original diagram.

Such instances as these seemed to sufficiently establish a case against the blind faith which appeared to be at present placed in the accuracy of the indicator diagrams. But, in conclusion, the author stated that he should be very disappointed if anything in this investigation should have the effect of diminishing reliance on the indicator itself. He would have the instrument treated fairly, and instead of being the object of unthinking worship he would have it the object of careful study and experimental investigation, so that the limits of its wonderful perfection might be known exactly, and that reliance placed on it which sprang from knowledge.

THE VISITATION OF THE ROYAL OBSERVATORY, GREENWICH

THE visitation of the Royal Observatory took place on Saturday last, when, in spite of bad weather, there was a numerous attendance. The following extracts (condensed in some cases) from the Report of the Astronomer-Royal to the Board of Visitors indicate the work of the past year. It will be gratifying to all to know that a considerable increase in the optical power of the Observatory is in contemplation.

Transit-Circle.—A reversion-prism made by Messrs. Troughton and Simms has been used since last June in observations with the collimators as well as with the transit-circle to reverse the apparent direction of measurement or of motion, a movement towards the left (as in transits of south stars) being converted into a movement towards the right, or upwards, or downwards, according to the position of the plane of reflection of the reversion-prism. The collimation-observations show no sensible personality depending on the apparent direction of measurement; it has, however, been considered well, in order to eliminate any possible effect of the kind, to take half the measures in each determination of collimation with the direction of movement of the wire reversed as regards right and left. In the transits the practice is to observe on each day two clock-stars and also circumpolar stars with the direction of motion reversed. A comparison of the results from the reversed and ordinary observations of clock-stars shows sensible differences in the case of some observers, who, however, have probably not yet settled down into a definite habit of observing stars which appear to move in the reverse direction.

In order to determine absolute personal equations in the observation of slow-moving as well as of quick-moving stars of various magnitudes (whether the motion be from right to left or the reverse) and of limbs of the sun, moon, or planets, the Astronomer Royal has arranged, in concert with Mr. Simms, a personal equation instrument to be used with the transit-circle. In this instrument, which is on the point of completion, and was seen at work on Saturday, a vertical plate with a circular aperture, 6 inches in diameter, to represent the sun or moon, and several small pinholes, to represent stars of different magnitudes, is placed in the focus of an object-glass of about 7 inches aperture and of about 50 feet focal length (which is attached to the dew-cap of the transit-circle, when horizontal and pointing north), and is carried smoothly by clockwork from east to west or west to east at a rate which may be varied at will from that of a very close circumpolar star to three or four times that of an equatorial star by an ingenious but simple mechanical contrivance devised by Mr. Simms. The apertures in the vertical plate are illuminated by direct sunlight or moonlight reflected by a plane mirror towards the object-glass, and the times of transit of the artificial sun, moon, or stars, which are to be observed over the wires of the transit-circle, are also registered automatically on the chronograph by means of insulated platinum studs, corresponding to the artificial objects, which make contact with other studs, corresponding to the wires in the field of view of the transit-circle.

Since last October transits of the close circumpolar stars have been taken at the middle wire set to successive revolutions of the R.A. micrometer, thus virtually introducing a system of very close equidistant wires for the slow-moving stars. It is thus found that a larger number of separate observations can be obtained in a moderate time, a point of special importance in changeable weather. The equality of successive intervals of the R.A. micrometer-screw was tested last January for each revolution through a range of twelve revolutions, and also for every tenth of the three middle revolutions, and the errors of the screw appear not to exceed the errors of observation. The determination was made by means of the south collimator, the eye-piece of the transit-circle having been turned through 90°. The observations of close circumpolar stars have also been discussed with a view of testing the equality of successive revolutions of the R.A. micrometer screw, the results being very satisfactory. The screws of the micro-scope-micrometers also were examined by means of the south collimator on March 27 and following days, successive intervals being measured for each revolution and third of a revolution from -1^r to 6^r. Though there is evidence of considerable wear in the individual screws, which have been in constant use since 1875, the method of using them (the action of the spring being in opposite directions for the micrometers of each pair) entirely eliminates this effect from the mean, and the resulting errors (which are probably casual errors of observations) do not exceed 0″·05 at any part of the screws.

The subjects of meridian observations in the past year have been as usual the sun, moon, planets, and fundamental stars, with other stars from a working catalogue, which now contains about 2,750 stars. About 380 stars have been lately added to the list from the "Harvard Photometry," with a view of making the forthcoming Greenwich Catalogue of stars down to the sixth magnitude as complete as possible. It is hoped that all of these stars will have been sufficiently observed by the end of 1886, when it is proposed to form a Ten-Year Catalogue, epoch 1882·0. The annual catalogue of stars observed in 1884 contains about 1,370 stars.

The following statement shows the number of observations with the transit-circle made in the twelve months ending 1885, May 20:

Transits, the separate limbs being counted at separate observations	...	5523
Determination of collimation error	...	299
Determinations of level error	...	376
Circle observations	...	5321
Determinations of nadir point, including the number of circle-observations	...	294
Reflection-observations of stars (similarly included)	...	619

The discordance between the nadir observation and the mean of the results from reflection observations of stars north and south of the zenith has recently become very small, the correction deduced for the first four months of the present year being only −0″·07. The mean correction indicated by the observations of 1884 was −0″·36, whilst those of 1883 gave the value −0″·45. The steady increase of this discordance from 1878 to 1883 and its subsequent decrease remained unexplained, no change having been introduced into the method of observation of the nadir point or of stars by reflection during the last two years.

The apparent flexure of the transit-circle, as found by means of the collimators, has again changed sign. From six determinations made on 1884 June 3, Sept. 9, Sept. 29, Oct. 5, Oct. 20, and May 20 (the reversion-prism being used on each occasion except the first) the resulting values (found by four different observers) are −0″·47, + 1″·00, + 0″·03, + 0″·10, and +0″·08, the mean of which is +0″·17, agreeing closely with the value + 0″·13 found by nine accordant determinations in the period 1879 to 1882, whilst the mean of five determinations by three different observers in 1883 gave the value − 0″·49. No correction for flexure (as distinct from the R − D correction) has been applied to the observations since 1879.

The correction for R − D, the error of assumed colatitude, and the position of the ecliptic, have been investigated for 1884. The computation of the geocentric and heliocentric errors for the planetary results is not yet complete.

The correction for discordance between reflection and direct observations of stars, deduced from observations in 1884 which extend from Z.D. 69° north to Z.D. 70° south is − 0″·02 + 0″·66 sin Z.D. The assumed formula $a + b \sin z$ represents the observations of 1884 satisfactorily throughout the whole range of zenith distance.

The value found for the colatitude from the observations of 1884 is 38°. 31′. 21″·91, differing only by 0″·01 from the assumed value; the correction to the tabular obliquity of the ecliptic is + 0″·57; and the discordance between the results from the summer and winter solstices is − 0″·99.

The mean error of the moon's tabular place (computed from Hansen's Lunar Tables with Prof. Newcomb's corrections) is +0s·02 in R.A. and + 0″·29 in longitude as deduced from 104 meridian observations in 1884.

Altazimuth.—The observations with this instrument have been restricted to the period from last quarter to first quarter in each lunation, the total number of observations of various kinds made in the 12 months ending 1885 May 20 being as follows:—

Azimuths of the moon and stars	321
Azimuths of the azimuth-mark	181
Azimuths of the collimating-mark	192
Zenith-distances of the moon	178
Zenith-distances of the collimating-mark	196

Since last December a "reversion prism" has been used to reverse the apparent direction of motion in the observation with lamp right and in that with lamp left on alternate nights.

Clocks.—On Jan. 1 the public clock at the Observatory entrance and the other mean solar clocks were put forward 12 hours so as to show Greenwich civil time, starting at midnight and reckoning from 0h. to 24h., which would correspond with the universal time recommended by the Washington Conference. The change from astronomical to civil reckoning has also been made in all the internal work of the Observatory, and has been carried out without any difficulty. Greenwich civil time is found to be more convenient on the whole for the purposes of this Observatory, but its introduction into the printed astronomical observations has been deferred to allow time for a general agreement amongst astronomers to be arrived at. It is proposed, however, to adopt the civil day without further delay in the printed magnetical results, thus reverting to the practice previous to 1848, and making the time-reckoning harmonise with that used in the meteorological results, the reckoning from 0h. to 24h. being for the future adopted in both cases.

Reflex Zenith Tube.—The observations of γ Draconis for determination of the temperature correction have been continued, and about 45 transits over the 30 wires have been observed at temperatures ranging from 46° to 72°. Seven transits of 9 Aurigæ were also observed last February at low temperatures ranging from 42° to 56°.

Equatorials.—The work on the Lassell equatoreal has occupied a great deal of attention during the past year, a number of repairs and alterations having been required in order to get the instrument into proper working order. The driving clock, which was found to drive the instrument at only three-fifths of the proper speed, has been altered, a slow motion in R.A. (to be worked from the observing stage) has been contrived, a new slide of improved construction has been made for gearing the driving-screw into the hour-circle, the teeth of the hour-circle have been re-cut, a firm declination clamp has been applied, an improved edge suspension for the large mirror (consisting of a steel band which encircles the mirror and is supported by brackets at six equidistant points of the circumference) has been contrived, a new and firmer mounting of the small mirror has been made, and the eye-piece has been mounted firmly on a plate which allows it to be tilted in any direction, for optical adjustment. The framed iron base which supports the instrument has been bricked up and filled with concrete, and this, with the other alterations, has greatly increased the stability of the telescope, which is now quite satisfactory. Difficulty is, however, still experienced from want of stability of the optical axis of the large mirror, which requires to be readjusted continually, as the telescope is moved. When the mirrors have been properly adjusted the definition appears to be very good, the companion to Vega being shown with remarkable distinctness without any trace of scattered light from the large star.

The south-east and Sheepshanks equatorials are in good order, as also is the Simms' six-inch equatorial mounted in the south ground.

With one or more of these equatorials, or with the altazimuth, 30 occultations of stars by the moon (19 disappearances and 11 reappearances, including 7 disappearances and 9 reappearances during the lunar eclipse of October 4), and 57 phenomena of

Jupiter's satellites, have been observed in the twelve months ending 1885 May 20, and the observations have all been completely reduced to the end of 1884. Comet (*c*) 1884 has been observed on four nights, the Lassell reflector or one of the other equatoreals being employed, and some measures of distances and position-angle of double stars, as well as a large number of observations for determining the value of 1rev. of the screw in different parts of the field of view have been made with the Airy double-image micrometer mounted on the Sheepshanks' or Simms' equatorial.

Micrometer measures of some of the satellites of Saturn (including Enceladus) were made on seven nights with the Lassell equatorial.

Spectroscopic and Photographic Observations.—The solar prominences have been observed with the half-prism spectroscope on only two days, the photographic reductions having pressed very severely on the spectroscopic assistant during the long continued maximum of sun-spots.

For the determination of motions of stars in the line of sight, 569 measures have been made of the displacement of the F line in the spectra of 47 stars, and 72 measures of the *b* lines in 14 stars, besides measures of the displacements of the *b* and F lines in the spectra of the east and west limbs of Jupiter, and of the east and west ansæ of the rings of Saturn, and comparisons with lines in the spectrum of the moon, or of the sky, made in the course of each night's observations of star-motions, or on the following morning, as a check on the general accuracy of the results for star-motions. The observations of the last twelve months confirm the change in the motion of Sirius, which now appears to be approaching the sun at the rate of about 20 miles a second. As there is great difficulty in the use of a pointer or cross-wires for measuring both the broad dark line in the star's spectrum and the narrow bright comparison line, Mr. Maunder has suggested the use of a reversion spectroscope (on the double-image principle) for these observations, and Prof. Pritchard has kindly lent the reversion spectroscope of the Oxford University Observatory, in order that the suitability of that form of instrument may be tested. The spectroscopic observations of all kinds are completely reduced to the present time.

In the twelve months ending 1885 May 20 photographs of the sun have been taken on 173 days, and of these 431 have been selected for preservation, the record being not so complete as usual, owing partly to the loss of several days during the adjustment of the instrument after the adaptation of the secondary magnifier, and partly to a failure of the supply of dry plates in July last during the absence of Mr. Maunder. There were only two days on which the sun's disk was observed to be free from spots.

The mean spotted area of the sun was slightly less in 1884 than in 1883 and slightly greater than in 1882, whilst the faculæ in 1884 showed a slight increase as compared with 1883, and a slight falling off as compared with 1882. It would seem that the maximum both of sun-spots and faculæ occurred about the end of 1883 or beginning of 1884.

For the year 1884 Greenwich photographs are available for measurement on 152 days, and Indian photographs filling up the gaps in the series on 159 days, making a total of 311 days out of 366 on which photographs have been measured. In 1883 the total number of days was 340, viz., Greenwich series 215 days, supplemented by Indian photographs received from the Solar Physics Committee on 125 days.

Magnetic Instruments.—The following are the principal results for magnetic elements for 1884:—

Approximate mean westerly declination	... ...	18°.8'.
Mean horizontal force	...	3·931 (in English units). 1·812 (in Metric units.)
Mean dip	... ...	67° 29' 8" (by 9-inch needles). 67 29 32 (by 6-inch needles). 67 30 9 (by 3-inch needles).

In the year 1884 there were only five days of great magnetic disturbance, but there were also about 20 days of lesser disturbance for which it appears desirable to publish tracings of the photographic curves. It may be interesting to add the tracings for a few quiet and nearly quiet days in order to exhibit the characteristics of the ordinary diurnal movement.

Commencing with 1883 the magnetic diurnal inequalities of declination, horizontal force, and vertical force have been discussed by the method of harmonic analysis, the harmonic expressions for these inequalities being obtained for each month and for the year with arguments expressed in apparent solar time as well as in mean solar time.

Meteorological Observations.—The mean temperature of the year 1884 was 50°·7, being 1°·4 higher than the average of the last 43 years. The highest air temperature (in the shade) was 94°·1 on Aug. 11, and the lowest 24°·5 on Nov. 25. The mean monthly temperature was above the average excepting in the months of April, June, Oct. and Nov.

The mean daily motion of the air in 1884 was 286 miles, being 3 miles greater than the average of the last 17 years. The greatest daily motion was 891 miles on Jan. 23, and the least 78 miles on Feb. 8. The only recorded pressure exceeding 20 lbs. on the square foot in 1884 was 22·7 lbs. on Jan. 23, after which the connecting chain of the pressure plate broke, as mentioned in the last report. It is probable that greater pressures occurred afterwards on the same day, and also in the gale of Jan. 26, at which date the chain had not been renewed.

During the year 1884 Osler's anemometer showed an excess of about 25 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 1884 was 1115, which is about 100 hours less than the average of the seven preceding years. The aggregate number of hours during which the sun was above the horizon was 4465, so that the mean proportion of sunshine for the year was 0·250, constant suushine being represented by 1.

The rainfall in 1884 was 18·0 inches, being about 7 inches below the average of the last 40 years.

Chronometers and Time Signals.—The number of chronometers now being tested at the Observatory is 151, and of these 103 (79 box-chronometers, 13 pocket-chronometers, and 11 deck-watches) belong to the Navy, 40 are placed here for the annual competitive trial, and 8 are on trial for purchase by the Austrian Government.

The first six chronometers in the competitive trial of 1884 were rather above the average of the last ten years as inferred from the trial numbers. As much difficulty is experienced in maintaining the chronometer oven at a nearly constant temperature, an apparatus has been procured from Mr. Kullberg which is designed to effect this automatically, by the action of a compensation-bar, which, as the temperature rises, gradually closes a small hole through which the supply of gas to the gas burners passes. The apparatus has not yet been brought into use, as the chronometer oven has been constantly required for testing chronometers since it has been received.

The automatic drop of the Greenwich time-ball failed on 6 days through the clock-train stopping. The ball was not raised on 3 days on account of the violence of the wind.

As regards the Deal time-ball, which is now dropped by current passing through the chronopher of the Post Office telegraphs, there have been fourteen cases of failure owing to interruption of the telegraphic connections, and on one day the current was too weak to release the trigger without the assistance of the attendant.

In connection with the establishment of hourly time signals at the Start or Lizard, which was long advocated by Sir G. B. Airy, I have received from the Committee of Lloyds', in answer to my inquiry, an assurance that that corporation would be willing to undertake the maintenance of hourly time-signals at any of their signal-stations, provided the Government would supply the necessary apparatus. After consultation with Capt. Wharton, it has been thought better that, before taking further steps, some preliminary trials should be made of a collapsible cone as an hourly time-signal, facilities for doing which exist at Devonport. As regards ball-drop or other time-signal, I would propose that it should be made automatically by a local clock, to be corrected daily by the help of a time-signal from Greenwich at 10 a.m., which should automatically start an auxiliary seconds pendulum, suspended freely just behind the clock pendulum. The attendant would then accelerate or retard his clock pendulum (by electro-magnetic action as in the Greenwich mean solar clock) so as to make it pass through the middle of its vibration at the same time and in the same direction as the auxiliary pendulum, and thus to indicate accurately Greenwich mean time. A return signal to Greenwich sent by

the local clock at the next hour (11 A.M.) would show that this clock had been properly corrected, and would be a guarantee for the general accuracy of the time-signals. Preliminary trials have shown that the observation of coincidence of vibration of two pendulums can be made with great certainty, and Messrs. E. Dent and Co. are now arranging for the mounting of an auxiliary pendulum on one of the transit of Venus clocks, and for adapting it to give hourly time-signals.

The errors of the Westminster clock have been under 1s. on 50 per cent. of the days of observation, between 1s. and 2s. on 29 per cent., between 2s. and 3s. on 10 per cent., between 3s. and 4s. on 7 per cent., and over 4s. on 4 per cent.

During the past year the Observatory has lost the valuable services of Mr. Dunkin, who retired on August 25, after an honourable service of forty-six years, which has been throughout characterised by remarkable zeal and ability, and has contributed largely to maintain the credit of the Observatory. Mr. Dunkin has been succeeded in the post of Chief Assistant by Mr. H. H. Turner, B.A., of Trinity College, Cambridge.

The report concludes as follows:—

During the past year the various classes of work carried on in this Observatory have been somewhat extended. The meridian observations are more numerous than usual, and various subsidiary investigations involving considerable labour have been undertaken with a view to increase their accuracy. A large number of spectroscopic determinations of star-motions have been obtained, and the long continued maximum of sun-spots has made the photographic measurements and computations much heavier than in any previous year. Extensions have also been made in the magnetic and meteorological branch, which appeared very desirable, but which have pressed rather severely on Mr. Ellis and his staff.

Turning to the future, I wish to invite the attention of the visitors to the circumstance that an increase in our optical means is required to enable us to carry out satisfactorily the determinations of proper motions of stars in the line of sight with the spectroscope, a work which peculiarly belongs to this Observatory, as supplementing the determinations of proper motions from meridian observations.

The aperture of our largest refractor (12¾ inches) is too small to allow of our observing successfully with the spectroscope any but the brightest stars, and though the Lassell reflector is somewhat more powerful, its mounting and clock-work are not adapted to carry a heavy spectroscope with the necessary steadiness and accuracy of motion. The firmness of the mounting of the south-east equatorial and the perfection of its clock-work would make it peculiarly suitable for this class of work if it carried a much larger object-glass.

After careful consideration of the conditions I have satisfied myself that an object-glass of 28 inches aperture and of 28 feet focal length could be mounted on the south-east equatorial, in place of the present object-glass of less than half that aperture; and I have ascertained that Mr. Grubb would be prepared to undertake the construction of such an object-glass with a tube suited to the special requirements of the case, so that the telescope would be equally available for eye-observation or for use with the spectroscope. With Mr. Grubb's assistance, I have prepared a model showing how this may be arranged.

While a large refractor is required specially for spectroscopic observations, it seems desirable also on other grounds that this Observatory should possess an equatorially mounted telescope comparable with those of other first-class observatories, so that we may no longer be prevented by deficient optical means from obtaining complete series of observations of comets and faint satellites.

VIVISECTION

A RETURN has been issued by the Home Office containing the reports of inspectors showing the number of experiments performed on living animals during the year 1884 under licences granted according to the Act 39 and 40 Victoria, c. 77, distinguishing painless from painful experiments.

The former of the two reports deals with England and Scotland, the latter with Ireland. They are as follows:—

"(1) The names of the 49 persons who held licences during any part of the year are given in the subjoined tables, in one of which are entered the names of those licensees who performed any experiments, 34 in number; and, in the other, the names of those who performed none.

"(2) The total number of experiments of all kinds performed during the year was about 441.

"Of these, 140 were done under the restrictions of the licence alone, 78 under the same restrictions, but under certificates in column 1 (lecture illustrations); 145 under certificates in column 2; 76 under those in column 3; and 2 under a certificate in column 4.

"(3) With regard to the infliction of pain, as in all the experiments, except those under special certificates in columns 2, 3, and 4, the animals are rendered insensible during the whole of the experiment, and are not allowed to recover consciousness, no appreciable suffering would be caused if the provisions of the Act are faithfully carried out, as there is not the least reason to doubt they were.

"With respect to experiments under certificates in columns 2, 3, and 4, which dispense either wholly or partially with the use of anæsthetics, it should be stated:—

"(*a*) That of the 145 experiments performed under certificates in column 2, 99 consisted in simple inoculation with a morbid virus, in which no operation beyond the prick of a needle was required, and for which the administration of an anæsthetic would only have entailed needless annoyance and distress to the animal. In these experiments any appreciable suffering would be felt only in those cases in which the inoculation took effect, involving about the same amount of pain as ensues on ordinary vaccination, before the brief period the animals were allowed to survive. Of such cases, according to the returns I have received, about 16 occurred. Of the remaining 46 experiments under these certificates, 24 were performed for the purpose of medico-legal inquiries in cases of suspected poisoning, resulting in the death by tetanus of three frogs and six mice, which survived, however, only a few minutes; to other cases under the same head were experiments on the infection of fish with a species of fungus, very destructive in certain rivers and streams; and five on the effects of immersion of fish in distilled water, which proved fatal to about thirty minnows and sticklebacks. In none of these cases could it be said that any appreciable suffering was inflicted. In seven cases, in which salts of ammonia were hypodermically injected, two are returned as having suffered pain, but of a very trifling character.

"(*b*) Of the 76 experiments under certificates in column 3, 47 required a simple operation, but this being done under anæsthesia, was unfelt, and the after-effects, though in many of the cases resulting in partial paralysis, are reported as having been unattended with actual pain in any case. The remaining 29 were by simple inoculation, and none were attended with pain.

"(4) In conclusion, therefore, it may be stated that the amount of direct or indirect actual suffering, as the result of physiological and therapeutical experiments performed in England and Scotland, under the Act in the year 1884, was wholly insignificant. "GEORGE BUSK, Inspector

"The Right Hon. the Secretary of State."

"16, Harcourt Street, Dublin, May 17

"SIR,—In accordance with your instructions I beg to submit the following table, showing the licences in force in Ireland during the year 1884 under the Act 39 and 40 Vict., c. 77. No certificate has been allowed during the year.

"Several of the licences in force during the previous year have expired, and renewals have not been sought for.

"Under the licences in force thirteen experiments have been made; they were all painless. I am of opinion that the experiments in question were useful ones; eleven of them were intended to elucidate the actions of drugs, and the remaining two to assist the investigation of certain circulatory phenomena which have a bearing upon the treatment of disease.

"I have, &c.,

"W. THORNLEY STOKER

"To the Right Hon. the Chief Secretary for Ireland."

In each case the report is followed by a list of all persons who hold such licences, the places where they are permitted to make experiments, and the nature of the certificate held.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—The Annual Report of the Museums and Lecture-Rooms Syndicate, recently published, contains the

reports of all the professors, lecturers, and heads of departments connected with natural science.

Prof. Thomson (Cavendish Professor of Physics) reports that during the Lent term ninety students attended the demonstrations, and there were ten persons doing original work in the laboratory. Lord Rayleigh states that during the last five years about 2500*l.* has been spent on the Cavendish Laboratory in addition to the University expenditure. This has come partly from fees, partly from the apparatus fund raised by subscription.

The Chemical Laboratory has been much over-crowded and improvements are scarcely possible until the new laboratory has been completed.

The register of the mineralogical collections is completed. The number of students increases; fifteen attended Mr. Solly's demonstrations in the Michaelmas term and nineteen in the Lent term.

The department of mechanism has continued to grow rapidly. During the year two new woorkrooms and a new foundry have been added and have met the most urgent requirements. Upwards of 1000*l.* worth of new machinery has been added at Prof. Stuart's expense during the last two years to meet immediate wants; and during that time the pupils have doubled in number. The lecture-rooms have become over-crowded, and new ones are much wanted. Prof. Stuart urges that the University should now purchase the machinery and apparatus used in teaching, which is his property. The undertaking is now wholly self-supporting, paying interest on the capital involved, and providing an adequate sinking fund.

The classes of practical morphology and elementary biology are now much better accommodated in the new rooms. One hundred Zeiss's microscopes have been purchased. The Balfour library has been enlarged, and proves of great value to students. Seven demonstrators have been fully occupied in the classes, in addition to two ladies who have superintended the women students. In the May Term, 1884, in which two years of students were combined, 206 men and 12 women went through the course of elementary biology. In the Lent term of 1885, 128 men and 7 women attended. In Elementary Morphology there were 68 students in last October term, and 87 in the recent Lent term.

Prof. Macalister has utilised the services of seven assistant Demonstrators, in addition to Mr. Hill, whose labour has been unremitting. Subjects for dissection have been secured from a wide area. Prof. Macalister has presented a series of models of the viscera of the body showing their proper relative positions, casts of frozen sections, 26 crania, and 160 specimens of bones showing peculiarities. No department of University work is so badly housed as the Department of Anatomy; but much good work is done in the limited space.

In the Museum of Comparative Anatomy and Zoology 72 additional species from Dr. Dohrn's collection have been remounted and displayed. An extensive collection of marine invertebrata from the New England coast has been forwarded from the National Museum at Washington, through the kind offices of Prof. Baird. The work of the Curator in Invertebrate Zoology has been principally expended upon the MacAndrew collection of shells. Mr. Cooke has published two extensive papers, and progressed with the rectification of the nomenclature and the catalogue.

A fine adult Echidna from New Guinea has been presented by Dr. Guillemard. Both skin and skeleton have been mounted. A complete skeleton of the red deer in a sub-fossil state has been procured from Burwell Fen by Mr. W. Stubbings, Assistant in the Museum; a complete skeleton of an African elephant, shot by Mr. W. Heape near Port Elizabeth, has been presented. Many other interesting acquisitions are named in the report.

Dr. H. Gadow, the Strickland Curator, has been forming a manuscript catalogue of the skins of birds in the Museum. An exhibited series of specimens is being placed systematically, with the important anatomical parts, nests and eggs, in an educational series. Twenty maps have been placed in the cases to illustrate the geographical distribution of birds. The University collection now consists of 9653 specimens of 3290 species. The Strickland collection, in addition, contains 600 specimens of 3125 species; and, with Mr. E. Newton's collection, there are in all 17,000 specimens, representing probably 4500 species.

Prof. Foster reports that the number of students of elementary physiology has risen from 77 in the Easter term, 1884, to 141 in the recent Lent term, exclusive of women students. Twenty-eight have attended advanced lectures also. Several important additions, such as a gas-engine, a centrifugal machine, recording and other apparatus, have been made to the Laboratory, by the aid of a gift of 500*l.* by an anonymous donor. The inadequacy of accommodation, both for practical work and for lecturing, is severely felt.

Prof. Ray has been successful in organising extended practical courses, as well as systematic lectures. The *post-mortem* examinations at Addenbrooke's Hospital have been placed under his superintendence. At present the only laboratory space available is obtained by encroaching on Dr. Foster's already overcrowded rooms.

Prof. Babington reports that the arrangement of the general Herbarium is now complete. The plants have been placed in orders and genera, according to Bentham and Hooker. The arrangement of species has not as yet been attempted. Mr. Potter and Mr. Gardiner have commenced the formation of a small Botanical Museum similar to that of Comparative Anatomy. Mr. Vines finds the new rooms very suitable both for class purposes and for research. Last term there were 29 advanced and 30 elementary students working in the laboratory.

The Geological Museum has acquired a fine collection of fossils from the Oolites of Dorset, chiefly by the liberality of Prof. Henry Sidgwick. Messrs. Roberts and Small brought useful additions from the Jura. Mr. Marr has added largely to the Cambrian and Silurian series. Mr. Keeping has collected and restored many specimens from Pliocene and Pleiostocene deposits. Mr. J. Robarts has worked most energetically as Prof. Hughes' assistant, in the museum, in teaching and collecting. Work is much hindered by the want of a lecture room and class-room.

Mr. Walter Gardiner, whose original work in vegetable histology is so well known, has been elected to a Fellowship at Clare College.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, May 6.—"On charging Secondary Batteries," by William Henry Preece, F.R.S.

Mr. Preece said he had for some months past been experimenting with secondary batteries with a view of getting an efficient, uniform, and constant source of current for electric lighting his house. The cells are of the Planté type, manufactured by the Elwell Parker Company of Wolverhampton. Each cell contains fourteen plates of plain sheet lead 17" × 11", which are suspended in well-insulated wood boxes filled with diluted sulphuric acid in the proportion of about 1 to 19. These plates are grouped in two groups of seven, each group being soldered to a lead strip, forming alternately the positive and negative poles of the cell. The plates of the respective poles are prevented from touching each other by ebonite grids or separators introduced by Mr. Charles Moseley to prevent short-circuiting through the buckling of the plates. Each plate offers a surface of 1·3 square feet, so that the total surface of lead of each group opposed to each other is 9·1 square feet; that is, 9·1 square feet of peroxidised lead is opposed to 9·1 square feet of spongy lead. Mr. Preece employs 24 of such cells. The charging current varies from 3 to 3½ amperes per square foot, while the current of discharge used in lighting his house varies from 1 to 1½ ampere per square foot. The total weight of each cell is 120 lbs. The plates are prepared by the Parker-Planté process before insertion in the cell, those forming the positive pole being well peroxidised, while those forming the negative pole are well coated with spongy lead. This process consists in immersing for a few hours the lead plates in a solution of nitric and sulphuric acids in the proportions—

Nitric acid	1
Sulphuric acid	2
Water	17

before fixing in the cells. This not only chemically cleans the lead surfaces, but it favours the formation of sulphate of lead in such a way as to be readily converted into lead peroxide and spongy lead on the passage of a strong current through the cells. The formation of the cells is thus expedited. They are thus, when put together, prepared at once to be charged. If they are not at once charged, local action sets in, and lead sulphate is injuriously formed.

A hydrometer, having a scale graduated from 1·050 to 1·150,

is used to indicate the density of the liquid while the cells are being charged and discharged. Mr. Preece puts into his battery a charge of about 120 ampere-hours twice a week. Hourly measurements of E.M.F. current and density of liquid have enabled him to know the condition of his battery at any period of charge or discharge. These measurements have been plotted out into curves, the ordinates showing volts, amperes, and specific gravity, and the abscissæ hourly observations. When each magnitude reaches its constant, bubbles of gas are freely given forth and energy is being wasted. The variation of the electromotive force and current strength is clearly due to the counter-electromotive force of the cells, which becomes a maximum only when the plates are fully formed. The counter-electromotive force partakes of the character of a higher resistance opposing the charging current, and increasing the proportion of the current through the shunt of the dynamo. Hence the changes of electromotive force are more marked than those of the current. Indeed, the changes in the electromotive force, as given by the voltmeter, are sufficient alone to indicate the progress and completion of the charge. They are more reliable than the evolution of gas.

The electrical leakage of Mr. Preece's cells is obviated by standing each cell on three porcelain supports, having cups half filled with resin oil on Messrs. Johnson and Phillip's plan.

Mr. Preece gives the E.M.F. of the battery at its terminals as—

When charging	2·25 per cell
When idle...	2·05 ,,
When discharging	1·90 ,,

and the internal resistance per cell as—

When charging	·0060 ohm
When discharging	·0017 ,,

But the latter is said to vary very markedly within the strength of current of discharge. This is shown by the following experiment, made with 23 cells of a smaller type than those described above, which are used in the Post Office :—

Current of discharge in amperes	Internal resistence in ohms
4·39	0·7608
7·25	0·4607
15·84	0·2816
25·07	0·1969

Thinking that this remarkable diminution of internal resistance might be due to the evolution of heat, Mr. Preece measured the temperature with a delicate thermometer.

Normal temperature of cell 12½° C. current of discharge :—

5 amperes	No alteration of temperature perceived
10 ,, ...	An exceedingly slight change
16 ,, ...	About 12¾°
20 ,, ...	Barely 13°

The current in each case was kept on for twenty minutes, hence the diminution, Mr. Preece says, is not due to heat.

Since the internal resistance varies in this way Mr. Preece now always takes the internal resistance with the same current, viz., 10 amperes.

The author of this paper asserts that the capacity of these batteries certainly improves with age, and up to the present time he has seen no sign of decay or deterioration.

M. Planté informed him that, though in course of time the peroxidised plate becomes very brittle, it is impossible to peroxidise it completely through ; there always remains a metallic core to give it strength. Mr. Preece finds that this is so. Up to the present moment he has made no careful measurements of the efficiency of his battery. He puts in about 240, and takes out about 200 ampere-hours weekly, and does not observe any change or fall in the electromotive force. When the electromotive force of these cells falls, it falls rapidly, indeed almost suddenly. Occasionally one plate of a group becomes inactive from undue local action, or from bad connection (shown by the colour). This plate is removed and put in a "hospital" cell, where it is brought into order either by a greater density of current or by reversal.

Reversing has a great beneficial action on a cell ; it not only improves its capacity, but it removes any cause of irregular working. It is advisable to do this periodically. Mr. Preece has two extra cells, which enables him to have two cells always under reversal by means of the charging current. It takes from 1,000 to 1,200 ampere-hours to reverse a cell, so that at this time of year it takes a month or more to complete the operation, and it will take a year to reverse the whole battery. Sixteen cells have been reversed during the past twelve months.

Chemical Society, May 21.—Dr. Hugo Müller, F.R.S., President, in the chair.—Messrs. E. G. Amphlett and E. G. Hogg were formally admitted fellows of the Society.—The following papers were read :—A colorimetric method for determining small quantities of iron, by Andrew Thomson, M.A. —On some sulphur compounds of calcium, by V. H. Veley. —Spectroscopic observations on dissolved cobaltous chloride, by Dr. W. J. Russell, F.R.S. The characteristic absorption-spectrum given by cobaltous chloride after dissolution in such media as pure and dry potassium chloride, sodium chloride, calcium chloride, alcohol, glacial acetic acid and in chlorhydric acid, is seen also in an aqueous solution. Hydrated cobaltous chloride gives an entirely different spectrum. If a somewhat faint indication of the spectrum of the chloride be taken as a standard, it is found possible to determine with tolerable accuracy when the amount of anhydrous chloride in solutions of varying strength and temperature is identical with that in the standard solution. A solution containing 4·18 grams of cobalt chloride in 10 c.c. of water at 0° C., when observed through a thickness of 7 mm., forms a convenient standard. If to 10 cc. of such a solution 2·9 cc. of water be added, then on raising the temperature to 33° an amount of anhydrous chloride is re-formed identical with that existing in the standard solution at 0° : this rise of temperature exactly counteracts the effect of adding 2·9 cc. of water. A series of determinations were made in this manner, and it was found that the number of c.c. of water added to the 10 cc. of standard being as given in the upper line, the temperature at which the spectrum appeared was as given in the lower line in the table :—

2·1		2·9		4·3		7·4		8·9	
26°		33°		43°		55°		63°	
	10·3		12·1		15·0		16·0		
	70°		75°		87°		95°		

Again, taking the most dilute solution, in which 16 cc. of water had been added to 10 c.c. of the standard solution, it was found that the same change was effected—*i.e.* that the chloride spectrum could be developed in it, by the addition to the solution of either 0·864 gram of hydrogen chloride gas, or 5·26 of sulphuric acid, or 2·47 of calcium chloride ; but that the addition of sodium chloride would not develop the bands, although on heating the solution after saturating it with this salt a temperature of 34·5° was sufficient, instead of 95°, to develop the bands. Zinc chloride was found to act in a different manner. Notwithstanding its power of combining with water, on adding it to the cobalt solution no banded spectrum shows itself, and even when added to a solution in which the spectrum is visible it causes its disappearance. The explanation is that it must have combined with cobalt chloride, forming a new and stable compound. On evaporating the solution this was found to be the case, and a new salt, a compound of cobalt and zinc, crystallised out. Cobalt bromide, both as a solid and in solution, gives a spectrum very similar to that given by the chloride, but the corresponding bands are nearer the red end of the spectrum. The salt is far more soluble in water than the chloride, and has a stronger affinity for water, as is shown by the much higher temperature required to neutralise the power with which water combines with it. The following determinations similar to those made with the chloride show the increase of temperature necessary to counteract the combining power of giving quantities of water with cobalt bromide :—

Standard	+ Water	Temp. 0° C.
10 c.c.		
10 ,,	+ 3·0	51
10 ,,	+ 4·3	57
10 ,,	+ 7·4	91

—The sulphides of titanium, by Prof. T. E. Thorpe, F.R.S.—Note on the formation of titanous chloride, by Prof. T. E. Thorpe, F.R.S.

Zoological Society, June 2.—Prof. W. H. Flower, V.P.R.S., President in the chair. Mr. Sclater exhibited drawings of and made remarks upon the specimens of various species

of Coly living in the Society's Collection. Mr. Beddard, on behalf of himself and Mr. Treves, read a paper on the anatomy of the Sondaic Rhinoceros (*Rhinoceros sondaicus*) which had died in the Society's Gardens in January last. A communication was read from Dr. Julius von Haast, F.R.S., C.M.Z.S., on *Megalapteryx hectori*, an extinct gigantic representative of the *Apteryx*, of which the remains had recently been discovered in New Zealand. Dr. Guillemard, F.Z.S., read the fourth and fifth parts of his report on the collection of birds formed during the voyage of the yacht *Marchesa*. The present communications treated of the birds collected at Celebes and on the Molucca Islands. Mr. J. Bland Sutton, F.Z.S., read a paper on the development and morphology of the human sphenoid bone, in which he attempted to show that the basi-temporals of the bird are not homologous with the *lingulæ sphenoidales*, but with the so-called pterygoid bones of the crocodile, and that the human *lingulæ* are homologous with the sphenotic of the bird. —Mr. Edgar A. Smith, F.Z.S., read a report on a collection of shells, chiefly land and fresh water, obtained by Mr. H. B. Guppy, R.N., Surgeon H.M.S. *Lark*, during a recent visit to Solomon Islands.

PARIS

Academy of Sciences, June 2.—M. Bouley, President, in the chair.—Human locomotion: stereoscopic images of the trajectories described in space by a point of the body while walking, running, or otherwise moving (two illustrations), by M. Marey.—Remarks on the "Registres d'expérience," a collection of sixty-nine volumes in MSS. by Henry Victor Regnault, dealing with a great variety of questions in chemistry, physics, thermodynamics, hygrometry, &c., presented to the Academy by M. Reiset.—On the treatment of nervo-pulmonary asthma and cardiac asthma by inhaling certain vapours all containing a special substance known as pyridine (C_5H_5N), by M. Germain Sée.—Account of a species of anæsthesia unattended by sleep, and with the perfect preservation of the intellect, the voluntary movements, the senses and sensibility to the touch, by M. Brown-Séquard. From numerous experiments made on the dog, monkey, and man, the author shows that, under the influence of an irritation set up in the laryngeal mucous membrane, sensibility to pain may disappear or be diminished for many hours without the least disturbance of the mental faculties, the senses, or the voluntary movements in man and animals.—Remarks on M. Lucien Biart's work on "The Aztecs, their History, Manners, and Customs," presented to the Academy by M. de Quatrefages. It was stated by the Secretary that this volume forms one of a series entitled "The Ethnological Library," to be edited by MM. de Quatrefages and Hamy, and to comprise, besides a general history of the races of mankind, a number of monographs devoted to the detailed study of the various branches of the human family.—Observations of the solar spots, faculæ, and protuberances made at the Observatory of the Roman College during the first quarter of the year 1885, by M. Tacchini. Compared with the corresponding period of the previous year the spots appear to have been more numerous, but of relatively smaller size, while little difference was observed in the recurrence of the faculæ. The same peculiarity was again noted of a maximum of faculæ coinciding with a minimum of spots.—Remarks on the physical appearances of the planet Uranus in the months of March, April, and May of the present year, by Père Lamey.—On a method of measuring the magnetic rotatory force of solid, fluid, and gaseous bodies in absolute unities, by M. Henri Becquerel. The numbers determined in various ways by other observers correspond very closely with that of the author as shown by the subjoined table:—

Gordon	0'·0433
Lord Rayleigh	0'·0430
L. Arons	0'·0439
Becquerel	0'·04341

—An optical method for the absolute measurement of short distances, by M. Macé de Lépinay.—On the spectrum of bodies in "radiant matter," in which many substances emit a phosphorescent light, by M. W. Crookes.—On the velocity with which prismatic sulphur is transformed to octahedric sulphur, by M. D. Gernez.—On the presence of sulphurous acid in the atmosphere of towns, by M. G. Witz. From the analysis of the ozone made at Montsouris and elsewhere the author finds that sulphurous acid exists in the air of towns where coal is consumed, its presence causing a considerable diminution of atmospheric ozone, accompanied by the formation of sulphuric acid; further, that by the slow but continuous action of sulphurous acid, and under the influence of the frequent changes in the degree of humidity, the peroxide of red lead used in colouring certain placards, is destroyed and sulphated. At the same time the protoxide of lead thus liberated is transformed to an insoluble sulphite. This salt being easily analysed, a new and certain means is thus obtained for determining the condition of the atmosphere in large cities.—The arsenic present in the soil of cemeteries considered from the toxicological standpoint, by MM. Schlagdenhauffen and Garnier.—Classification and anatomy of the Tectibranchea, a family of mollusks abounding in the Bay of Marseilles, by M. A. Vayssière. Of this family twenty-two species are grouped under the sub-order Cephalaspidea, six under Anaspidea, and nine under Notaspidea. All belong to the order of Opistobranchea, the exceptions indicated by Hering being based on erroneous data.—On the spores and reproductive processes in *Sphærocarpus terrestris*, *Targionia hypophylla*, and other plants of the same order, by M. Leclerc du Sablon.—On the problem of repetitions and symmetry in the mineral kingdom (one illustration), by M. P. Curie.—On an apparatus adapted for the comparative study of opaque minerals, which cannot be easily examined under the microscope, by M. A. Inostrauzeff.—On a unique specimen of hydrous silex belonging to the quaternary formation of the Loing Valley, department of Seine-et-Marne, by M. Stan. Meunier.—On the upper Miocene formations of the Cerdagne district, a lacustrine basin on the southern slope of the Eastern Pyrenees, by MM. L. Rérolle and Ch. Depéret.—Description of a self-registering calorimeter adapted for recording the temperature of the human body, three illustrations, by M. A. d'Arsonval.—On electric alcoholic fermentation, by M. Em. Bourquelot. From his experiments the author finds that this fermentation, as originally determined by Dubrunfant, may be modified by the temperature, by dilution, and by the alcohol formed during the fermentation itself.—On the uniformity of the process of spermatogenesis in the order of mammals, by M. Laulanié.—Action of cocaïne on the invertebrate animals, by M. Richard.—A contribution to the study of antiseptics: action of the antiseptics on the higher organisms, iodide and chloride of mercury, by MM. A. Mairet, Pilatte, and Combemal.—Influence of the lunar declinations on the displacement of the atmospheric currents, a reply to M. de Parville, by M. A. Poincaré.

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THURSDAY, JUNE 18, 1885

BÜTSCHLI'S "PROTOZOA"

Bronn's Classen und Ordnungen des Thierreichs. New Issue. (Leipzig: C. F. Winter, 1883-4-5.)

THE important work on the lowest division of the animal kingdom which Prof. Bütschli, of Heidelberg, has undertaken for the publishers of the well-known series of zoological treatises originated by the late Prof. Bronn, is so far advanced as to enable us to form some estimate of its merits and to call for an extended notice. The separate parts of Prof. Bütschli's work which have appeared at intervals during the last two years have now accumulated so as to form a large octavo of 900 pages and 50 plates. The whole of the Protozoa have been discussed with the exception of the Ciliata, the Dino-flagellata (formerly called Cilio-flagellata), and the Acinetaria. The work does not comprise in its scope the Mycetozoa, which should, in the opinion of the present writer, be included in the animal kingdom. This is the less to be regretted, since an excellent work on this group has been recently published by Dr. Zopf, of Berlin, in the "Encyklopädie der Naturwissenschaften," and may be obtained separately of the publishers, Trewendt, of Breslau.

That the Mycetozoa are to be considered as animals rather than as plants is the opinion of no less an authority than the botanist De Bary, who has done more than any other observer to elucidate their life-history and structure.

Bütschli divides the Protozoa into classes as follows—the Sarkodina, the Sporozoa, the Mastigophora, and presumably the Ciliata and the Tentaculifera, though of the last two he has not yet written.

The Sarkodina are divided into the sub-classes Rhizopoda, Heliozoa, and Radiolaria.

The class Sporozoa contains the sub-classes Gregarinida, Coccidia, Myxosporidia, and Sarcosporidia.

The Mastigophora are grouped in sub-classes as Flagellata, Choanoflagellata, Cystoflagellata, and Cilioflagellata (now altered to Dinoflagellata).

Each of the sub-classes is treated of in turn in the thoroughly systematic and comprehensive manner which the readers of Bronn's "Thierreich" know so well and have so long appreciated. The treatment commences with a "Historical Review of the Development of our Knowledge of the Sub-class," which is no formal repetition of familiar commonplaces, but a really critical statement of the share contributed by various earlier naturalists to the building up of our present conceptions on the subject. This is followed by a wonderfully complete list of memoirs and papers relating to the group—under the heading "Literature." We have in many instances tested the completeness of these lists, and have found that even short papers in obscure periodicals which happen to contain facts of real importance have been duly hunted up and recorded by Prof. Bütschli.

Then follows a "Short Survey of the Morphological Characteristics of the Sub-class and its Chief Divisions," and after this each prominent morphological factor is taken separately and its variations in the group very thoroughly discussed, references being given to the widely scattered writings of the numerous microscopists who have advanced this or that view or added this or that quantum of fact to our knowledge. Thus in the portion of the work relating to the Rhizopoda we find—

(1) The shell-structure of the Rhizopoda. A. Material of the shell—(*a*) chitinous shells; (*b*) calcareous shells; (*c*) shells built up of foreign particles; (*d*) siliceous shells. B. The morphological structure of the Rhizopod shell—(*a*) homaxonic shells; (*b*) monaxonic shells; (*c*) polythalamous shells; (*d*) abnormal shell-formation.

(2) The structure of the soft body of the Rhizopoda—(*a*) general characters of the soft body; (*b*) properties of the protoplasm of the Rhizopod-body in general; (*c*) differentiation of the protoplasm into special zones or regions; (*d*) coloration of the protoplasm; (*e*) peculiar bodies enclosed by the protoplasm, namely, non-contractile vacuoles, gas-bubbles, and peculiar products of metabolism, contractile vacuoles, nuclei; (*f*) pseudopodia, movement and inception of nutriment in the Rhizopoda; (*g*) gelatinous investment of the soft body.

(3) Relation of the soft body to the shell and formation of the shell by the soft body.

(4) Reproductive phenomena, colony-formation, and encystment of the Rhizopoda—(*a*) reproduction by simple division or budding; (*b*) colony-formation in connection with the division or budding of the Rhizopoda; (*c*) encystment in connection with or without reproduction; (*d*) copulation and conjugation in the Rhizopoda; (*e*) review of the attempts made to prove the existence of a sexual reproduction in the Rhizopoda.

(5) Biological relations of the Rhizopoda—(*a*) habitat; (*b*) nutrition; (*c*) dependance on external life-conditions.

(6) Taxonomy of the Rhizopoda—(*a*) historical development; (*b*) review of the system of the Rhizopoda, with brief characterisation of the divisions, inclusive of genera.

(8) Geographical distribution of the Rhizopoda.

(9) Palæontological development of the Rhizopoda.

This exhaustive discussion of the Rhizopoda occupies about 250 pages and 13 plates, in which the most important forms are figured: the figures being selected from all sources, and showing not only shell-structure but all that is known with regard to the protoplasmic body.

In the same thorough manner the subsequent groups of Sarkodina, of Sporozoa and Mastigophora are dealt with.

One point, however, to which we have not yet alluded gives Prof. Bütschli's work an altogether exceptional value. From what we have hitherto said it might appear that the work is simply a well-digested and critical survey of other men's work. This is not the case; the discussion of each group possesses a special value and importance from the fact that Prof. Bütschli has made very extensive researches himself in regard to the Protozoa, and has especially given attention to doubtful points, so that he is able to speak with the authority of a specialist in nearly every case. Portions of these researches, for instance those on the Radiolaria, on the Gregarinida and Myxosporidia (Psorosperms), and on the Flagellata have been already published from time to time during the past five years by Prof. Bütschli in various scientific journals. They have everywhere excited the greatest interest and have been recognised as most important additions to knowledge. In the present work they appear in due

place aad enable Prof. Bütschli to give a decisive opinion upon many points on which authorities have hitherto differed. Many of the illustrations in the admirably engraved plates are also original.

We may perhaps remind our readers that it is to Prof. Bütschli that we owe the first important paper in the recent development of our knowledge of the karyokinetic figures of dividing cell-nuclei. It is his investigation which demonstrated the identity of the changes in the nuclei of Ciliate Infusoria with the curious fibrillation of normal tissue-cells when in course of division, and more than any others have given a wide basis to the recent generalisations on this subject.

Our author is not only extremely fair and scrupulous in citing all discoverable authorities for the facts which he sets forth as to the structure, &c., of Protozoa (our English microscopists of all ranks will find themselves cited and fairly considered), but he exhibits admirable judgment, temper, and caution in his treatment of vexed questions. He has wisely withheld his full discussion of the classification of the Radiolaria until such time as Haeckel's *Challenger* work on the group is published. In the meantime his analysis of the various forms of skeleton which occur in that group is a masterly essay on a very difficult subject.

With regard to the question of the chlorophyll corpuscles of some Protozoa—considered by Brandt as parasitic Algæ—we gather that Prof. Bütschli leans to the acceptance of that view ; but we shall look for a more definite judgment from him in relation to that question when he has to discuss such forms as the Ciliata, *Stentor*, *Bursaria*, and *Ophrydium*.

It is noteworthy that Prof. Bütschli includes the Volvocina and the "Protococcus" forms in the Flagellata, being convinced of their relationship here in spite of their "holophytic" nutrition.

It would be impossible here to point out the numerous new views of importance which are advanced in Prof. Bütschli's work. It must be sufficient to say that the book is absolutely invaluable to every student of microscopic life, and is perhaps the most remarkable attempt yet made by a distinguished original observer to co-ordinate and render available for use the entire series of works of his predecessors in a large and important field of study.

E. R. LANKESTER

PHÆNOLOGY

Resultate der wichtigsten pflanzen-phänologischen Beobachtungen in Europa, nebst einer Frühlingskarte. Von Dr. H. Hoffmann, Professor der Botanik in Giessen. Anhang, Dr. Egon Ihne, *Die Norwegischen, Schwedischen, und Finnländischen Beobachtungen.* (Giessen : J. Ricker'sche Buchhandlung, 1885.)

THIS work, the results of forty years' labour, forms a most important contribution to the literature on the subject of phænology.

The work begins with an introduction, in which is explained the importance of phænological observations, particularly with regard to comparative climatology and biology. Then follows an investigation of the degree of accuracy to be obtained by this kind of observation, succeeded by a discussion as to how many years such observations ought to be continued for obtaining useful and trustworthy information for comparative investigation. A table is then given of those plants and their phases which the author, after forty years' observations, thinks the most proper for adoption with a view to international reception. The number is fifty-three, and they are arranged according to the calendar, to facilitate observation ; which system appears with regard to accuracy preferable to an alphabetical arrangement.

A short notice follows of the most important general results of the work with respect to climatology and biology, abstracted from the observations from the whole of Europe. At the end of the introduction the author points out the next tasks for phænological researchers.

The remainder of the book contains an alphabetical list of all phænological stations throughout Europe (about 2000), with the geographical situation and elevation above sea-level. Under each station are given in an alphabetical arrangement the mean dates of the simple phases known from the place, with the number of years of observation.

It is to be seen that from a great number of these but one or two years' observations have been published, whereas others extend to above thirty years. These dates are to be employed for comparing any single place with all the others. The mean dates are given as completely as possible, because such comparisons are the chief object of the author for publishing this work. They are extracted and calculated from a vast number of lists published in a great many periodicals and works of all nations.

With regard to spring flowers, the author himself has followed the plan of comparisons, giving under each station an indication of the number of days the single species open their flowers, sooner or later than at Giessen, the residence of the author, from which place, generally speaking, the most comprehensive observations have been published. In a "spring map" of Europe at the end of the book the results of these investigations are entered, by which the mean progress of spring through different countries may be seen at a glance.

OUR BOOK SHELF

Louis Pasteur, his Life and Labours. By his Son-in-Law. Translated from the French by Lady Claud Hamilton. (London : Longmans, Green, & Co., 1885.)

THE name of M. Pasteur, owing to his many brilliant and eminently practical discoveries, has been for some years so prominently before the general public that a popular and connected account of his life and labours cannot fail to be interesting and instructive reading to every educated member of the community. In this respect the present volume must be considered a signal success and a valuable addition to popular scientific literature. But the importance of the book reaches a step further, for it gives to the scientific world an authentic account of the development and progress of M. Pasteur's discoveries, since it is written by one who has been and is still living with M. Pasteur in the bonds of intimate friendship, and who has received his information directly from M. Pasteur himself. While to the general reader the achievement of a discovery is the only and great point of interest, to the scientific reader it is only one of many, the history of a discovery being one of them, and not the least important one, for it reveals methods and manner, and it gives us a true insight into the working of the

mind, more so than the contemplation of the actual results. Looking at the book in this sense, we must consider it of inestimable value to every worker in the same field of research.

The many and great researches of M. Pasteur—amongst which may be mentioned his discoveries that every one of the many kinds of fermentations depends on the growth and activity of a definite and specific microbe; his long-continued controversy and final refutation of the doctrine of spontaneous generation, his immensely practical discoveries on the silkworm diseases, on the attenuation of the virus of splenic fever and of hydrophobia are described with great lucidity and their history and progress rendered in a very spirited and fascinating manner. Reading the volume, one does not know what to admire more in M. Pasteur's life and labours — the way in which a problem is stated, worked, and solved in all its theoretical and practical bearings; the energy and perseverance with which he forces nature to yield up her secrets; the fertility and resources of his genius, or the ready way in which he goes to work to set at rest by direct experiment all objections and to remove possible sources of error. His is a truly grand life and his labours grander still!

The translator is to be congratulated on the admirable way in which she has fulfilled her task. Prof. Tyndall's preface forms an interesting and valuable part of the book. E. KLEIN

The Microtomist's Vade-Mecum. A Handbook of the Methods of Microscopic Anatomy. By Arther Bolles Lee. (London: J. and A. Churchill, 1885.)

IN the preface the author tells us that the aim of the book is to put into the hands of the instructed anatomist "a concise but complete account of all the methods that have been recommended as useful for the purpose of microscopic anatomy," and also "that it is to serve as a guide to the beginner." After a perusal of the book we venture to say that, although the book will prove useful, it is neither a concise, still less a complete, account of all the methods, nor will it serve as a guide to the beginner. As far as we can see, it is a collection of formulæ, published by various authors in various journals and archives, and particularly reported in the *Journal* of the Royal Microscopical Society. The formulæ are more or less promiscuously given, and without an attempt of intelligible selection. For many formulæ references to their authors are given, but in some places these references are incomplete, in others they are wrong, since methods discovered by one are ascribed to another. Nor can we see the use of describing a host of minute and sometimes quite insignificant modifications of a certain method, as A's, B's, C's, &c., method.

As regards the beginner, we venture to say that the book will fail to come up to the expectations of its author. What the author for this purpose ought to have done is to give us a list of ready methods which he himself has tried and found useful in the examination of the various tissues.

The important branch of the examination of living issues, the methods used for the application of reagents, heat, gases, electrical currents, &c., on fresh and living tissues are not included in the book; their treatment, and a few illustrations of apparatus used in microscopic *technique*, would prove a useful addition. E. KLEIN

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 Late Prof. Clifford's Kinetic

PROF. TAIT, in his notice of Clifford's "Common Sense of the Exact Sciences" (NATURE, vol. xxxii. p. 124) has brought so prominently forward the statement made in Prof. Pearson's footnote—"the manuscript of the 'Kinetic' was left in a completed state," that I think it is fitting I should somewhat anticipate what will ultimately be stated when the manuscript in my hands has been printed. All the manuscript bearing upon the "Dynamic," after having, I think, passed under Mr. F. Pollock's eyes, was handed over to me, and with it Mrs. Clifford gave me, for use,[1] nine German text-books in case I should need them to fill up any gaps in the manuscript. It is needless to say that there have been "reasons" why this manuscript has not hitherto seen the light; suffice it now to say that the *continuous* portion has been received by Messrs. Macmillan, and the printing is to proceed forthwith. But of what does the *continuous* part consist? I have a draught before me of the work as originally contemplated by the author: Books i., ii., iii., form the "Kinematic"; Book iv., entitled "Forces," is broken up into ten or eleven sections. It is this portion which is *continuous*, and which takes up about forty pages of manuscript. Book v. was to treat of "Stresses;" Book vi., of "Heat;" and Book vii., of "Waves and Vibrations." Of these latter books I have only stray leaves here and there. It is said "Fools rush in where angels fear to tread." I certainly do not propose to try to supplement Clifford's work, but what I do propose is to get out all the *continuous* part in continuation as approximately as I can of the "Kinematic" and to relegate the odds and ends to an appendix. If any mathematician thinks some other course preferable, I shall be glad to let him see the "slips," and will hope to profit by his advice. I am in the receipt of letters from distinguished teachers which express a hope that the lectures I referred to (NATURE, vol. xxvii. p. 4) may see the light; but this point is still, I believe, under consideration. R. TUCKER

University College School, June 13

Sky-Glows

A MAGNIFICENT display of red sky-glow has been seen here. The last observed was in September last (the 17th, the 27th, and the 28th), and only feeble ones have been noticed since up to June 11. At that date the sky glowed with a magnificent grayish pink on the whole of the northern horizon until 9 o'clock p.m. Yesterday the glow was still brighter, and at 9 15 p.m. it extended over the whole of the northern and north-eastern horizon. It was brighter than even last year, but acquired its maximum of brilliancy at a later hour than last summer.

Clairvaux-sur-Aube, France P. K.

Flying Fish

AN excellent opportunity of observing the aerial means of propulsion in the flying fish was afforded me during a six days' calm lately when crossing the Bay of Bengal. This must be my excuse for again touching this subject. I watched day by day some hundreds rise under the bows of the ship. The water surface was a glassy calm. As each fish rose it spread its wings at once, apparently beating the surface with them two or three strokes before they steadied out. I say apparently, for it was not a definite beat so much as a struggle to rise. The tail which, of course, under water was in rapid motion, to escape from the ship, now gave ten or a dozen rapid beats, which could be counted by the ripples on the still surface, and the fish was off in aerial flight. As each fish lost the impetus of the first rise, which generally happened at about forty yards, the binoculars showed us the anal fins, which had till now been fully extended, drooping to feel the water. As soon as the surface was felt the tail was quickly introduced, and five or six smart strokes, also indicated by ripples, brought the impetus up again and carried the fish about another thirty yards, when another droop sent it on again, and so forth, some of the older fish travelling in this way 400 to 500 yards. The younger fish frequently fell awkwardly in this attempt to regain impetus. Where waves are running it requires a clever fish to gain impetus by a few judicious strokes on the crest of a wave, and many a fish tumbles over in the attempt.

I once saw a fish rise close to the ship's quarter, and it flew parallel with the ship, pursued below by a dolphin or bonita. The latter followed every sway of the flying fish, keeping almost under it. At the first dip of the tail the pursuer made a dart forward, but missed it, and again dogged its pray by keeping

[1] These books are to be presented to University College Library after I have done with them.

just under it. On the second dip the tail went into its pursuer's mouth, and there was an end of the flyer. It always struck me that it seemed a strain on the fish to keep the wings extended.

May 15 ALFRED CARPENTER

THE UNIVERSAL MERIDIAN[1]

AFTER some preliminary historical matter Dr. Janssen proceeded:—The question as to which of all the meridians encircling the earth ought to serve as the starting line in the general numeration of the longitudes, is the question known as that of the *prime meridian*—a famous question oftentimes taken in hand, never definitively settled, and which the Congress of Washington was charged to decide. Such was at least its intention.

The ancients, who had just ideas in all matters, perfectly understood that a prime meridian ought to be placed at the origin of the lands to be measured. Marinus of Tyre, and after him Ptolemy, chose quite naturally, as the point of departure for their longitudes, the extremity of the world which was best known to them. What was this extremity? It was the islands which navigators encountered beyond the pillars of Hercules in an enchanting climate, where the inhabitants, freed from every toil, lived in peace and happiness on the abundant spontaneous fruits of a prodigal soil, the Fortunate Isles, as they were called, which people pleased themselves with assigning, as a final resting place (Elysian fields) to the souls of heroes!

Homer, Hesiod, Pindar, Plutarch, speak to us of these Fortunate Isles, which were then regarded as the extreme limit of the western dependencies of Africa. Afterwards they were the unknown solitudes of the ocean.

It is from these isles, then, that the great heir of the geography of the Greeks starts his numeration of longitudes. Here again, however, the ignorance of the ancients in the matter of measures did not allow the maintaining of so natural a point of departure. The indifferent knowledge of the position of the Fortunate Isles damaged the whole system, and people later on were compelled to revert to the continent where the measures were less uncertain.

Following Greek science came the middle ages, when the scientific idea disappeared, and was replaced by a religious or political idea. The first line of longitudes was taken anywhere. People took their meridians from capitals, or remarkable places; every one chose his own centre, and the confusion grew to be intolerable. It is noteworthy how it was France which gave the signal for the resuscitation of the scientific idea in this question, and that it is to the great Richelieu we owe it.

It is, however, a false idea of Richelieu's action to consider it as directed by a pure intention of scientific reform, and by the desire alone of serving the general interests. Richelieu is above all a political spirit, and political interests dominate his preoccupations. At the same time, however, he is a unifying and innovating genius, who feels the necessity of order and serves that necessity by general, great, and elevated measures, for such is the form of his spirit.

What, in fact, was the point of departure of a reform such as science disengaged from all personal interest would alone dictate at the present day? A jealous quarrel among maritime nations in reference to commerce!

At the commencement of the seventeenth century France made a trial of commerce in distant parts, particularly in the Indies and America.

The navigation and traffic of these countries were then in the hands of the Spanish and Portuguese, who, however little they agreed on the division of these rich spoils among each other, were nevertheless wonderfully united when there was a question of interdicting others from sharing in them. The French ships appearing in the seas either of the East or West Indies were, in point of fact, chased by the Spaniards and the Portuguese! Awaiting the time till he had rendered the French navy strong enough to dispute with these nations a property which on the whole was the right of all the world, Richelieu sought to draw around France a maritime zone of protection. He accordingly negotiated and obtained that on this side of the prime meridian fixed on this occasion and to the north of the tropic of Cancer every French ship, whencesoever it may have come and whatever its cargo, should be safe from the pursuit of foreign vessels. Beyond these limits the argument of the strongest was to have force. France was at peace with Spain and Portugal on this side, at war on the other. A curious state of affairs, recalling to some extent the word of Pascal: "Vérité en deçà, erreur au delà!"

And yet have we really the right at this day to look on an arrangement of this kind as such a strange one? Have we not now what the casuists of international law call the *état de représailles*—a state in virtue of which one may blockade the ports of a nation, burn its arsenals and destroy its armies, without being in declared war, and without ceasing diplomatic relations with it?

The object of the great Minister was evidently to secure a refuge for our marine till such time as it was able to contend with others—a goal for which he laboured with such admirable success that before his death our navy was constituted and the basis laid of that colonial greatness which came with Louis XIV. and Colbert.

Such, then, was the political motive at work. But in pursuing this question of colonial commerce the mind of Richelieu was for a moment turned to geography. He needed a pure line of demarcation, not liable to be disputed, and found it in the ancient meridian of the Canaries. He resumes the geographical idea of Marinus of Tyre and of Ptolemy. He places his meridian as far to the west as possible in the archipelago of the Canaries—in the island of Ferro, and the longitudes are to be counted east of it. All the other meridians of the continent are excluded.

Accordingly, and I insist on the fact, all the qualifications of a universal meridian, such as science might be able to establish at this day, were combined in Richelieu's meridian.

(1). It is universal and fit to be so, seeing it personifies no nation, but is, on the contrary, the determination of a purely geographical idea; namely, the position farthest to the west of the ancient world.

(2). The numeration of the longitudes is very natural. It brings the numerical augmentation of the longitude into harmony with that of the local time. It sets forth no negative longitude—a system which, in our opinion, is defective, when there is a question of universal numeration of longitudes.

(3). It places the first meridian in the sea, as geographers have always desired.

The appointment of Richelieu had but one fault: it was in advance of its time—not in respect of its utility and urgency, but of its means of realisation.

In order to establish a meridian at any point it is necessary to be able to connect this point exactly with all well-known points which are to be brought into relation to it. Now, by reason of various circumstances, chief amongst which was the state of war then prevailing, the longitude of this island of Ferro was not known till a century later, when P. Fouillée, astronomer and naturalist, proceeded to the Canaries by order of the King and the Academy, and there made observations on the occultations of the satellites of Jupiter, whence he determined the position of Orotara in Teneriffe, and consequently, by means of a triangulation, the position also of the island of Ferro.

[1] Lecture by Dr. Janssen at the Paris Geographical Society.

In the meantime a conventional position had been arranged for the island of Ferro. In fact, at the beginning of the seventeenth century our geographer Delisle is found placing the meridian of the island of Ferro on his maps 20° W. from Paris.

The grand geographical idea of Richelieu was, accordingly, not maintained in its integrity. Paris, in fact, gave the point of departure.

Delisle was a geographer of very great merit, and accomplished a real reform in the science by always seeking to establish astronomical determinations as the basis of geography. Delisle and d'Anville placed France in the seventeenth century in the front rank in geography. Be it added that, while France had thus an undisputed superiority in geography, she at the same time took the initiative in inventing hydrographic methods, and producing the most beautiful hydrographic works, as I had occasion to call to remembrance at the Congress.

In thus speaking of the labours of France shall we not be allowed to recall our present activity in the branches which engage us? I shall say but a word in passing. But in fine, are we not accomplishing great things even at the present day? The creation of the port of Rochelle, established on new and profound scientific principles; the geodetic junction of Spain and Africa; the great geodetic labours of France resumed; the publication of the astronomical and nautical ephemerides, the most complete and perfect in existence; the fair series of determinations of longitude of high precision, undertaken under the auspices of the Bureau of Longitudes; those sublime cosmogonical theories which are being elaborated at this very moment; finally, and without passing beyond the domain of geography, let us not forget the great enterprises of our president, who everywhere vindicates the genius of France, and whom age seems to spare in the interest of our glory—have we not in all that a sum of sterling substance, and is it not proper to call it to mind at a moment when every one is putting his claims forward?

These preliminary explanations made, we may now, with your permission, address ourselves to an analysis of the labours of the Washington Congress.

This Congress, assembled by the zeal of the United States Government, was formed by the diplomatic and scientific representatives of the different States invited. It was officially charged with the task of studying the question of a universal meridian and of cosmopolitan time, and of formulating propositions, which, it is true, were not to be binding on the Governments represented, but were yet to serve as a basis for further negotiations and definitive resolutions.

When the invitation of the American Government reached the Government of France, the latter applied to the Academy to name the delegates which should represent France scientifically at the Congress. This step was followed by the appointment of a Grand Commission comprising representatives of all the sciences and services interested, and in which the Academy of Sciences was largely represented.

This Commission, presided over by the Dean of our Astronomical Section, held numerous meetings, at which they discussed with the greatest care and with high authority the questions composing the programme of the Washington Congress. The resolutions which this Commission adopted, formulated in a remarkable report of M. Gaspari and fully accepted by the Government, formed the basis of the instructions given to the French delegates.

The Congress opened on October 1 in the Diplomatic Hall of the Department of State.

On the formal demand of the French delegation the Congress allowed that the motions and speeches delivered in the English language should be translated into French, and that the *procès-verbaux* should be drawn up in the two languages. To secure the accuracy of the French version M. Janssen accepted the duties of secretary.

The Congress invited certain learned men present at Washington to assist at the sittings, and to take part in the discussions. Among them may be named Messrs. Newcomb, Asaph Hall, Sir William Thomson, and Prof. Hilgard.

On examining the composition of the assembly it will be seen how largely England and America were represented, and yet, to add to the force which such a numerous and eminent representation was calculated to give them in the discussion, there was joined to it, under the form of invitation, the support of the most eminent men of learning of America or England present at Washington.

Finally, without at all wishing to call in question the independence of any one present at the Congress, it is yet difficult not to be struck by the fact of invitations being addressed to all the small States politically allied with the United States.

Such was the arena on which France was called to defend her interests.

Luckily, however, we had no personal interest to contend for. The France of the nineteenth century does not, any more than the France of the eighteenth and seventeenth centuries, deem herself entitled to consider national interest in questions of a scientific and universal character.

In conformity, therefore, with the spirit which ruled the institution of the metrical system the French representation at the Washington Congress solely maintained the principle of a meridian such as science would designate and such as would be most advantageous for the general interest.

At the opening of the sittings a member of the American delegation, expressing, no doubt, the sentiment of his colleagues, at once proposed the meridian of Greenwich as the international meridian. If this proposition had been adopted the main question which called the Congress together would have been decided, and that, so to say, without discussion, and without the questions of principle and general interest, which we wished to defend, being so much as entered on.

The delegate of France raised his voice against this summary and inadmissible method of procedure. He pointed out that, before proceeding to choose any meridian in particular, it was necessary to come to a decision on the question as to whether a universal meridian should be fixed upon or not, and, if this question were settled in the affirmative, according to what principles they should choose this meridian.

The legitimacy of this demand was evident. It was accepted, and the proposition of the American delegate was temporarily withdrawn.

The question of fixing a single meridian of departure for all nations having been submitted to the Congress, it was unanimously agreed to choose such a meridian.

It next remained to be decided according to what principle this meridian should be chosen—whether, namely, the choice should be made among the observatories already existing, or whether the choice should be made with a view exclusively to geographical conditions, and to the service which the meridian was destined to render.

On this question the French scientific delegate begged permission to speak, and delivered the following discourse:—

"If after so many fruitless attempts recorded by history to arrange a single universal system of longitudes this question is now again resumed, then in our opinion it has no chance of definitive success unless it is established on a purely geographical basis to the rigorous exclusion of all national rivalries.

"We do not, therefore, come here to support a candidature, we put ourselves completely outside the arena of

debate, and are consequently infinitely freer to express our opinion and discuss the question from the one point of view of the interests of the projected reform.

"The history of geography shows us very numerous attempts at the unification of longitudes, and on searching into the causes of the failure of those attempts, many of them very happily conceived, one is struck by the fact that they seem reducible to two main causes, one of a scientific, the other of a moral nature. The cause of a scientific nature lies in the inability of the ancients to determine exactly the relative positions of points taken on the globe, particularly in the case of an island removed from a continent, where the distance between the two was not determinable by itinerary measures.

"It was thus, for example, that the first meridian of Marinus of Tyre and of Ptolemy, placed in the so-called Fortunate Islands, could not continue to be used, notwithstanding the advantage belonging to the choice of a position in the extreme west of the then known world, on account of the uncertainty attaching to this point of departure.

"This very regrettable reverse served to give a wrong direction to the question. People were obliged to revert to the continent. Instead of regarding a common origin of longitudes indicated by nature, people took their first meridian from a capital, from remarkable places, from observations. The second cause to which I referred, the cause of a moral kind—namely, national jealousy—led to the multiplication of geographical origins, whereas the nature of things would have demanded their reduction to one single origin.

"In the seventeenth century Cardinal de Richelieu, seeing this confusion, wanted to resume the idea of Marinus, and assembled at Paris learned men of France and foreign countries. The famous meridian of the island of Ferro was the result of their conferences. Here is a lesson which we ought not to lose sight of: the meridian of the island of Ferro, which had at first the purely geographical and neutral character alone able to render it, and maintain it as, a first international meridian, was displaced from its primary position by the geographer Guillaume Delisle, who, to simplify the figures, placed it in round numbers 20° west of Paris. This unhappy simplification completely changed the principle of impersonality. It was no longer an independent meridian, but the meridian of Paris disguised. Nor were the consequences slow in making themselves felt. The meridian of the island of Ferro, from that time regarded as a purely French meridian, wounded national susceptibilities, and thus lost the future which was certainly in store for it had it remained true to its first intention.

"This was a real misfortune for geography. Our maps in their process of improvement ought to have maintained the unity of departure, instead of confusing it ever more and more.

"If from the time when astronomical methods were sufficiently advanced to allow the fixing of relative positions with the degree of precision required for general geography (a state obtaining from the end of the seventeenth century), the idea of Marinus of Tyre, so just and so geographical, had been resumed, the reform would have been effected two centuries sooner, and we should now have been in the full enjoyment of it. But people fell into the error of losing sight of the very principles of the question, an error to which the foundation and multiplication of observatories at that time greatly contributed. Furnishing relative positions, as they of course did, with great precision, each of these establishments was chosen by the nation possessing it to give it a point of departure for longitudes, so that the intervention of astronomy in these questions of a geographical nature—an intervention which, properly understood, should have been so advantageous—served only to remove us further from the object to be attained.

"The study of these questions leads us to establish a very necessary distinction between the meridians of a geographical or hydrographical nature, and the meridians of observatories.

"The meridians of observatories must be regarded as essentially national. Their office is to enable observatories to depend on each other for the unification of their observations. They also serve as a basis for geodetic and topographical labours executed in connection with them. Their functions, however, being of an entirely special character, ought in general to be limited to the country possessing them.

"The first meridians in geography, on the other hand, do not require to be fixed with a precision quite so delicate as that exacted by astronomy; but in return their domain ought to be comprehensive, and while it is serviceable to multiply observatories, it is necessary to reduce to the utmost the origins of longitude in geography.

"It may further be said that if the site of an observatory ought to be chosen under considerations of an astronomical description, a meridian of departure in geography ought to be fixed on grounds of a geographical description.

"Have these two so different functions always been well comprehended, and a distinction of such vital moment properly observed? By no manner of means.

"Seeing the observatories, by reason of the labours of high precision executed by them, furnish admirable data, each nation in a position to do so has assigned to its principal observatory not only the geodetic or topographical works undertaken at home—a task very proper to it; but likewise the general works of geography or hydrography executed abroad—a confusion of functions comprising in it the germs of all the difficulties under which we now labour.

"In proportion, therefore, as cartographic labours accumulated, the necessity of establishing unity in all that relates especially to general geography became more and more felt. This explains how the question of a single meridian of departure has been so often raised in recent times.

"Among the assemblies occupied with this question that principally deserving our attention is the one held at Rome last year. For many even of our colleagues the conclusions adopted by the Congress of Rome settle the matter. Those conclusions must, therefore, very particularly engage our attention.

"On reading the reports of the sittings of that assembly I was struck by the fact that in a meeting embracing so many men eminent for their learning and speculations, it was the *Utilitarian* side of the question which was especially considered, and which finally dictated the sense of the resolution taken.

"Thus, instead of laying down the great principle that the meridian which should be offered to the world as a point of departure for all the longitudes of the earth ought, above everything else, to have an essentially geographical and impersonal character, the question was simply asked, which among the meridians of observatories was the one possessing—permit me the expression—the largest following (*la clientèle la plus nombreuse*).

"In a question of a geographical, much more than of a hydrographical, interest, as almost all mariners confess (seeing that, in fact, there exist but two prime hydrographical meridians, Greenwich and Paris), a primary meridian is taken, the dominating character of which is marine. And this meridian, instead of being chosen according to the configuration of the continents, is claimed for an observatory. That is to say, the prime meridian is chosen for a mere chance spot on the globe, and one which, moreover, is very inconvenient, for the function the meridian is intended to perform. Instead, finally, of profiting by the lessons of the past, an element of national rivalry is

introduced into a question which ought to unite the votes of all interested.

"Well, I say that considerations of economy and of use and wont ought not to blind us to the principles which should govern this question, and which can alone render its settlement universally acceptable and permanent.

"But further, this argument of economy, and use, and wont, which is advanced as a reason of determinative force, has validity, it is true, for the majority for whom it is brought forward, but for them alone, and leaves for us exclusively the burden of change in habits, publications, and maps.

"Seeing the report holds us of so light account in the balance, allow me briefly to recall the past and the present of our hydrography, and for this purpose I cannot do better than cite a few passages from a work communicated to me, and emanating from one of our foremost hydrographers. 'France,' says he, 'created more than two centuries ago the oldest nautical ephemerides in existence. She was the first to conceive and execute the great geodetic operations having for their object the construction of maps civil and military, the measure of meridional arcs in Europe, America, and Africa. All these works were and are regulated by the meridian of Paris. Almost all the astronomical tables which the astronomers and mariners of the entire world make use of at this day are French, and calculated in reference to the meridian of Paris. As regards oceanography, more particularly marine surveying, the precise methods employed at the present day by all the nations are of French origin, and our maps, all based on the meridian of Paris, bear names such as those of Bourgainville, La Pérouse, Fleurieu, Borda, d'Entrecasteaux, Beautemps Beaupré, Duperrey, Dumont d'Urville, Daussy—to mention but a small number of those who are no more.

"Our existing hydrographical collections count more than 4000 charts. Deducting from this number those which the progress of exploration has rendered no longer available, there remain about 2600 charts in use.

"Of this number more than a half represent original French surveys which foreign nations have in great part reproduced. Of the remainder the general maps are the result of the labours of discussion carried out at the marine depôt where all documents, French as much as foreign, were utilised, and relatively few of them are the expressions pure and simple of foreign labours. Our surveys are not limited to the coasts of France and its colonies. There is hardly a region on the globe for which we do not possess original labours: Newfoundland, the coasts of Guiana, of Brazil and La Plata, Madagascar, numerous points of Japan and China, 187 original charts relative to the Pacific Ocean. We must not omit mentioning the fine work of our hydrographical engineers on the West coast of Italy, which was honoured by the International Jury with the grand medal of honour at the universal exhibition of 1867. The exclusive use by mariners of the meridian of Paris is grounded on considerations of a past of 200 years such as we have briefly recalled.

"The adoption of another prime meridian would involve a change in the graduation of the 2600 charts of our hydrography, would involve a similar change in our maps for nautical instruction numbering over 600, and would of necessity entail a corresponding change in the *connaissance des temps*.

"These are considerations deserving to be pondered. Well, if under these conditions the projected reform, instead of being inspired by the high principles which should govern this subject, is to take for its basis simply a regard for the use and wont of the largest number and their exemption from all sacrifice, reserving for us exclusively the burden of change and the abandonment of a dear and glorious past, are we not, then, justified in saying that a proposal formulated in this sense would not be acceptable?

"When at the end of the last century France established the metre, did she proceed in this way? Did she, as a measure of economy, and not to change anything in her habits, propose her foot-rule to the world? You know the facts. The truth is, we turned everything at home topsy-turvy—habits and material. And the measure chosen related, as it is, only to the dimensions of our globe, is so well disengaged from every French tie that in future ages the traveller who will trample on the ruins of our cities will be able to ask himself by what people was invented the metrical measure which his feet may chance to light on.

"Permit me to say that it is in this way a reform is established and rendered acceptable. It is by setting oneself the example of self-sacrifice and by completely effacing oneself in his work that resistance is disarmed and that a sincere love of progress is attested.

"I hasten to say that I am persuaded that the proposal voted at Rome was neither made nor suggested by England, but I doubt whether, if accepted, it will render a true service to the English nation. An immense majority of the sailors of the globe navigate with English charts, it is true, but it is a homage of fact rendered to the great maritime activity of this nation. The day, however, when this supremacy, freely accorded, is changed into a supremacy official and imposed, it will undergo the vicissitudes of every human power, and this institution, which by its nature is of a purely scientific order, and to which we desire to assure a long and peaceable future, will become an object of keen and jealous rivalry among the nations.

"All this shows how much wiser it would be to take for the origin of terrestrial longitudes a point determined by purely geographical considerations. On our globe nature has so distinctly separated the continent on which the great American nation are now developing themselves that from a geographical point of view there are but two possible solutions, both very natural.

"The first solution would consist in returning to the solution of the ancients with a little modification, by placing our first meridian towards the Azores; the second in relegating it to the immense straits separating America from Asia, towards the confines of the north, where the New World reaches out a hand to the Old.

"These two solutions may be discussed, as they have often and again quite recently been by one of our ablest geologists, M. de Chancourtois.

"Each of these meridians unites in it the fundamental conditions required by geography, and on which people have always been agreed, when national meridians were eliminated from the debates. As to the determination of the point adopted, the astronomical methods which are now so perfect would furnish it with as a great a degree of exactness as geography would require.

"But what need of a special and costly determination of longitude for a point which may be placed arbitrarily provided it is comprised within certain limits, such as to satisfy the condition, for example, of passing by a strait or traversing an island? It is enough to mark out approximately the point adopted. The position thus obtained will be referred to each of the great observatories, which will be related to one another and chosen for this purpose, and this list of relative positions will constitute the definition of the first meridian. As to a material sign on the globe, should such be wanted, a point by no means necessary, it will have to be placed in conformity with this definition, its place would have to be shifted till such conformity was obtained.

(*To be continued.*)

GUESSINGS AT TRUTH

I.

OLD SPENSER, in his wondrous Allegory, tells us—

" . . . he, that never *would*,
Could never :—"

We are constantly reminded that we must creep before we can walk. So that we cannot look coldly or sarcastically on

" . . . budding Genius' earliest essàye,"

provided always that we are sure of the earliness. For there often is a strange resemblance between the erratic first flights of the scientific fledgeling and the habitual evolutions of the time-hardened Paradoxer or of the Paper-Scientist.

Besides the mere dozen or so of really successful Physicists, all that the world seems able to produce at any one time, even in these later years, and whose efforts can at the best be rarely called more than *Guesses*, there is an untold multitude whose *Guessings* are irrepressible. These, unlike some at least of the former, never hide their light under a bushel. From week to week we view with curious awe the increasing piles of pamphlets under which our shelves and table sag, groan, and crack! Let us make an effort, and get rid of some of them. Not to the waste-basket—at least not at once—for there is something in almost every bundle of hay (in the Soudan it is not needles, but bricks and slag), and this is usually worth searching for, were it only in the interests of justice to those who have thus (unconsciously?) hidden them. We take the bundles as they come; many are rotten and can be tossed aside at once, others require more careful scrutiny.

The first we light upon is by our particularly modest contributor John O'Toole.[1] [He does not seem to be aware of the powers of Peroxide of Hydrogen, which (though we did not proclaim the fact) enabled us on a former occasion easily to penetrate his *incognito*. But his secret is safe with us.] His present work is a singularly quaint protest against the modern abuse of elementary dynamical terms, and as such is well worthy of careful perusal. There can be little doubt that, of all physical subjects, as presented in an elementary form to the beginner, Dynamics is the most repulsive. And it stands at the very threshold. Mr. O'Toole shows the natural working of a clear, logical, mind in the middle of the present chaos. His pamphlet is one which should be read by all; for, though he hits all round and sometimes attacks the very giants of Science, he invariably hits fair as well as hard. It would take a whole article to discuss fully the questions he raises: suffice it to say that the root of the confusion which he so justly exposes is that little, but much-abused word *Force*; and to quote the following pregnant sentence as showing his point of view :—

" When we behold . . . a group or sequence of phenomena, we *insert* force among them of ourselves, because we know from experience that if our organism were substituted for the acting or resisting body, we should have the sensation of pressure."

Next we take a couple of smaller, but more ambitious, pamphlets[2] :—in each of which the Past, Present, and Future of the Universe are promptly settled, though the terms of settlement are by no means identical. When we find, however, that Herr Zehnder, in the second sentence of his pamphlet, says that insuperable objections can be raised against the hypotheses of Helmholtz as well as against those of Kant, Herschel, and Laplace, *because they take too little account of the existing laws of mechanics*, we begin to understand him; and we have only to turn over a few pages to find him thoroughly revealed. His bugbear is the Dissipation of Energy :—and he informs us that the " Eternal Circulation of Matter " —in virtue of which all aggregations such as the sun will ultimately explode into their former nebulous condition, to recommence their condensation, &c.,—is an immediate consequence of THE PRINCIPLE OF THE CONSERVATION OF LIGHT!

Our rival author sums up *his* Kreislauf as follows :—

". . . life, matter, and all things, are the necessary and inevitable outcome of the existence of Space. Space or Room, in any form whatever, must of necessity be a form of force or energy, and all things are just phases or manifestations of the working of this force or energy; the Earth is dissolving in Space like a lump of Salt in Water, but New Worlds are being formed in Suns; this dissolving and forming process will go on for ever; and consequently life will be eternal; . . ."

This is a step in advance even of Descartes, with whom Space and Matter were the same. We leave to the reader to judge which of the two has the more grotesquely grinned through the horse-collar, the German Swiss or the Scotsman.

Our next step is a large one, no less than from the Universe to the Atom.[1] The work now before us is a very curious one. The author has hunted widely for his materials, and (very naturally) selects such only as suit his theory. So long as he can utilise Sir W. Thomson or Clerk-Maxwell he does so; but, when he finds their statements incompatible with his theory, he has no difficulty in picking up what he wants from Zeuner, Rühlmann, Deschanel, &c. He seems, however, not to be acquainted with the elaborate work of Athanase Dupré. This is unfortunate, for in it he would have found little difficulty in obtaining whatever he might require. The object of the essay, briefly stated, is to frame a theory of the liquid and solid states, somewhat on the lines of the kinetic gas-theory :—only it seems we must have a mutual force between particles, whose law is something between the inverse 4th and inverse 5th powers of the distance. But somehow the law itself seems to vary with the distance; so that " we must apply the theory of probabilities to determine the potential at any centre due to the surrounding atoms." As a striking instance of Mr. Whiting's extensive range of quotation, we note that he refers, for the sum of a common series (given everywhere in elementary text-books of Trigonometry), to no less august an authority than Riemann in his *Partielle Differential-gleichungen!* We do not venture farther to criticise the work of a writer who can, as a matter of course, invoke such irresistible authorities.

We now come to a whole series of memoirs, tracts, letters, and pamphlets :—usually of American origin :—which deal specially with the vexed question of the Sun's temperature. From these we select one only, as the work of the most persistent, if not the most lucid or successful, of the many mere guessers on this subject.[2] For the others consult Van Nostrand's *Engineering Magazine*, *&c., passim*. Something, if not very much, has been done in this matter in Europe. Pouillet, J. Herschel, Crova, Rosetti, Violle, and others have at all events gone to work in a scientific way :—though (as is obvious from the results of Prof. Langley recently given in our columns) the values obtained by them can be but very rough approximations. A few of Mr. Ericsson's weightier sayings will pretty well show the value and character of his treatise. At p. 58 we are told that

" . . . the actinometer merely shows the thermometric interval of solar intensity on Fahrenheit's scale, without reference to the position of that interval on a scale which commences at the accepted 'absolute zero.' I regard this absolute zero, however, as an *ignis-fatuus*, retreating as fast as we approach it."

[1] *Anna Dynamica*. Dublin: Hodges, Figgis, and Co., 1884.
[2] *Ueber die Entwickelung des Weltalls und den Ewigen Kreislauf der Materie*. Von L. Zehnder. Basel, 1885.
On the Future of Life and the Universe, according to Science. Dundee: W. A. Drummond, 1883.

[1] *A New Theory of Cohesion*, &c. By Harold Whiting. (Cambridge, U.S., University Press, 1884.)
[2] *Solar Heat (an Extract from a work on " Radiant Heat")*. By John Ericsson. New York, 1885.

The little kinematical, or rather quasi-corpuscular, *excursus* to which pp. 71–74 are devoted, is one of the richest pieces of *paradoxing* (in De Morgan's sense) that we have ever met with. Here is a little bit of it :—

"Pouillet, having ascertained the number of thermal units imparted to the water in his pyrheliometer of 3·93 ins. diameter, imagined that he had measured only the energy of the rays contained in a pencil of 11·9 square inches section ; whereas, in reality, he had, at the end of his experiment of five minutes' duration, subjected his instrument to the action of the entire number of rays contained in a passing pencil or sunbeam, the section of which we ascertain by multiplying the orbital advance of the earth during five minutes, 28,836,000 ft., by the diameter of the pyrheliometer, 0·305 ft."

Thus it is the *number* of rays, not the time of exposure to one ray, which determines the result!

One more quotation, a very short one, must be given. It is from p. 136, and we put two words in italics :—

"In view of the fact that projectile force *diminishes inversely* as the square of the depth of the medium penetrated. . . ."

It is not easy to fix on the exact meaning of this very curious statement. Hence we must take it literally, whatever be the consequences. Discussion of penetration would obviously be useless in such a case, for the whole projectile force (even were it infinite) would be gone before penetration had commenced!

The immense expense which has been lavished on this volume, and on its truly wonderful illustrations, is calculated to produce reflections even more painful than those evoked by the perusal of the text itself. From the materials here given, *something* may yet be made, but certainly not on the lines chosen by the author.

We hope, shortly, to return to our store, and to select for the instruction and warning of our readers a few additional specimens, by no means inferior in quality to those just dealt with. G. H.

PROFESSOR FLEEMING JENKIN, LL.D., F.R.S.

ON Friday last, most unexpectedly and greatly to the grief of all his friends, died Prof. Fleeming Jenkin at Edinburgh, at the age of fifty-two. He had been in somewhat delicate health for a considerable time, but was, as usual, personally directing the engineering operations in connection with telpherage in London and Sussex, and seemed to have greatly gained in health and strength when he started for Edinburgh some days before his death. But blood-poisoning succeeded a slight surgical operation, and his death rapidly followed.

He was born in Kent in 1833, and was the son of the late Capt. Charles Jenkin, R.N. His school-days were spent at Jedburgh, Edinburgh, and Frankfort-on-the-Maine, while he took his M.A. degree at the University of Genoa, and began his engineering career in Marseilles, thus acquiring a wide knowledge of languages and of peoples which was most valuable to him afterwards in his scientific and social life.

In 1851 he returned to England, and was apprenticed to Messrs. Fairbairn's in Manchester, from which time his progress was rapid. We hope that the interesting and highly creditable history of his subsequent introduction as a well-trained mechanical engineer to submarine telegraphy (then in its extreme youth) and to Sir William Thomson, which led to his soon taking charge of the testing of the first Atlantic cable in 1858, and to a friendship and partnership with Thomson and Varley, will yet be told by some one who can do full justice to it. Our grief at Varley's loss is yet fresh, and we deeply sympathise with Sir William Thomson at the close of this partnership, the existence of which has been synonymous with the progress of submarine telegraphy.

On the appointment of the Committee of the British Association on Electrical Standards Jenkin's services were solicited, and the good work that he did as a member of this Committee is amply shown by his large contributions to the Reports on Electrical Standards, and which contain an account of his absolute measurement of the capacity of a condenser, the first such determination ever made ; and the chapters that he wrote in connection with these Reports on the subject of "Absolute Units" formed the only available text-book for the student of mathematical electricity before about the year 1872. Appended to these reports are the Cantor lectures which he delivered on the construction, laying, and testing of submarine cables, and these lectures showed as wide an acquaintance with the practice of electrical science as do the other chapters referred to with the theory of the subject.

In 1865 he was elected a Fellow of the Royal Society and Professor of Engineering in University College, London, and in 1868 he became Professor in the University of Edinburgh, where he created a School of Engineering to which considerable numbers of prominent Engineers and Professors of Engineering acknowledge their indebtedness. In the following year the Royal Society of Edinburgh elected him a Fellow, and subsequently he became a Member of the Institution of Civil Engineers, having been made an Associate of that Institution as early as 1859. In 1883 the honorary degree of LL.D. was conferred on him by the University of Glasgow.

Jenkin's book on Electricity and Magnetism, published in 1873, was a revelation to non-mathematical and even to many mathematical men, of the ideas which had until then been wrapped up in the mystery of mathematics or in the practice of the submarine cable testing-rooms. Sir William Thomson had been publishing many detached papers on electricity in the mathematical journals, and had been applying his knowledge in practice, so that an exact science of electrical quantities had been growing up among submarine cable engineers ; but the electricity of the text-books remained as unscientific and primitive as of old : the knowledge of the practical men had become indeed far more scientific than the knowledge of the schools.

Fully recognising this, Prof. Jenkin made in his book a totally new departure, and presented electricity and magnetism for the first time in a text-book as subjects capable of quantitative study. To understand the great effect produced by this book, which has now passed through many editions, it must be remembered that neither Clerk-Maxwell's treatise, nor Thomson's reprint of his Mathematical Papers appeared until 1873, and that at that time "electric potential," which to-day has its commercial unit, was to every one, except the engineers of submarine telegraphy, a mere mathematical function.

In 1882 a lecture was delivered at the Royal Institution on Electric Railways, and the system devised by Profs. Ayrton and Perry for effecting an absolute block, and thus enabling any number of electric trains to be run without the employment of drivers, guards, or signalmen, was described and exhibited by a working model. An account of this was read by Prof. Jenkin, and he at once saw that it contained the solution of a plan that he had been thinking over for doing on a large scale by electricity what had previously been done on a small scale with pneumatic tubes. *Telpherage*, or the automatic electric transport of goods, was the outcome, and the development of practical methods of running carriers electrically along a steel rod suspended in the air from wooden posts, occupied him, with the other two inventors, during the last three years of his life, the system being one which needed new invention in every one of its details. His inventive power is described by his assistants as wonderfully active and prolific, and he had energetic characteristics which only seldom accompany inventive genius, and which made his cooperation invaluable to the other directors of the Telpherage Company. It is deeply to be regretted that, having busied himself so actively in the long series of telpherage experi-

ments carried out in Hertfordshire, he did not live to see the completion of the first commercial "telpher line" now being erected at Glynder in Sussex.

The building of houses on sanitary principles interested him largely, and the Sanitary Protection Associations in Edinburgh and in London owed their existence to his initiation, and their success was largely due to his constant exertions. His article on "Bridges" in the "Encyclopædia Britannica," his book on "Healthy Houses," and his primer on "Magnetism and Electricity," are well known to scientific readers, but not perhaps to the readers of his numerous articles in the quarterly reviews and monthly magazines, the last of which was his recent article on "Telpherage" in *Good Words*. His numerous scientific papers published since 1864 are to be found in the *Proceedings* of the British Association, the *Philosophical Magazine*, the *Proceedings* and *Transactions* of the Royal Societies of London and Edinburgh, the *Journal* of the Society of Arts, the *American Journal of Science*, and the *Journal* of the Society of Telegraph Engineers.

Technical education much interested him long before it acquired its present interest for the public, and he presided at meetings of the Society of Arts and other societies when papers on that subject were brought forward. As a director of the Watt Institute in Edinburgh for several years he helped to advance technical education in Scotland.

He was an enthusiastic admirer of ability in other men, and he was especially warm in his encouragement of beginners, whether they were his own pupils or not. To gain his help it was only necessary to let him see that it was anxiously wished for, and that the recipient was not likely to make a mean use of it. He had marked dramatic power, and the plays acted in his drawing-room will long be remembered by his friends; while to his conversation, his general reading and wide sympathies gave a charm which was as powerfully felt as it is now regretfully remembered by all who were fortunate enough to know him.

THE GEOLOGICAL SURVEY OF BELGIUM

ALL who are interested in the careful and methodical investigation of the geological structure of the European continent will be sorry to learn that the Belgian Chamber of Representatives has cut down the vote for the prosecution of the detailed Geological Survey of Belgium so seriously as practically to suspend the work. It is miserable to see personal dislikes, religious differences and political antagonism imported into the discussion of a scientific project. Every competent witness must bear testimony to the minute fidelity and conscientious labour with which M. Dupont and his staff have carried out their Survey. If any fault can be found with his maps it is that they are too complete. They give more information than any ordinary reader can assimilate. Each sheet, indeed, is a detailed treatise on the area which it depicts. There are certainly no such elaborately exhaustive maps published in any other country; and Belgium may justly boast that she has led the way in an important advance in the delineation of geological features. It is an open secret, however, that the official geologists have all along encountered the determined opposition of the "géologues libres" who were not so fortunate as to be entrusted with the control of the work. The Survey having been planned by the Liberal Ministry, and being stoutly supported by the authorities, has until now been able to hold on its course. Much time was, no doubt necessarily, spent by M. Dupont in perfecting his system of colour-printing, and the delay in the appearance of his maps, possibly also the difficulty found by the malcontents in understanding them, were used as arguments for a total reorganisation of the staff. The opposition has recently been renewed under the clerical Government now in power, and unfortunately with more success. From the published debate it is clear that the Minister in whose department the estimate for the Geological Map was prepared, and who was officially bound to support that estimate, sat still without speaking in its defence, and the House, taking this silence, no doubt, as an expression of the inclination of the new Government, cut down the vote. We are sure that this retrograde step will be regretted by all who wish well to the progress of science. Into the personal squabbles connected with the subject we have no wish to enter. But as a public act of unwisdom the vote of the House of Representatives will, we hope, be rescinded and the prosecution of the Survey will be again allowed to proceed. If any fault is found with the way in which the map has been prepared, surely the Commission contains talent and energy enough to inquire into this and set matters right without practically bringing the Survey to a stand.

THE CONGO[1]

THESE two welcome volumes from Mr. Stanley testify to the accelerated rate of events in these latter times. It is only twelve years since Livingstone died in the vain search for the sources of the Nile down by Lake Bangweolo, and under the belief that no river but the Nile could sweep past Nyangwe with such a breadth and volume as he found the Lualaba to have. He was not singular in cherishing such a belief; many geographers believed, like him, that the Congo could not fetch such a sweeping circuit, and that the Lualaba must make its way northwards in spite of differences of level and somehow add its waters to the Albert Nyanza. It is only eight years since Mr. Stanley dispersed the delusion, and solved the problem both of the Nile and the Congo; it is just about six years since he began operations as the agent of the International African Association. To judge from the narrative of his journey across the continent, there was no blacker part of the Black Continent than the river banks between Nyangwe and the Atlantic, and no more intractable people than many of the tribes through whom he and his men had to run the gauntlet. Yet already, almost solely by his exertions, this most unpromising region has become "A land of settled government," at least on paper. It has engaged the continued attention of diplomatists from all the great States of the world for months, and is the subject of as many treaties as if it had been founded a century ago.

In reality, however, it is something more than a paper State. No one can read Mr. Stanley's narrative without being convinced that all along the river from Vivi to Stanley Falls there already exists what may fairly be regarded as an organised Government, carried on from some twenty-four stations as centres. But with the merely political aspects of this successful undertaking we cannot deal here. It is certainly an interesting experiment, both from a political and social point of view, this attempt to raise into a State a region not yet redeemed from savagery. What the ultimate result will be it is hard to say; on the one side a great mass of savagery, and on the other the most advanced European influences in politics, in commerce, in industry, in religion. For already we find bands of missionaries everywhere, and as among them are many men of prudence, tact, and ability, Mr. Stanley acts wisely in encouraging their efforts; they will certainly be of service in helping him to accomplish the object he has in view.

Without the aid of the latest applications of science, Mr. Stanley could never have succeeded in accomplishing all he has done in the brief period of six years. Steam has been of infinite service to him, and engineer-

[1] "The Congo, and the Founding of its Free State." By Henry M. Stanley. Two Vols. (London: Sampson Low and Co., 1885.)

ing contrivances in many ways. His flotilla of steamers, some of them most ingeniously contrived for the special navigation of the Congo, may be said to have been everything to him in carrying out his work; and the Congo Free State may be fairly set down as another "triumph of steam." Mr. Stanley claims for the Congo Free State an area of over a million square miles and a population of 42,608,000. As to the area, that is probably not far out; but the population seems to us excessive. Mr. Stanley reaches this great figure by generalising the density which he finds on the banks of the river itself. Between Stanley Pool and Stanley Falls, a distance of about 1000 miles, and including part of the Biyerré and Kwa Rivers, he finds a population of 806,300, and takes for granted that a similar density will prevail throughout the whole of the Congo Basin. This is very unlikely. In uncivilised countries the population naturally crowds itself along the river banks, and it would be very unsafe to calculate on finding regions at a distance from rivers equally well populated. Throughout the whole of the million square miles claimed by the Congo State only a few lines of exploration have as yet been run, though we know that as a whole it is probably the best-watered region in Africa, and possibly therefore the most thickly peopled. But the tendency among African geographers recently has been to reduce previous estimates of the population of Africa, and instead of 200 millions it is thought that 170 millions is one more likely to be nearer the mark. But all estimates, except for districts that have been settled for some time, are necessarily conjectural; and even for Morocco the greatest difference exists between the estimates of different travellers.

On the Lower Congo the Free State has been able to secure only a comparatively narrow strip of territory on the north bank—enough, however, to give it the right of free navigation between the sea and Vivi, where the first series of cataracts begin. From Vivi upwards to Manyanga the State possesses territory on both sides, when France comes in and claims the whole of the right bank of the river to the Likona tributary in 1° S. lat. Thence the Free State expands into boundless and unknown regions, which we hope it will do its best to explore and open up to science as well as to commerce. The aim in the north has been evidently to draw the boundary of the

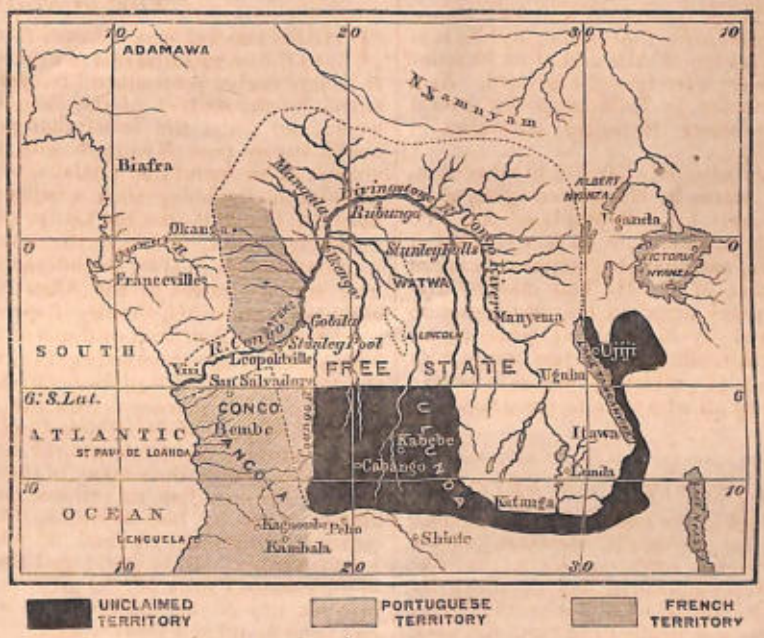

FIG. 1.—Political Divisions of the Congo Basin.

State between the basins of the Nile and the Congo. The western basin of the Upper Nile, no doubt, is fairly well known, but the region between that and the Upper Congo is just that part of Africa about which we know scarcely anything. The boundary on this side, therefore, has been drawn with the freedom of conjecture. All the rivers that are not known to send their waters to the Nile must, in Mr. Stanley's opinion, come down to the Congo, or, at least, ought to do so, and are made to conform with Mr. Stanley's idea of what is right and proper, in the large map which accompanies his work. In spite of Dr. Junker's discovery of the water-shed which separates the Nepoko from the Welle, they are both made to send their waters southward to swell the magnificent Aruwimi. This may be so; only actual exploration will decide the matter. It is mainly to settle this question that Dr. Lenz is preparing to proceed to the Upper Congo as leader of an expedition into the region that lies between that region and the Upper Nile tributaries. And here we have one very beneficial result of the work which Mr. Stanley has done on the Congo. His numerous stations form so many starting-points for further exploration. They can be easily and rapidly reached from the West Coast, and through the agencies at their command, all the men and goods obtained necessary for the conduct of an expedition into the interior. If every station on the river were made the basis of further exploring work, one of the greatest blanks in our knowledge of Africa would soon be filled up. In the interest of the enterprise itself this must be done. If the manifold products of the wonderful land over which Mr. Stanley is so enthusiastic are to be brought down to the river for shipment to the upper terminus of the future railway that is to convey them past the cataracts, it is evident that station after station must be pushed on into the interior. Among the white *employés* of the Association are many men of education and intelligence; and while their first duty is to look after the interests of the "Free State," these interests, instead of suffering, are likely to be advanced by a scientific knowledge of the country around the States. Already good meteorological work has been done at Vivi by Dr. Danckelmann, whose recently published

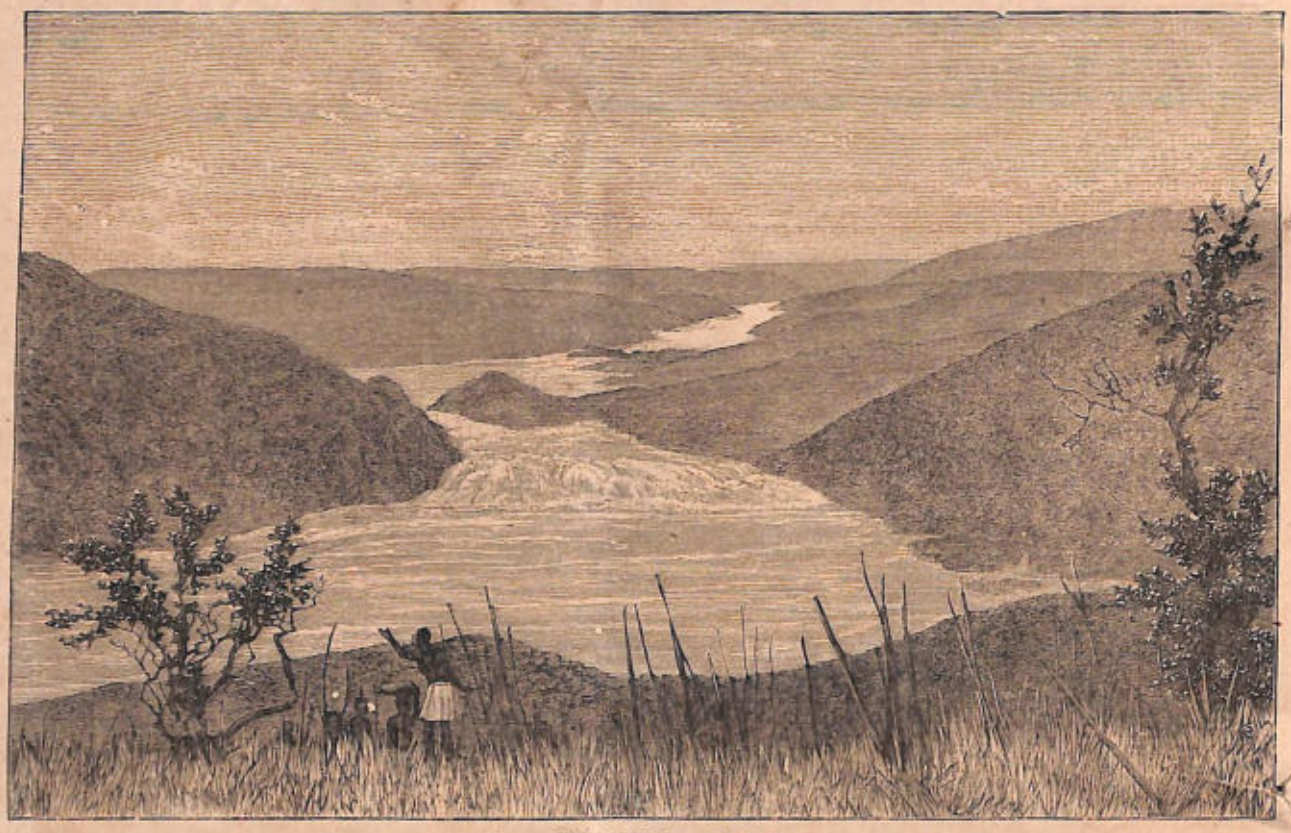

Fig. 2.—Yellala Falls from Left Bank.

Fig. 3.—Head of Lake Leopold II.

observations we reviewed some time ago. The utility of such observations is evident from the volumes before us. Mr. Stanley makes considerable use of them in his chapters on the Climate of the Congo. These chapters are of much interest; they are written mainly with a view to show that, with reasonable precautions, Central Africa ought to be perfectly tolerable to the European constitution. What these precautions are he describes in minute detail. At the same time he admits that a lengthened residence in such tropic regions must in the end tell on

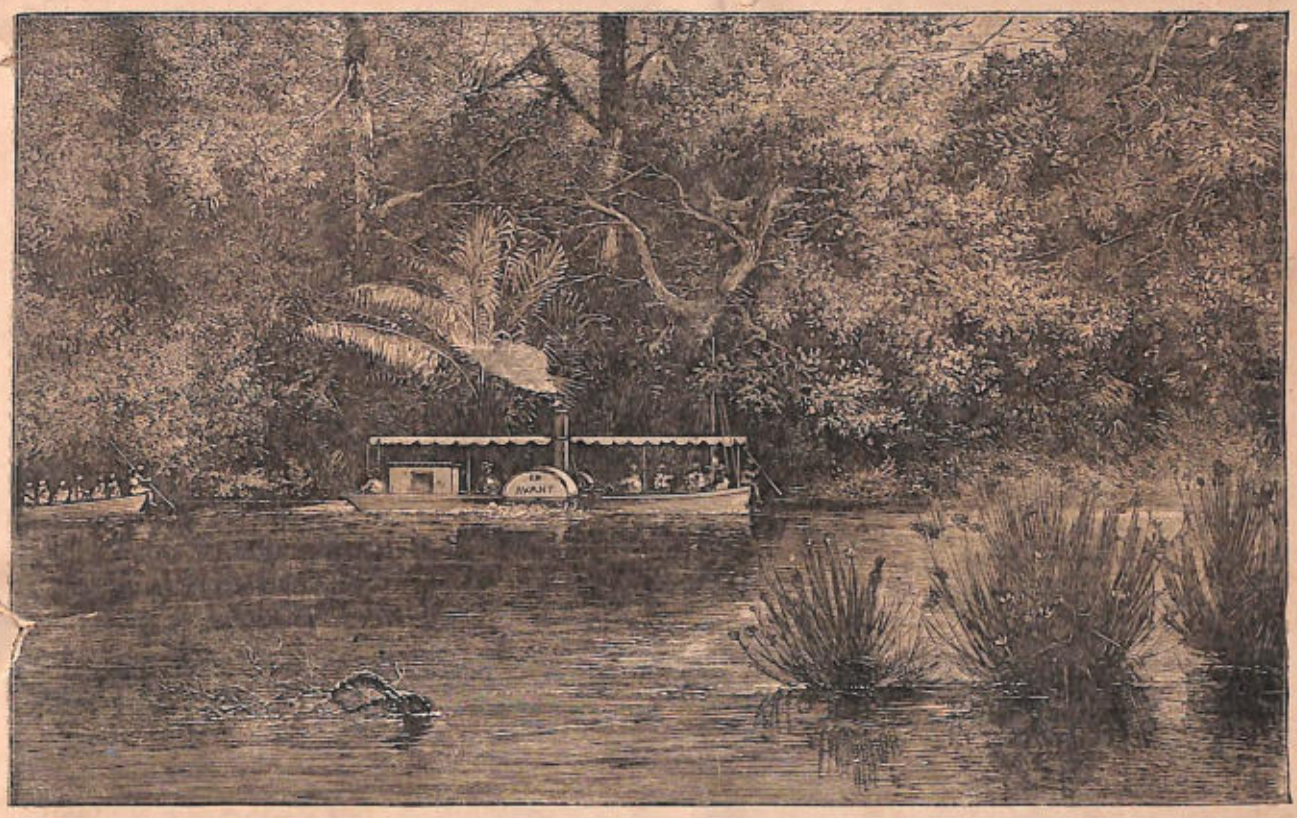

Fig. 4.—Banks of the Upper Congo.

the Europeans, and is only possible with a run home every eighteen months. Thus it is clear that if the resources of the Congo are to be developed, it must be by native labour, and there is therefore every inducement to treat the population humanely.

Of course, Mr. Stanley himself in his frequent journeys

Fig. 5.—A Type of the Basoko.

up and down the river has added considerably to our knowledge of it. His original sketch of its course, made in one rush downwards, seems, however, to have been wonderfully accurate; though the hundreds of observations as to direction, altitude, depth, and width has enabled him to lay it down with much greater precision. It is to be hoped that the geology of the basin will be well worked out, and even from a "utilitarian" standpoint it might be useful for the Association to engage one or two competent men to work out the geology. The numerous cataracts on the lower as well as on the upper river prove that there is much here to interest the geologist. On the lower river, just where the great central plateau begins to shelve down to the coast, they are to be expected; but what is the exact geological explanation of the numerous cataracts on the upper river and its tributaries, as far south as Bangweolo, let us hope, will ere very long be explained. The banks of the river itself are in many places remarkably picturesque; indeed Mr. Stanley would make us believe that he thinks no other river is equal to it in this respect. Magnificent bluffs, he tells us, are met with in many places, and gorges that are almost *cañons*. At Stanley Pool and elsewhere the river has broadened out into lake-like reaches studded with islands, and at one place a few miles south of the equator there is a complicated offshoot of lakes and streams which reminds one of what is observed in so many places on the Central and Lower Amazon. This stretch has not, however, been completely explored, though Mr. Stanley's account of his journey up the Kwa and Mfini to Lake Leopold is one of the most interesting chapters in the volume. The Kwa discharges at about 3° S. lat., and Lake Leopold, Mr. Stanley joins conjecturally to Lake Montumba, which is connected with the Congo at about fifty miles south of the equator.

With regard to the volume of discharge of the Congo, from careful observations made at Stanley Pool, Mr. Stanley calculated that it reached 1,436,850 cubic feet per second when the river at that point was at its lowest. During flood it rises, he believes, twelve feet higher, giving a volume of 2,529,600 feet per second. If these estimates are correct, then Mr. Stanley calculates that the river discharges into the sea three million cubic feet of water per second.

Mr. Stanley's new work is so fully occupied with the details of the founding of his numerous stations, his dealings with chiefs and people, his road-making and other engineering enterprises, and the general work of engineering the enterprise, that there is little space left for geographical details. He does give a list of the products of the Upper Congo region, but as this is entirely from a commercial standpoint, its value to science is not great. The various species of palms, as might be expected, abound on the banks of the river and its islands, the oil-palm being the most valuable from a commercial point of view. Then come the various species of india-rubber plants, besides other gum-producing trees. Ivory, Mr. Stanley reckons only fifth in rank among the natural products of the Congo. He presumes that there are

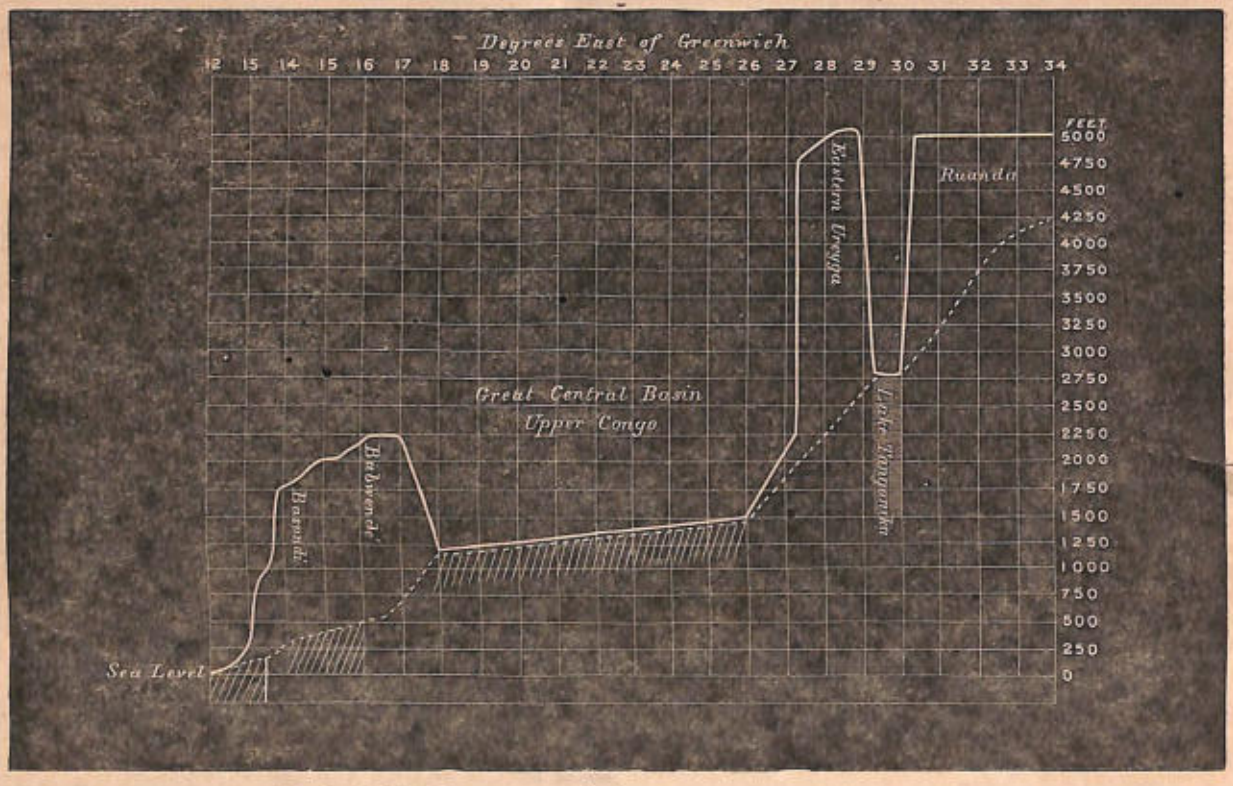

FIG. 6.—Profile of Country between the Sea and Ruanda, across the Congo Basin.

almost 200,000 elephants in about 15,000 herds in the Congo basin, each carrying an average of 50 lbs. weight of ivory in his head. Iron, he tells us, is abundant. The copper mines near Philippeville supply a large portion of Western Africa with their ingots. Plumbago is also abundant, and gold has been found in the beds of streams. Mr. Stanley gives a long list of tropical plants which abound in the Congo basin, while several European vegetables and fruits have been found to thrive. The Arabs, moreover, he tells us, are introducing the large-grained upland rice with extraordinary success. He adds many details concerning the trade, actual and possible, of the Congo region, his object, of course, being to show that here exists a magnificent field for the European trader, European capital, and European settlers.

Mr. Stanley's work is chiefly of value as telling the story of one of the most unique and interesting enterprises on record. This story he tells with abounding interest; there are many incidents throughout the volume told with the dramatic effect so well known to readers of "Through the Dark Continent." The work of founding the Free State has been well begun, but it is only the beginning; for the sake of its complete success it is to be hoped that nothing may occur to sever Mr. Stanley's connection with it until it has been firmly established.

NOTES

THE Royal Society's *conversazione*, held on the evening of June 10, was a very great success, and those who had the labour of bringing the various things together must have felt themselves amply rewarded by the great interest taken in them by the Fellows and guests, both ladies and gentlemen, who attended. Among the objects exhibited we may note the following:—Geological map (unpublished) of Palestine and Arabia Petræa, exhibited by Prof. Edward Hull, F.R.S.; original drawings of the skeletal, digestive, and vocal organs of birds, made in the years 1842-46, drawn and exhibited by Prof. W. K. Parker, F.R.S.; Sketches of the eclipse of the moon, October 4, 1884, and a very beautiful series of sketches of the wonderful sunsets and after-glows, painted and exhibited by Mr. W. Ascroft; star-charting by photography (enlarged prints from negatives made in 1883 and 1884), exhibited by Mr. A. A.

Common, F R.S.; electrical influence machine, exhibited by Mr. James Wimshurst; New microscope with novel fine adjustment and sub-stage arrangements, exhibited by Mr. Crouch; large Nicol prism polariscope, for projecting axes of crystals, &c., on the screen (improved form), exhibited by Messrs. Harvey and Peak; Tate's calculating machine, exhibited by the inventor. By means of this machine long operations in the fundamental rules of arithmetic can be performed with rapidity and unfailing accuracy. Eight figures can be multiplied by eight figures in about fifteen seconds. New forms of spectroscopes, exhibited by Mr. A. Hilger; photographs of fractures of railway carriage and waggon axles, tested to destruction by Mr. Thos. Andrews, Wortley Iron Works, near Sheffield, exhibited by Mr. Andrews; three cases of living animals: (1) Examples of the Tuatera (*Sphenodon punctatus*) from New Zealand. This reptile is remarkable as deviating from all the lizards in its osseous structure, and is considered by Dr. Günther (*Phil. Trans.*, 1867, p. 620) to constitute an order by itself—*Rhynchocephalia*. (2) Large bird-eating spider of the genus *Mygale* from Burmah—probably *M. fasciata*. (3) Butterflies and moths, showing the way in which living insects are exhibited in the Zoological Society's Insect House, exhibited by the Zoological Society of London. A series of microscopic sections of vegetable tissues, prepared and lent by Mr. J. E. Sunderland, of Hatherlow, near Stockport, showing remarkable effects of double and triple anilin staining; a series of botanical microscopic preparations, mounted by Charles Vance Smith, of Carmarthen, being part of a series prepared by him to illustrate the text-books of Julius Sachs and Otto Thomé, exhibited by Prof. Moseley, F.R.S. A series of slides with stained specimens of *Tænia echinococcus* of the dog, prepared and lent for the occasion by Dr. J. Davies Thomas, of Adelaide, Australia, in illustration of his paper on the artificial rearing of this parasite by feeding with human hydatids (to be read before the Royal Society, June 18); a slide showing the same species of tape-worm, reared by Mr. Edward Nettleship, F.R.C.S., by means of hydatids obtained from the lungs of a sheep (*Proc. Roy. Soc.*, 1866). To compare with the above:—Specimens, in bottles, of *Tænia serrata*, *T. marginata*, and *T. cænurus*, &c., artificially reared by Dr. Cobbold, by feeding dogs with the scolices appropriate to each particular species. Also adult examples of *Tænia cucumerina* and of *T. canis lagopodis* (*T. litterata*), the latter from Iceland, prepared by Dr. Krabbe, *Bothriocephalus dubius*, and other species from the cat and dog, exhibited by Dr. Cobbold, F.R.S. Case of gems, including a great Indian diamond, the largest known opal, a series of cat's eyes, and allied mineralogical specimens, exhibited by Mr. Bryce Wright, F.R.G.S.; "Frith's Selenium Cells," showing the alteration of resistance and photo-electric currents due to the action of light on selenium, exhibited by Prof. W. Grylls Adams, F.R.S; a sulphur cell, the electrical resistance of which, like that of selenium, is reduced by light, exhibited by Mr. Shelford Bidwell. The sulphur has been heated while in contact with silver, and therefore contains some sulphide of silver. The electrodes are of silver. The original integrating machine, invented by Mr. C. V. Boys; engine-power meter which has been developed from the same, exhibited by Mr. Boys.

We give in another column, on the *audi alteram partem* principle, the first part of an address recently given by Dr. Janssen, putting before us the French view of the Prime Meridian question. It will be gathered from it that the feeling in France is strongly against the conclusion at which the Washington Congress arrived. Taking the world as it is, however, much as a strictly neutral prime meridian might be to be desired, the general opinion will probably be that the Congress arrived at the only *practical* solution.

We are glad to see that University College, Liverpool, is about to appoint a Professor of Engineering. An endowment of 375*l.* has been raised, and the advertisement of the Chair appears this week in our pages. We understand that a certain amount of professional work, such as is consistent with a due fulfilment of the duties of the Chair, will be permitted, and recognised as enabling the Professor to keep himself in touch with the life of the practical world. The College already has endowed Chairs of Mathematics, Physics, Chemistry, and Biology, in addition to the Literary and Medical Departments: it has lately become a part of the Victoria University, and in many ways it shows signs of health and vitality.

In the production of the first part of the Philological Society's new English Dictionary, the editor, Dr. Murray, was obliged to advance 150*l.* out of his own resources, and, further, to incur a debt of 500*l.* The delegates of the Clarendon Press, who are publishing the Dictionary, decline to contribute more than 100*l.* towards the payment of this debt, and the Council of the Philological Society deem it their duty, therefore, to appeal to the public to relieve Dr. Murray from a debt incurred on behalf of what is really a national undertaking. It is to be hoped that there will be no difficulty in obtaining the sum required; those of our readers who are inclined to help should send their subscriptions to Mr. Benjamin Dawson, the Mount, Hampstead, London, N.W.

The Spanish Commission of Medical Inspection has examined the composition of the liquids and virus employed by Dr. Ferran against cholera. The opinion of the majority of the members is that the presence of Koch's *Bacillus virgulus* cannot be questioned. After some opposition, the Spanish Government granted the necessary authorisations for inoculation, which has been practised on a number of doctors and four newspaper writers. It is said, moreover, that all the inoculated patients experienced during the first twenty-four hours after the operation all the symptoms of cholera with more or less intensity, but without any fatality having occurred. When twenty-four hours had elapsed, a favourable reaction took place. The question which remains to solve is the extent of the protection resulting from Dr. Ferran's system. The numbers given are in favour of the new theory, but all the documents coming from Spain on cholera must be received with caution, owing to the intense panic prevailing in that country since the last outbreak of the plague was noticed in Valencia. A fact curious to notice is the tendency of the rural populations of this province to congregate in the cities in spite of all the measures taken against this exodus. *El Imparcial* states that not less than 7000 people have located themselves in the chief city.

Prof. Pasteur, the *Standard* Paris correspondent states, has published an interesting letter from Dr. Ferran, concerning vaccination for cholera. In this letter Dr. Ferran asserts that the results obtained become every day more irresistibly eloquent. The experience of Alcira had been confirmed in numerous other towns. Anti-cholera vaccination had been practised upon all classes of society, but in many places the greater number of those operated upon belonged to the pauper class, and the results proved no less satisfactory. While of opinion that one inoculation is effective, Dr. Ferran recommends that it be repeated, in order to make assurance doubly sure. In reference to the official prohibition of vaccination for cholera (which has since been cancelled in deference to public opinion), Dr. Ferran intimates that the measure was taken in consequence of two persons belonging to an already cholera-visited family dying the day after vaccination. These casualties Dr. Ferran attributes to the use of impure lymph, and states that in 16,000 cases, for which he had personally inspected the lymph, no evil results had followed. It is

not claimed that vaccination for cholera will give actual immunity, but that it will alleviate the attack whenever it may come. Anti-cholera vaccination, affirms Dr. Ferran, can never itself be the cause of an attack. If an attack comes within five days of vaccination it must have been previously contracted. Dr. Ferran attributes the discovery of anti-cholera vaccination to the theories of Prof. Pasteur.

Dr. Cornish, known for his investigations into the nature of cholera, has proposed (according to *Allen's Indian Mail*) that as between 300 and 400 persons are every year judicially sentenced to death in the Indian Empire and its dependencies, a number of these, say one-tenth, be made, with their own full knowledge and consent, subjects of experiments as to the spread of cholera, on condition that if they escape their lives be spared. An international commission of experts might, he suggests, be appointed to determine upon the experimental tests needed to ascertain if cholera is or is not a disease capable of being communicated from person to person. This would do more in the space of a few months to help forward the inquiry into the nature of cholera than has been accomplished by indirect observation during the last century. But if the principle underlying this proposal is admitted by the Indian Government, it might be extended to other most important experiments, such as the various causes and cure of cholera, the cure for snake-bites, hydrophobia, and the like.

The following is an official statement of the number of visitors to the Whitechapel Fine Art Exhibition during the time it was open in March and April last:—Saturday, March 28, 1008; Sunday, March 29, 2494; Monday, March 30, 2622; Tuesday, March 31, 3332; Wednesday, April 1, 3292; Thursday, April 2, 1823; Good Friday, April 3, 3703; Saturday, April 4, 3269; Easter Sunday, April 5, 2717; Easter Monday, April 6, 4332; Easter Tuesday, April 7, 3720; Wednesday, April 8, 2944; Thursday, April 9, 2872; Friday, April 10, 1942; Saturday, April 11, 3348; Sunday, April 12, 3345; total for 16 days; 46,763. The Exhibition was opened in the afternoon of March 28, admission being by ticket only until 6 p.m., 6 to 10 p.m. free; after that it was opened free from 10 to 10 daily (Sundays 2 to 10).

At the meeting of the International Committee of Meteorology (instituted by the Congress held at Rome) in the beginning of September next, at Paris, the following topics will be considered:—Report of the Secretary on the work of the Committee since the Copenhagen meeting; report of MM. Brito Capello, Hildebrandson, and Ley on the observation of Cirrus; Should a third International Congress be convoked? the establishment of stations of the first order on the Congo; discussion of the meteorological *résumés* issued in different countries, and eventual preparation of a more uniform plan; the utility of American meteorological telegrams proposed by Gen. Hazen, and organisation of their distribution in Europe; best means of securing the timely reception of meteorological telegrams; ought barometric heights to be reduced to the pressure under 45° of latitude? Should meteorological hours be reckoned from 1 to 24 in conformity with the resolution of the Washington Conference? Designation of a completely covered sky as to the form of clouds; definition of days of rain and snow; should not a uniform height above the ground be recommended for pluviometers? recent progress in the more exact measurement of snow; international meteorological tables; modification of the rules for administration of the International Meteorological Committee. Communications should be addressed to Mr. R. H. Scott, F.R.S., Meteorological Office, 116, Victoria Street, London, S.W.

In a communication to the Physical Society of Berlin, on April 24 Herr Kayser read a note concerning his experiments on the condensation of gases on surfaces, and Bunsen's criticisms thereon. In a paper published last year Bunsen had declared that the previous results under this head were erroneous, inasmuch as the observers had proceeded upon the false assumption that a maximum of condensation was attained in a few hours or days, Bunsen himself finding that the condensation might go on slowly for years. Herr Kayser, however, had, in reply, pointed out that Bunsen had not been sufficiently careful in cleaning the glass surfaces on which his experiments were made, and he now had the satisfaction to announce that Bunsen, after repeating his experiments with the necessary precautions, had arrived at the same conclusion as himself, namely, that there was no demonstrably slow condensation, but that the maximum of condensation was reached with extraordinary rapidity.

The project to build a "Grassi-Museum" has now assumed a tangible shape at Leipzig, inasmuch as the site for the new museum has been chosen. The new museum is to contain the collections belonging to the Ethnographical Society, which are now crammed into premises entirely unsuitable for them.

Dr. Otto Zacharias has recently made interesting researches concerning the freshwater fauna of the Silesian Riesengebirge and the county of Glatz. The Royal Prussian Academy of Sciences has just granted him a sum of money towards the continuance of his labours.

Mr. Howard Newton, assistant municipal engineer, of Singapore, has published a series of notes and experiments on the different kinds of timber in ordinary use in the Straits Settlements. The pamphlet contains observations on the forests adjoining our colonies in the Malay Peninsula, and the need already of conservation. The trees are felled in large numbers for ordinary use, and the jungles are cleared and exhausted by the Chinese gambier and pepper planters. Twenty specimens of woods are then described in detail, and finally an account of the mode in which the experiments were conducted and elaborate tables of the results follow. The breaking weights of some of the timbers tested were as follow:—1850, 1836, 1656, 1374, 1286, and 1284 lbs. Notes on the toughness, fracture, deflection, &c., are also given. It is curious to notice that some of the finest trees near Singapore (in the Johore forests) have no botanical equivalents. Mr. Newton specially mentions a tree called by the Malays the *ballow*, which grows from 60 to 100 feet in height, with a diameter of 3 to 6 feet. It is a close-grained, tenacious, hard, heavy wood, very valuable for building. It is called popularly Johore teak, although it does not belong to the natural order *Verbenaceæ*.

The Russian Geographical Society has awarded a gold medal to M. Klossowski for his work on thunderstorms in Russia. We take the following from M. Rykatcher's analysis of this remarkable work. The initiative of thunderstorm observations having been taken by the Geographical Society in 1871, no less than 1821 regular observations were made during the years 1873 to 1882 at 176 different stations. For 145 of them annual and monthly averages were calculated, and gave the following interesting results. The minimum of thunderstorms (5 to 7 per year) is found in the north; their number increases towards the Gulf of Finland (with a depression south of it) and on the middle Volga, where it reaches 12 to 15 per year, and remains nearly the same throughout middle and southern Russia, with a slight decrease in the Crimea. A rapid increase in the number of thunderstorms is found in Western Russia, especially in Bessarabia (33 at Kishineff), as also in the East, at Tamboff, Penza, and on the Lower Don. The maximum of thunderstorms, 41 per year, is found at Tiflis. As might be expected, the thunderstorms are more frequent where the summer rains and the relative humidity are the greatest. Their diurnal maximum is between

3 and 6 p.m., and the minimum between 3 and 6 a.m. Availing himself of the synoptical maps of Hofmeyer for 1874 to 1876, the author compares, day after day, the thunderstorms with the cyclones which reach Russia, and he arrives at the important conclusion that thunderstorms in Russia—without exception—accompany cyclones, their appearance being influenced at the same time by the local state of temperature and humidity. Marié-Davy, Mohn, and others subdivided thunderstorms into cyclonic and local ones, and the continental ones were reckoned to the second category; but M. Klossowski shows that even in so continental a climate as that of Russia, thunderstorms depend also directly on cyclones. They appear on the borders of the cyclones and mostly in their south-eastern quarters. By further researches, the author arrived at the conclusion that thunderstorms in Russia are secondary or tertiary cyclones appearing on the borders of a cyclone, and thus explains the oscillations of the barometer during thunderstorms, already noticed by Messrs. Scott, Mascart, and others. Hail is obviously closely connected with thunderstorms. It also accompanies cyclones and is always concentrated in its south-eastern quarter, in the zone of 750 to 760 millimetres' pressure. On the whole, the work of M. Klossowski is a valuable contribution to the study of electrical energy in the atmosphere.

In a lecture delivered in the Institute of the Khedive at Cairo, Dr. G. Schweinfurth has given some account of the seats of manufacture of prehistoric stone implements in the desert of Eastern Egypt discovered by him in 1876 and 1877, and again visited and examined by him in his last journey. The two spots referred to are in the Wadi Sanur and Wadi Warag. The former lies due east of Beni Suef at a distance of thirty miles from that town; the latter is in the upper portion of the Wadi at the place where this water-course begins to be discernible as a longitudinal depression on the heights of the western part of northern Galala. Dr. Schweinfurth's belief that the two sites in question are really those of ancient manufactories of stone implements is grounded partly on the presence of accumulations of cores in the beds of the streams, partly on the fact that the raw material is found abundantly in the neighbourhood. The source of the raw material is a bed of flints belonging to the upper nummulitic limestone corresponding to that which exists behind Cairo. Implements and utensils indicating a stone period have now, Dr. Schweinfurth remarks, been found even in the very heart of Africa, and these show a surprising resemblance in form to those discovered in Europe. Those recently obtained by himself from Sanur and Warag, however, are of a special type, and Dr. Schweinfurth regards them as clearly distinguished from the forms already familiar by the fact that the facets are usually only upon one side and are very seldom seen surrounding the entire core.

In connection with the trial of Pel for poisoning, which has just resulted in Paris in the condemnation of the accused, some interesting experiments were conducted at the Morgue with a view to testing whether it was possible, as alleged by the prosecution, that the murderer could have got rid of the body of one of his victims by burning it piece by piece in a common stove. The professional witnesses stated that they procured a body weighing sixty kilogrammes. They removed from it forty kilogrammes of organic matter, and lighted a fire of wooden logs. They thus ascertained that in an hour the complete reduction to ashes of one kilogramme of organic matter could be effected, and in forty hours the complete combustion of a body weighing sixty kilogrammes could be completed. The accompanying smell was not disagreeable. The bearing of this on the question of cremation is obvious. It is possible to consume the human body by fire at a comparatively small expense, as these experiments show. In Japan, where cremation has been practised for ages, the quantity of wood consumed in the cheapest cremation is so small that European doctors doubted the evidence of eye-witnesses. Cremation of the lowest class costs only two shillings, on account of the small quantity of wood used, and the operation generally lasts from six to nine hours. The smell for a considerable distance around the crematorium is, however, of a very offensive kind, and the accessories are, as a rule, far from agreeable. There is, however, no doubt that the body can be consumed at a far less expenditure of fuel than is generally considered possible.

The following appears in the *Times*:—Last autumn, a bookseller named Meyer, of Ronneburg, tied a water-proof label under the wing of a swallow which had occupied a nest at his house, and had become comparatively familiar. On it he wrote a query in German to the effect that he wished to know where the swallow would pass the winter. The bird returned to its former nest bearing an exchange label similarly fastened, saying, in German also, "in Florence, at Castellari's house, and I bear many salutations."

The Austrian Government has refused to authorise the establishment of private cremation societies, on the ground that they might encourage crime. The decree states that murders are often detected by the exhumation of bodies, and that, even if bodies were to be examined before cremation, there would be no time to apply in every case those delicate chemical tests which are used where poisoning is suspected.

A telegram from Tiflis states that a severe earthquake has occurred in the Eastern Caucasus. The town of Sikuch is said to have been completely swallowed up. The loss of property is estimated at several million roubles.

The latest telegrams from India state that the Cashmere earthquakes continue to occur with increased severity. It is reported that 2280 persons have perished in the district of Muzufusabad.

Information has been received at the Hague from Java that the state of Krakatoa was causing some anxiety. Towards the end of April subterranean sounds were heard in the neighbourhood day after day, and flames arose from the crater. The rocks which emerged from the sea during the last eruption suddenly disappeared.

From a report of Mr. H. Walker, Commissioner of Lands of British North Borneo, it appears that gold exists in considerable quantities in that territory. Some natives had brought a little to Sandakan, and Mr. Walker set out to verify its existence in the Sagama district. He searched thirty or forty different places and found gold at almost every place, generally in small distinct specks, large enough to be gathered with the fingers, sometimes larger, and always in conjunction with a black metallic dust and iron or copper pyrites. The rocks met with were granite, gneiss, quartz, limestone, jasper, porphyries, red sandstone. Steps will probably be taken to have the whole region thoroughly examined by a competent geologist. The minerals already ascertained to exist in North Borneo are gold, silver, copper, chromium, tin, plumbago, lead, and coal. Antimony and cinnabar are reported. On the west coast chromium, copper, and arsenic have been found; in the neighbourhood of Kinabalu silver ore and pyrites; a sample of native copper has been sent to London; a rich sample of galena and silver, yielding on assay 115 ounces of silver to the ton, has been found. Hitherto the officials of the Company and the other Europeans on the coast have been dependent for local information respecting these and other minerals on the rough statements of natives. It appears certain, however, that, besides its great forest and agricultural wealth, British North Borneo is also rich in minerals—how rich

cannot be said until a thorough examination by an expert has been made.

ACCORDING to the *San Francisco Courier* the great glacier of Alaska is moving at the rate of a quarter of a mile per annum. The front presents a wall of ice 500 feet in thickness; its breadth varies from three to ten miles, and its length is about 150 miles. Almost every quarter of an hour hundreds of tons of ice in large blocks fall into the sea, which they agitate in the most violent manner. The waves are said to be such that they toss about the largest vessels which approach the glacier as if they were small boats. The ice is extremely pure and dazzling to the eye; it has tints of the lightest blue as well as of the deepest indigo. The top is very rough and broken, forming small hills, and even chains of mountains in miniature. This immense mass of ice, said to be more than an average of a thousand feet thick, advances daily towards the sea.

IT is contemplated to use the electric light in Algiers for night work during harvest time, in order to escape the heat, which is almost murderous for Europeans, and is an obstacle to their carrying on agricultural work.

THE borings undertaken for scientific purposes in the shaft situated near the railway station of Koetzschau, about five miles from Lützen (Germany), have now reached the depth of 1500 metres. Observations of temperature are now being made in the shaft.

THE Norwegian Government has voted a sum of 50*l.* to Dr. O. J. Olsen for the prosecution of his studies of wild edible mushrooms.

THE education of girls in Russia does not appear to stand very high. According to the *Moskow Viedomoski* only 21 children out of 100 attending school were girls. The proportion varies with the religion. Thus, of Protestants the number was greatest, viz. 45·4 per cent.; of Jews, 34·1 per cent.; and of Roman Catholics, 14·4 per cent. The number is lowest amongst Greek Catholics, viz. 12·3 per cent.

THE additions to the Zoological Society's Gardens during the past week include a White-fronted Capuchin Monkey (*Cebus albifrons* ♂) from South America, presented by Mr. E. Luxmore Marshall; a Macaque Monkey (*Macacus cynomolgus* ♂) from India, presented by Mr. A. R. Brown; a Martinique Gallinule (*Ionornis martinicus*), captured at sea, presented by Mr. G. S. Webb; two Grey-breasted Parrakeets (*Bolborhynchus monachus*) from Montevideo, presented by Miss Buist; a Red and Blue Macaw (*Ara macao*) from Brazil, presented by Mr. J. W. Beswick Purchas; a Yellow Conure (*Conurus solstitialis*) from Venezuela, presented by Mr. Albert H. Nicholson; a Barn Owl (*Strix flammea*), British, presented by Mr. W. Ostle; an Æsculapian Snake (*Coluber æsculapii*) from Central Europe, presented by Miss Lenox Conyngham; a Domestic Sheep (*Ovis aries*, var. ♂) from Somali Land, deposited; two Larger Tree-Ducks (*Dendrocygna major*) from India, two Gould's Monitors (*Varanus gouldi*), two Great Cyclodus (*Cyclodus gigas*), two Carpet Snakes (*Morelia variegata*), three Diamond Snakes (*Morelia spilotes*) from New South Wales, received in exchange; a Japanese Deer (*Cervus sika*), three Pigmy Hogs (*Porcula salvania*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

COMETARY ORBITS.—Prof. J. G. Galle has formed a most useful and very complete catalogue of orbits of comets which have been calculated since the publication of the third edition of Olbers's "Methode zur Berechnung der Cometenbahnen" in 1864. This catalogue appears in Nos. 2665-66 of the *Astronomische Nachrichten*. In one table are collected orbits of comets before 1860, which have been more definitively determined during the past twenty years, with a few orbits of ancient comets computed for the first time or founded upon better data, including those observed by Toscanelli; in a second table are contained the most reliable orbits of all comets discovered since the year 1860. The elements are given in an approximate form only, but in the notes accompanying each table reference is made to the place of original publication. Prof. Galle's *résumé* will be of much service to the student in this branch of a tronomy. It appears to have been drawn up on the suggestion of Prof. Krüger, seeing that there was no immediate intention of publishing a fourth edition of Olbers's celebrated treatise. Five newly-detected comets of short period figure in the second table.

BINARY STARS.—The following calculated angles and distances of several of the more rapidly revolving double-stars will serve to indicate how nearly measures made about the present time are represented by the best available orbits:—

Star	Epoch	Pos.	Dist.	Authority for orbit
		°	"	
ζ Cancri ...	1885·0	62·0	0·93	Seeliger
	1886·0	57·6	0·95	
η Coronæ Bor. ...	1885·5	173·9	0·61	Doberck
	1886·5	182·2	0·65	
ζ Herculis ...	1885·5	90·3	1·49	Doberck
	1886·5	85·3	1·50	
μ^2 Herculis ...	1885·5	285·6	0·80	Doberck
	1886·5	296·5	0·76	

Dubjago's orbit of β Delphini (Burnham 151) gives for 1885·6, Pos. 238°·1, Dist. 0″·28.

TYCHO'S NOVA OF 1572.—Some years since it was shown by Prof. Wolf that this object was observed by Lindauer at Winterthur on November 7, 1572, and it is equally certain that it was seen by Maurolycus at Messina at its meridian transit on the following evening, though there appears to be some confusion between altitude and declination in his published description. It was not seen by Tycho until November 11.

In 1808 the Abbé Scina, in a work printed at Palermo, entitled "Elogio di Francesco Maurolico," referred to his observations of this star, apparently given in the first instance in a special treatise written by Maurolycus (*Judicium de nova stella*), to which Lalande alludes in his Bibliography, and subsequently in 1613 in a life of the astronomer written by his nephew. According to Clavius, Maurolycus thus records his first observation of the star: "Hanc ego stellam in hoc Messanæ horizonte observans in meridiano extantem circa tertiam noctis horam reperi altitudinem ejus esse 62. Unde conjecturam feci eam locari quasi, in summitate circuli arctici, ut distet hic a meo vertice per gradus 28, ac proinde ab æquatore per gradus 66½ fere, quoniam Messanæ latitudo habet gradus 38½, et eam sitam in puncto, in quo colurus æquinoctiorum secat arcticum circulum, aut ipsi puncto vicinissimum."

According to Argelander the place of the star for 1573·0 was in right ascension 0h. 1m. 52s., declination 61° 46′·4; the sidereal time at mean noon at Messina on November 8 was 15h. 49m. 50s., and consequently the star was on the meridian at 8h. 10m. 41s. mean time, or at 8h. 24m. 46s. apparent time, 3h. 24m. after sunset, and, the latitude of Messina being 38° 11′, the meridian altitude was 66° 25′, which was the distance from the equator given by Maurolycus. Nevertheless the Abbé Scina did not agree with Piazzi's suggestion that there was a typographical error in Clavius, and that 61½° should be substituted for 66½°. The only alternative, however, would point to an error of 4° or 5° in the observation (or estimation), and Scina writes of Maurolycus at this time that he was "très-avancé en âge (il avait alors 78 ans) dépourvu d'instrumens, accablá d'infirmités." . . . Zach sought unsuccessfully for the special work by Maurolycus, as well as for his "Life" by his nephew; Lalande gives no particulars of the former, and hence recourse has to be had to Clavius, who, as stated above, made some extracts from the *Judicium*.

ASTRONOMICAL PHENOMENA FOR THE WEEK, 1885, JUNE 21-27

(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 21

Sun rises, 3h. 45m. ; souths, 12h. 1m. 30·5s. ; sets, 20h. 18m. ; decl. on meridian, 23° 27′ N. : Sidereal Time at Sunset, 14h. 19m.

Moon (Full on June 27, 11h.) rises, 14h. 14m. ; souths, 19h. 44m. ; sets, 1h. 5m.* ; decl. on meridian, 8° 24′ S.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury ...	3 12	11 29	19 46	23 33 N.
Venus ...	4 38	12 58	21 18	23 51 N.
Mars ...	2 4	10 0	17 56	20 26 N.
Jupiter ...	9 6	16 13	23 20	12 9 N.
Saturn ...	3 43	11 52	20 2	22 30 N.

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

Phenomena of Jupiter's Satellites

June	h. m.		June	h. m.	
21 ...	21 9	I. occ. disap.	25 ...	22 30	III. ecl. reap.
22 ...	20 47	I. tr. egr.	27 ...	20 23	I. tr. ing.

The Phenomena of Jupiter's Satellites are such as are visible at Greenwich

June	h.	
21 ...	— ...	Sun at greatest declination north ; longest day in northern latitude.
24 ...	8 ...	Mercury at least distance from the Sun.
26 ...	20 ...	Venus at least distance from the Sun.
27 ...	15 ...	Mercury in superior conjunction with the Sun.

GEOGRAPHICAL NOTES

THE last issue of the *Izvestia* of the Russian Geographical Society (xx., 6) contains an interesting paper, by M. Kosyakoff, topographer, who accompanied, in 1882, Dr. Regel during his journey through Karategin and Darvaz. The paper deals almost exclusively with the topography of the explored region, and thus gives a plain description of the explored routes, containing the necessary topographical data for forming an opinion on the much-debated questions as to the orography of that part of the Pamir region. A route-map, on the scale of ten miles to an inch, accompanies the paper. Starting from Penjkent, M. Kosyakoff soon reached the 9800 feet high lake, Kouli-kalam. Then he crossed the 12,000 feet high and snow-covered Badkhana Mountains which separate the Zarafshan from the upper Surkhab, tributary of the Fan, and continuing to make his way amidst deep and rocky mountain-gorges, he soon reached the lake, Iskander-kul, 7120 feet above the sea-level. Thence, crossing the Mura Pass, richly clothed with vegetation on its northern slope, the expedition descended to Karatag and Hissar, and, by a route quite suitable for carriages, they proceeded further to Kabadian. A good route along the Waksh River brought Dr. Regel and his travelling companions to Kurgantube ; but, to reach Koulab, they had to cross the Tash-robat Pass, all covered from top to foot with pistach trees. From Kulab, which is more animated than Kabadian, the expedition went to the rich Mumin-abad Valley, peopled with Tadjiks agriculturists ; thence to the twenty-five villages of the Dara district, and, continuing their journey north-east on the right bank of the Pendj, they soon reached Kala-i-khumb. The Pendj River being there but thirty-five miles distant from Tavil-dara on the Waksh, the expedition went there before proceeding further up the Pendj, and followed the upper Waksh in a north east direction for some fifty-five miles. From Kala-i-khumb, M. Kosyakoff made a further very interesting excursion up the Pendj and its tributary, the Vantch, up to its source, whence he was compelled by a fever to return to Kala-i-khumb and thence to Samarcand. The map published by the *Izvestia* contains, moreover, the very interesting route from Tavil-dara to Bal-juan, and thence to Hissar, and further west to Baisoun, Anar-bulak, and Var-tube.

AMONG the works announced for this year by the Russian Geographical Society we see the last fascicule of the valuable "Geographical and Statistical Dictionary of Russia ;" the atlas of maps to accompany Baron Kaulbars' work on the delta of the Amu-Daria ; a geognostic map of the shores of Lake Baikal, by M. Chersky ; the work of Dr. Sperck on the Amur region ; and a work by M. de Vollan on the songs of Ugrian Russians. There is promised, also, the long-expected results of the great survey of Siberia, from the Ural Mountains to Lake Baikal, accomplished in 1874. The commander of the expedition having died since, the work had to be given for calculations to other persons ; but now the name of M. Tillo, who has undertaken its publication, is a guarantee that this capital work will not be lost to science.

DR. FISCHER, of the University of Marburg, the author of a monograph on the climate of Mediterranean countries, read a paper before a recent meeting of the Verein für Erdkunde at Halle on the morphology of the coasts of the Mediterranean, which is reprinted in the *Hallische Zeitung*. "The Mediterranean," he said, "was specially important for some investigations into physical geography, for it has been the theatre of a long history, and we have therefore information about its coasts extending over many centuries. Although it washes the shores of three continents, this sea exhibits a striking similarity in its *fauna* and *flora* everywhere. It must, therefore, in its present form, belong to one of the most recent geological periods, even though particular basins may be much older. It owes its origin to great movements in the crust of the earth, and the form of its coasts is attributable to the same cause, modified by more recent influences. In the present coast formation in the north-western basin, two different types are perceptible, which may most conveniently be designated as the North Sicilian and the Languedoc types. If we follow the coast of Italy from Naples, then the Sicilian and North African coasts around to the Straits of Gibraltar, we meet with twenty-two smaller bays having the form of a semicircle. Their sizes do not vary greatly, the chord of the smallest being 15 km., that of the largest 65, and that of the great majority between 30 and 35 kms. Over this extent the coasts are almost everywhere precipitous, and a short distance from the shore the sea deepens rapidly. How has this formation arisen?" Quoting Suess's "Das Antlitz der Erde," Dr. Fischer said, "there appeared to be all along this coast a great fissure in the crust of the earth. The formation of the Appennines, the Atlas and the occurrence of volcanic phenomena along the whole line would point to this. But this would not account for the bays here mentioned ; many of these are probably due to the sea washing away the softer from amongst the harder rocks. The projecting headlands are hard, old, crystalline rocks, while inside are the newer and softer kinds. These inlets, too, are not found everywhere along the coast, but only where the harder rocks are present. That the coasts here are greatly exposed to denudation by the action of the waves is shown by the numerous caves and cliffs, and the violent surge which beats against the vast harbour-works of the French on the coast of Algeria. The prevailing winds there are north and north-east, and thus assist the waves. Another factor is the current, which flows eastwards along the north coast of Africa from the Straits of Gibraltar. This meets the projecting capes and headlands, which deflect part of it into the bays, creating in the latter a counter-current which acts as a scour, keeping the bottom free from alluvium, and also exercising its influence on the semi-circular formation of the inlets. The Bay of Tunis is an exception. This is much deeper than the others, and the currents cannot therefore exercise the same influence over it. The alluvium is deposited, the River Medjerda brings down its contribution, and the result is a constant formation of land there. This bay belongs rather, on this account, to the second type, existing on the Mediterranean coasts of Northern Italy and Languedoc. The Tuscan coast was originally similar to that of Lower Italy, but it has now been altered beyond recognition. Here, to the west of the Appennines there is a wide district with easily-denuded rocks. The rivers, especially since man has so disafforested the region, bring down vast quantities of alluvium. The current which flows into the Tyrrhenian Sea is deflected northward along the coast, and causes the deposit of the alluvium inshore, so that the ancient bays are gradually silting up. In ancient times the shores of this now harbourless sea had numerous bays, and Tyrrhenians were skilful navigators. At the mouth of the Arno the operation is best seen. Pisa, which was founded as the port on the sea at the mouth of the river, was no longer on the coast in Strabo's time, and is now some distance inland. The land-formation on the coasts of Languedoc is even more striking. In former times there were steep shores, protected by a row of islands, behind which lay a calm inland sea, on which the city of Narbonne was built. The sea silted up from inside and out—from inside by the rivers, from outside by the currents created by the frequent south-east winds which conveyed the alluvium of the eastern rivers, especially the Rhone, and deposited it there. The islands became joined to the land, and the inland sea disappeared. Thus arose on these coasts the flat plains, behind which are small lakes and marshes.

AT the meeting of the Paris Geographical Society of May 22 further information was read respecting the expedition of M. Teisserenc de Bort to explore the Sahara. Leaving Tuggurt, they marched south-south-west to Hassi Ouled Miloud, the last point visited by the Flatters mission. Thence, passing through Bereçoff, they ultimately reached Gabes. Near Ghourd-Rouned M. de Bort found well-marked traces of an old lake of sweet water, about a kilometre long, and 700 or 800 m. wide. In the depression thus created there were evidences of a prehistoric station in numerous flint arrow-heads, and from this point to Gabes the presence of man at a very ancient epoch was attested by chipped flints.—M. de Quatrefages read a paper on the Red Indians, and on the half-breeds of the United States and Canada. The position which the writer maintains is that the Indians do not diminish so rapidly as is generally believed, as, for example, the Maoris. The half-castes are put in the census as whites; Indian women married to whites are similarly counted. "Placed in favourable conditions, the Red-skins, far from diminishing in number, have increased, and are increasing. But they have not preserved their ethnic purity. Mixture with white blood has taken place even in the most remote tribes, and perhaps now the number of natives of pure blood is insignificant everywhere; but, on the other hand, the blood of the natives is mixing more and more with that of the whites, and the latter accept more easily day by day the half-breed as one of themselves." Although the Red Indians are disappearing as such, they will still live in the future true Anglo-American race. M. Henri Condreau gave a succinct account of six journeys which he made between 1881 and 1885 in Guiana. The writer is Professor at the Lycée at Cayenne, and performed two of these journeys during vacations; the others were undertaken at the request of the Governor of French Guiana. The most important one was from Manaos through the whole of Central Guiana, between the Rio Negro and Cayenne. He had already performed two-thirds of his task, and passed the sources of the Trombette, when he lost all his articles for barter amongst the Indians, and was deserted by his followers. During four months he was alone amongst savages, ultimately arriving at his destination by a forced march of thirty days through the virgin forest.

BEFORE the Society of Commercial Geography in Paris, M. Andreau described the prairies of Guiana which he traversed in his journey between the Rio Negro and Cayenne. Behind the enormous forests which extend inland from the coasts he found prairies wholly devoid of trees, where the air was dry and the climate mild. He strongly advocated the establishment of agricultural colonies there, describing the climate as in all respects the reverse of that found on the coast.

THE well-known African traveller, Major Serpa Pinto, is stated to have discovered large coal-fields south of the Rovuma River. The Rovuma is a coast river, and its estuary is situated about 11° S. lat. Along its banks runs the ancient caravan route from Cape Delgado to Lake Nyassa. The coal-fields were first claimed by the Sultan of Zanzibar, but have now been taken possession of by the Portuguese Government.

A SCIENTIFIC expedition under the charge of Lieut. Hovgaard, of the Danish Navy, is being prepared to investigate the eastern coasts of Greenland. M. Gamel, the owner of the vessel, has put it at M. Hovgaard's disposal, and the Danish Government will pay the cost of the expedition.

M. HANSEN-BLANGSTED has reported to the Geographical Society of Paris that the first steamer coming directly from the open sea arrived at Cologne on March 18. It is called the *Industry*, belongs to a company of Mannheim, and is of 513 tons burden. "This is an event important not only for Cologne, but also for every town on the Rhine."

PROF. KARL GOTTSCHE, of the University of Kiel, has just returned from his travels in Eastern Asia. After having lectured on Mineralogy and Geology for several years at Tokio, he undertook a scientific exploring expedition in Korea, at the request of the Korean Government, which lasted until December, 1884. His route extended over 3000 kilometres. Dr. Gottsche intends shortly to publish his geological, mineralogical, and ethnographical investigations of Korea. To our knowledge this is the first scientific investigation of the great East-Asiatic peninsula.

DR. H. Z. C. TEN KATE departed on May 18 from Southampton. He goes to the interior of Surinam, where he intends to devote himself to anthropological and ethnological studies. A grant has been given to him by Dr. Riebeck (Halle a/S) and Prince Roland Bonaparte.

A TELEGRAM dated "near Herat, June 9," states that, pending the settlement of the frontier question, the Frontier Commission is exploring and mapping out the country in all directions.

ON THE MESOZOIC FLORAS OF THE ROCKY MOUNTAIN REGION OF CANADA[1]

IN a previous memoir, published in the *Transactions* of the Royal Society of Canada, vol. i., the author had noticed a lower cretaceous flora consisting wholly of pines and cycads occurring in the Queen Charlotte Islands, and had described a dicotyledonous flora of Middle Cretaceous age from the country adjacent to the Peace River, and also the rich Upper Cretaceous flora of the coal formation of Vancouver's Island—comparing these with the flora of the Laramie series of the North-West Territory, which he believed to constitute a transition group connecting the Upper Cretaceous with the Eocene Tertiary.

The present paper referred more particularly to a remarkable Jurasso-Cretaceous flora recently discovered by Dr. G. M. Dawson in the Rocky Mountains, and to intermediate groups of plants between this and the Middle Cretaceous, serving to extend greatly our knowledge of the Lower Cretaceous flora and to render more complete the series of plants between this and the Laramie.

The oldest of these floras is found in beds which it is proposed to call the Kootanie group, from a tribe of Indians of that name who hunted over that part of the Rocky Mountains between the 49th and 52nd parallels. Plants of this age have been found on the branches of the Old Man River, on the Martin Creek, at Coal Creek, and at one locality far to the north-west on the Suskwa River. The containing rocks are sandstones, shales, and conglomerates, with seams of coal, in some places anthracitic. They may be traced for 140 miles in a north and south direction and form troughs included in the Palæozoic formations of the mountains. The plants found are conifers, cycads, and ferns, the cycads being especially abundant and belonging to the genera Dioonites, Zamites, Podozamites, and Anomozamites. Some of these cycadaceous plants, as well as of the conifers, are identical with species described by Heer from the Jurassic of Siberia, while others occur in the Lower Cretaceous of Greenland. The almost world-wide *Podozamites lanceolatus* is very characteristic, and there are leaves of *Salisburya sibirica*, a Siberian Mesozoic species, and branches of *Sequoia smittiana*, a species characteristic of the Lower Cretaceous of Greenland. No dicotyledonous leaves have been found in these beds, whose plants connect in a remarkable way the extinct floras of Asia and America and those of the Jurassic and Cretaceous periods.

Above these are beds which, with some of the previous species, contain a few dicotyledonous leaves, which may be provisionally referred to the genera *Sterculia* and *Laurus*; and still higher the formation abounds in remains of dicotyledonous plants, of which additional collections have been made by Mr. T. C. Weston. The beds containing these, though probably divisible into two groups, may be named the Mill Creek series, and are approximately on the horizon of the Dakota group of the United States geologists, as illustrated by Lesquereux and others. The species are described in the paper, and differ for the most part from those of the Dunvegan group of the Peace River series, which is probably of the age of the Niobrara group, and, of course, still more from the overlying Laramie group. With regard to the latter, the author adduced some new facts confirmatory of his previously expressed view as to the position of the Laramie at the top of the Cretaceous and base of the Eocene, and also tending to show that some of the plants still held by certain palæo-botanists to be of Miocene age are really, in Canada at least, fossils of the Laramie group, and consequently considerably older than is currently supposed. The collections of plants studied by the author had for the most part been placed at his disposal by the Director of the Geological Survey.

[1] Read before the Royal Society of Canada, May, 1885, by Sir William Dawson, C.M.G., LL.D., F.R.S.

HYDROMECHANICS

THE last of the series of lectures at the Institution of Civil Engineers during the session of 1884–85 on "The Theory and Practice of Hydromechanics," was delivered on Thursday

evening, May 7, by Sir Edward Reed, K.C.B., M.P., on "The Forms of Ships." The President, Sir Frederick Bramwell, F.R.S., occupied the chair.

In the course of his address the Lecturer briefly explained the great development which the science of fluid resistance had undergone of late years, largely owing to the labours of Stokes, Rankine and others, but more largely still to those admirable investigations which had been carried out under the patronage of the Admiralty by the late Dr. William Froude, and subsequently by his son, Mr. R. E. Froude. He likewise explained the very great effect which those investigations had produced in the Royal Navy, owing to the judicious and prompt adoption of Froude's results by the Admiralty Constructors. Stress was laid throughout the lecture upon the importance of adjusting the form and proportions of ships not only to the loads which they have to carry, but likewise to the weight of the materials entering into their structure. It was a common error to judge of the merits of steamships by the relations which exist between their displacement, steam power, and speed, as expressed by formulæ of various kinds. Approximations to the theoretical form of least resistance were sought by some naval designers, and all considerable departures from that form were regarded as objectionable. The Lecturer, on the contrary, pointed out that no such theoretical form was any true or proper guide for a naval designer, since every change in the average weight of the hull necessitated a corresponding change in the form and proportions of the ship, and the great merit of a designer often was that he adopted forms differing widely from the abstract forms of the schools, and presenting a very inferior appearance when put into what are known as "Constants of Performance." This was illustrated by examples derived partly from actual ships and partly from calculations made for the purpose. Two actual warships were compared, one attaining the high figure of 213 marks when examined by the received formulæ, and the other gaining but 172 marks; yet in the Lecturer's view the latter was far and away the better ship, because she performed precisely the same service as the other, being inferior in no respect, and yet had cost less than the other by £114,000, and expended no more steam-power in attaining an equal speed. The Lecturer remarked that he should probably have regarded the abstract "form of least resistance" with more respect but for the circumstance that the designing of armoured vessels in which he was much engaged is "a branch of naval construction of much too concrete and ponderous a character to admit of any dalliance with abstract or fancy forms." He went on to express his regret that, owing largely to the restrictions which granite docks imposed upon naval constructors, and to the absence of iron floating docks capable of receiving ships of any form, and owing to other causes likewise, the construction of armoured ships—by which he meant ships which had a sufficient volume protected above the water to keep them afloat and upright while the armour remained intact—had been abandoned, and the first place upon the sea had been offered to any nation which had the courage and the will to assume it. In his opinion this was a purely voluntary abandonment, and was not the result of any scientific or economic necessity. He admitted that great changes in forms and proportions were very desirable in our great line-of-battle ships; for example, a great increase of breadth was necessary in order to economise the side armour, and to keep the ram and torpedo at ample distance from the boilers and magazines, which should be protected by an inner citadel, so to speak, well removed from the outer one. But so far was true science from presenting obstacles to these and other important changes, it actually invited these very changes, and increase of beam in particular had been shown by Froude to facilitate the attainment of practical invulnerability combined with very high speed. Size and cost were among the bugbears of our naval administration; by the true engineer they were always regarded as secondary to great and noble objects, among which objects he included the naval preeminence of our country. At any rate, there was no engineering obstacle whatever to England constructing and sending to sea, not merely those great and swift but delicate and fragile Atlantic hotels in which the British Navy is now to embark and fight, for the want of something better, but also war-ships—real war-ships—almost as invulnerable as these islands themselves, and capable of bearing the once-proud flag of England boldly into the waters of any enemy whatever.

On the motion of the President, a cordial vote of thanks was passed to Sir Edward Reed for his interesting and instructive lecture.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—In the second part of the Natural Science Tripos the examiners have placed the following in the first class in alphabetical order:—Men: Acton (Botany), St. John's; Eve, B.A. (Physics), Pembroke; Fitzpatrick (Physics), Christ's; Gordon (Physiology), Trinity; Shore (Physiology), St. John's; F. M. Young, B.A. (Physics), Trinity.

The Senior Wrangler, Mr. Berry, of King's College, was a student at University College School and College; the Second Wrangler, Mr. Love, of St. John's, was educated at Wolverhampton Grammar School. The Wranglers, thirty-four in number, are alone eligible to compete in the third part of the Mathematical Tripos a year hence.

In the Natural Sciences Tripos, Part 1, the following were placed in the first class, in alphabetical order:—Men: Bury, Trinity; Couldridge, Emmanuel; Edgeworth, Caius; Evans, F. P., St. John's; Oliver, F. W., Trinity; Rolleston, St. John's; Seward, St. John's; Walters, H. G., Trinity. Women: Freund, J., Girton; Willoughby, C. A. J., Newnham.

The University Lectureship in Mathematics, lately held by Prof. J. J. Thomson, will be filled up by the General Board of Studies and the Special Board for Mathematics early in the Michaelmas Term.

It is proposed, in dealing with the increased income of the Craven Fund, to establish a new Studentship of 200*l*. a year for research in the Languages and History of Ancient Greece and Rome and the Comparative Philology of the Indo-European Languages; the Studentship to be tenable for one year, but a student might be re-elected on not more than two occasions.

It is proposed still further to systematise and improve the courses of local lectures in populous centres, and to give students University certificates and exemptions in all cases where satisfactory work has been done, instead of confining these special privileges to affiliated Colleges. The majority of the courses given in the past winter have been scientific, and the work continues to extend, under the energetic administration of Dr. R.D. Roberts. Much difficulty exists in some of the most promising centres, where the students (miners and artisans) are poor, in providing funds. There ought to be no difficulty in persuading colliery proprietors and manufacturers to find the money needed.

SCIENTIFIC SERIALS

Bulletins de la Société d'Anthropologie de Paris, 5me Fascicule, 1884.—On ancient superstitions still surviving among the Bretons, by M. Bonnemère. An interesting paper, showing among many other proofs of superstition that the peasantry believe in the possession by certain individuals, whom they characterise as "Ribotteurs," of the power of injuring others by causing their milch cows to lose their milk. The so-called "Ribotteurs" are believed to acquire this power by roaming naked through the fields on the night of April 30 to gather, at early dawn, the May dew, in which dwells the malevolent property of drying up the milk of cows.—On the uni-discoidal placenta of a mandril, by M. Chudzinski.—On the degree of atrophy of the olfactory nerves compatible with the persistence of the sense of smell, by M. Mathias Duval. The writer draws attention to the number of cases in which a post-mortem examination has proved the atrophy, or even total absence, of olfactory nerves, although there had been no apparent defect in the sense of smell during life. M. Dally is of opinion that in such cases an excess of the gray matter of the brain at any one point may serve to supplement a deficiency in some other cerebral region.—M. Topinard presented to the Society a copy of his great chart of the relative heights, registered among the conscripts and in the public schools of different parts of France.—Report of proceedings at the first meeting of the "Conférence Transformiste," organised last year in memory of Darwin. In accordance with the scheme of the Conference an address was to be annually delivered by a member of the Anthropological Society of Paris, who was to indicate the influence which Darwinian ("Transformist") views had had on the special branch of scientific inquiry which the lecturer prosecuted.—This year's address in the Physical Section of the Conference was delivered by M. Duval, who chose for his theme the evolution of the eye from the early development of the visual organs among the lower animals. His treatise is profusely illustrated by admirable dia-

grammatic woodcuts.—In the Psychical Section of the Conference M. Letourneau treated of the evolution of morality, tracing the rise and progress and various fluctuations of the moral sense among different races.—M. Pozzi, in announcing the decision of the Committee for awarding the Broca prize, explained that he and his colleagues had selected the works of three among the numerous competitors, viz. MM. Collignon, Chudzinski, and Testut, as of pre-eminent merit. The prize was, however, unanimously awarded to the last-named, M. Testut's great work, "Muscular Anomalies in Man explained by Comparative Anatomy," having secured him this distinction both on account of its able and exhaustive character and its great literary merits. The selected essays of MM. Collignon and Chudzinski, treated respectively of the "anthropometric differences of the leading races of France," and of the "Anatomy of the Negro." In his address M. Pozzi gave a summary of M. Testut's work, of which he spoke in terms of unqualified praise, both as regards the methods with which his observations had been conducted, and the manner in which the results were compared and tested.—Report of the eulogy on Paul Broca, delivered by M. Dally on the day the Broca prize was awarded for the first time. As an old friend and colleague, M. Dally, in his historical and literary notice of the life and works of Broca, was able to give many hitherto unknown particulars, which add largely to the interest of his address.

Bulletins de la Société d'Anthropologie de Paris, 1er Fascicule, 1885, containing *résumé* of the rules, organisation, and actual condition of the Society, with lists of members, affiliated societies, and recent obituary, &c., &c., &c. Among the works presented to the Society at its inaugural meeting, 1885, special notice is due to the "Elements of General Anthropology," by M. Topinard, who here gives a *résumé* of his lectures at the School of Anthropologie since 1876; the "Gitaños of Spain and Portugal," by M. Bataillard; "Ethnic Mutilations," by M. Magitot; and "Cannibalism among the Red-Skins," by M. Letourneau. In regard to each of these, the authors treated at great length of the objects aimed at in their respective works, the character and scope of which they fully explained.—M. Chudzinski presented the Society with the cast of the deltoid muscle of a negro, showing an anomalous separation of the bundles, which had a Simian character.—M. Delisle drew attention to an ox's head belonging to *Bos indicus* of Senegal, in which a perfectly developed horn protruded from between the nasal bones.—A paper by Dr. Hoffman, of Washington, on a curious relic found in South California, supposed to have been a case for keeping the colouring-matters and instruments employed in tattooing.—On the Quaternary deposits of Rosny (Nogent-sur-Marne), by M. Eck. Among these finds are fine teeth of *Elephas primigenius*, *Rhinoceros tichorhinus*, *Equus*, &c.—Report by M. Gouin, of Cagliari, on the skulls and objects found by M. Issel in the recently-opened cave at Orreri, in the Island of Sardinia. M. Issel believes, from his study of the prehistoric remains of Western France, Spain, and the basin of the Mediterranean generally, that these and the finds at Orreri all point equally to the diffusion of a primitive race, which was extant in the Canary Isles within historic times.—On Laos, by M. P. Neis, who explored the Laotian territory bordering on Cambodia in 1882-84. The author, as a French official, enjoyed exceptional advantages for travelling in Cochin China and the neighbouring districts, and his careful study of the character and habits of the people has enabled him to collect much interesting information regarding the distinctive anthropological and social characteristics of the different races of Indo-China. M. Neis sees no ground for the opinion that these races exhibit traces of a Negrito element, but he draws attention to the fact that everywhere the Mongol is displacing the Thay and other ancient nationalities, although this is most evident in the territories between Mam-on and Tonkin, and he believes that, unless the King of Siam takes prompt measures to stop this invasion, Siamese supremacy and French authority will be alike endangered.—Ceylon and its inhabitants in ancient and modern times, by M. Beauregard. The author derives his materials from English sources.—On the caves of Saumoussay, by M. Bonnemère, who believes that these grottoes served in prehistoric ages as a tannery.—On the measurements of the long-bones as a basis for the reconstruction of the entire skeleton, by M. Topinard, with plates of the osteometric instrument used by Broca.—On will, considered from a physiological point of view, by M. Fauvelle.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, May 7, with a note added May 12.—"On the Electric Resistance of a New Alloy named Platinoid." By J. T. Bottomley, M.A., F.R.S.E.

In the course of a series of experiments on the electric resistance of various metals and alloys and in particular on the variation of the electric resistance of these metals and alloys with temperature, the author has examined a new alloy (called by the inventor "platinoid"), which has turned out to have important properties.

This alloy is the invention of Mr. F. W. Martino, of Sheffield, who kindly supplied specimens of the metal, and wires specially drawn down to the finer gauges for experiments.

Platinoid is practically German silver with the addition of a small percentage (1 or 2 per cent.) of metallic tungsten. The tungsten is added in the form of phosphide of tungsten, a considerable percentage of which is in the first place fused with a portion of the copper. The nickel is then added; and then the zinc and the remainder of the copper. The mixture requires to be re-fused more than once, and during the process the phosphorus and a considerable portion of the tungsten originally added is removed as scoriæ. In the end there is obtained a beautiful white alloy, which is platinoid. When polished the alloy is scarcely distinguishable in appearance from silver. To test the quality claimed for it as to being untarnishable, the author has been keeping ornamental specimens lying exposed to the ordinary town atmosphere; and has satisfied himself that the alloy has a very remarkable power of resisting the tarnishing influence of the air of a large town.

It is, however, the electric resistance of platinoid that has chiefly interested the author. German silver wire has proved of great use in the construction of galvanometer coils and resistance coils, on account of two important properties, viz., its very high resistance and the smallness of the variation of its resistance with change of temperature. Both those properties are possessed in a still higher degree by platinoid alloy.

The resistance of German silver differs considerably in different specimens. It is commonly stated to be $21{\cdot}17 \times 10^{-6}$ B.A. ohms between opposite faces of a centimetre cube at 0° C.;[1] or, reducing to legal ohms, $20{\cdot}935 \times 10^{-6}$ legal ohms between the opposite faces of a centimetre cube. The following table shows the resistance of a number of specimens of platinoid wire:

Specifying number	Diameter in decimals of a centimetre	Cross Section	Resistance legal ohms per metre	Resistance between opposite faces of a centimetre cube legal ohms.
16	·1610	·0204300	·181	$36{\cdot}98 \times 10^{-6}$
17	·1430	·0160200	·202	32·36
18	·1230	·0119400	·288	34·38
19	·1110	·0096770	·353	34·16
20	·0865	·0058760	·555	32·61
A	·0595	·0027180	1·250	$34{\cdot}76 \times 10^{-6}$
B	·0495	·0019240	1·707	32·85
28	·0402	·0012690	2·605	33·06
29	·0340	·0009070	3·412	30·94
32	·0290	·0006605	4·371	28·87
36	·0220	·0003801	8·219	31·24

It appears from these results that the specific resistance of platinoid is about *one and a half* times that of German silver.

The experiments on the variation of resistance of platinoid with temperature were carried on in the following way. The specimen of platinoid to be tested was wound on a wooden bobbin, on the surface of which a screw had been cut, and the spires of the helix were kept separate by lying between the threads of the screw. This coil was immersed in a bath of oil, and was connected in series with a known wire of German silver, the temperature of which was kept constant, and with a single Daniell's cell. The differences of potential between the two ends of the platinoid wire and the two ends of the German silver wire were determined by applying the electrodes of a a high-resistance galvanometer. The ratio of the differences of potential is the same as the ratio of the resistances of the two wires.

[1] Given by Prof. Fleeming Jenkin, F.R.S., as expressing the results of Matthiessen's experiments.

In the following table is shown the ratio of the resistances of a specimen of platinoid wire at different temperatures to its resistance at zero. The wire used was the same as that specified as No. 20 in the table of resistances. The length of the wire experimented on was about four-fifths of a metre. The only trouble in the experiment was the keeping the oil-bath, which was filled with linseed oil, thoroughly stirred, and of uniform temperature throughout.

Temperature.	Resistance. The Res. at 0° C. being = 1.
0°	1·0
10	1·0024
20	1·0044
30	1·0075
40	1·0066
50	1·0097
60	1·0126
70	1·0134
80	1·0166
90	1·0188
100	1·0209

This gives for the average percentage variation of resistance per 1° C., between the temperatures 0° C. and 100° C., the number 0·02087. A second wire tested very carefully in a similar way gave for this average percentage variation between 0° and 100°, 0·022 per degree, with a steadily increasing rate of variation from the beginning.

To compare this increase in resistance due to increase of temperature with that observed in other metals and alloys, we find that the percentage increase of resistance for 1° C. at 20° C. for copper is 0·388, platinum-silver alloy 0·031, gold silver alloy 0·065, and for German silver 0·044. These numbers were obtained by Matthiessen in the course of his experiments for finding a suitable metal or alloy for the purpose of constructing the British Association standards of electric resistance. It appears that the variation of resistance of platinoid with temperature is very much smaller than the smallest observed for any of the metals and alloys then examined.

The modulus of rigidity, the Young's modulus (or modulus for elastic longitudinal extension), and the breaking weight for platinoid wire were also determined. The wire used was a portion of that marked *A* in the foregoing table. This wire is a little larger than No. 24 of the Board of Trade standard wire gauge, and has a diameter of 0·0595 cm.

The rigidity modulus was found to be $4751{\cdot}8 \times 10^6$ grammes weight per square centimetre. The Young's modulus is $1222{\cdot}4 \times 10^6$ grammes weight per square centimetre.

The breaking weight is about $6{\cdot}029 \times 10^6$ grammes weight per square centimetre.

The specific gravity of platinoid wire has also been found by the author to be 8·78 compared with water at 20° C. Platinoid when drawn hard is softened, like copper, by heating and sudden cooling.

Physical Society, May 23.—Prof. Guthrie, President, in the chair.—Dr. A. H. Fison was elected a Member of the Society.—The following communications were read:—Experiments showing the variations caused by magnetisation in the length of iron, steel, and nickel rods, by Mr. Shelford Bidwell. The subject of the extension and retraction of bars of iron and nickel under the action of magnetic force has been investigated by Drs. Joule and A. M. Mayer, and by Mr. Barrett. In the present experiments the magnetising force has been increased, with the result of bringing out some striking and novel characteristics. The apparatus employed consisted of a vertical magnetising helix considerably longer than the experimental rod, the latter forming the central portion of a compound rod, the two ends being of brass. The lower end of this rod is plane, and stands on a firm support; the upper end is a knife-edge, which bears against a brass lever 18 cm. in length, about 1 cm. from the fulcrum; the portion of the rod to be examined is in the central portion of the helix. The above lever is furnished with another knife-edge at the end, which acts in a similar manner on a second lever, at the extremity of which is a small mirror. A lamp and vertical scale being placed at a distance of 470 cm., the slightest motion of the mirror could be read with great accuracy, an elongation of the bar, amounting to 1-100,000th mm., being easily detected. A few of the more important results are as follow:—In the case of soft iron the bar continually increased in length till nearly saturated, up to which point Mr. Joule had traced it, but then it reached a maximum, decreased, and continued decreasing to the limit of the experiments, at which point the retraction was about double of what the extension had been. The effect depended upon the thickness of the bar, an increase of diameter diminishing the maximum extension, and increasing the critical magnetising force, or that force which produced the maximum extension; the results seemed to show that this extension varied inversely as the square root of the diameter of the bar. The general behaviour of steel was the same as that of soft iron, but the critical point varied with the hardness and temper of the metal, appearing to be a minimum for steel of yellow temper. The results of experiments upon nickel coincided with those obtained by Prof. Barrett, the effect of magnetisation being to cause a continuous retraction greater than that obtained with soft iron. In answer to Prof. Hughes, who believed that the effect of the coil was always to produce *retraction* of the bar, the *extension* at first being due to the molecular arrangement of the particles during magnetisation, Mr. Bidwell further described an experiment showing that the action of the coil was to produce the *extension* of a magnet. Two thin strips of soft iron fastened together at the ends, their central portions being about 2 cm. apart, were placed in the coil. On making the current the ends were drawn out, the sides coming together. Prof. Forbes suggested that the effect of thickness was really owing to the irregularity of magnetisation produced by the ends, and that in future experiments the middle of the bar only should be examined.—On the spectral image produced by a slowly rotating vacuum-tube, by Mr. Shelford Bidwell.—Note on the action of light in diminishing the resistance of selenium, by Mr. Shelford Bidwell. As the result of the investigation upon the behaviour of selenium, Messrs. Adams and Day arrived at the conclusion that it conducted electrolytically. Since this would necessitate the assumption that selenium is not an element according to accepted theories, caution must be exercised in accepting this. It seemed possible, however, that since the selenium in the cells had always undergone a prolonged cooking in contact with the metal terminals, selenides of these metals might exist in the selenium, forming a kind of network, and thus affording conduction through the mass, which, without the cooking, is non-conducting. It had not been possible to test this directly, but a somewhat analogous case had been tried. Some precipitated silver had been heated for some hours with sulphur, and the clear liquid poured off. A cell was then made by coiling two silver wires side by side upon a strip of mica, the spaces between the wires being filled with the prepared sulphur, which would contain a small quantity of sulphide of silver. It was found necessary to reduce the resistance of the cell by placing a small strip of silver leaf over the sulphur and cooking again. The cell thus prepared was very sensitive to light: by burning a piece of magnesium near, the resistance was reduced to one-third. Mr. Clark said that Mr. Bidwell's cells probably contained sulphides of copper or silver, substances which the researches of Faraday had shown conducted electrolytically in the solid condition. On the other hand, Cu_2Se and Ag_2Se conducted like metals and were probably often present in the ordinary selenium light cells. Mr. Clark thought that Mr. Bidwell's paper raised this question: What influence had light upon the electrolytic conduction of Cu_2S and Ag_2S and upon the metallic conduction of Cu_2Se and Ag_2Se?—On certain cases of electrolytic decomposition, by Mr. J. W. Clark.—The first part of this paper consisted of a critical examination of the behaviour of those substances which have been described as exceptions to Faraday's laws, with the object of generalising as to the condition of internal or molecular structure corresponding to their electrical properties. The second part described an experimental investigation into the nature of the conduction of fused mercuric iodide and mercuric chloride, both of which were stated to undergo electrolytic conduction. Decomposition and re-combination of the products of electrolytic action may, however, follow so closely as to simulate metallic conduction. The first product of electrolytic decomposition of mercuric iodide was stated to be iodine and mercuroso-mercuric-iodide (Hg_4I_6), which latter, under the continued action of the current, yields free mercury. Similarly it was found that fused mercuric chloride, when electrolysed between graphite terminals, split up into chlorine and mercurous chloride. Metallic conduction, *i.e.* conduction without decomposition, in fused compound solids, therefore appears to be unknown.—Note on electrical symbols, by Mr. J. Munro.

Mathematical Society, June 11.—J. W. L. Glaisher, F.R.S., President, in the chair.—Prof. J. Larmor was admitted

into the Society.—Mr. Basset read a paper on the potential of an electrified spherical bowl, and on the motion of an infinite liquid about such a bowl, upon which Prof. Larmor made some remarks.—Mr. Elliott communicated a short paper by M. Z. J. Rogers, entitled, notes on the polism of the inscribed and circumscribing polygon.—Mr. Kempe, F.R.S., made a brief communication on pairs of collinear points; and a paper by Prof. Mannheim, liaison géométrique entre les sphères osculatrices de deux courbes qui ont les mêmes normales principales, was taken as read.

Chemical Society, June 4.—Dr. Hugo Müller, F.R.S., President, in the chair.—Mr. Harold Follows was admitted as a Fellow of the Society.—The following paper was read:—On the constitution of the haloid derivatives of naphthalene, by Prof. Meldola.

Anthropological Institute, June 9.—Francis Galton, F.R.S., President, in the chair.—Prince Roland Bonaparte exhibited a large collection of photographs of Lapps.—Mr. P. A. Holst exhibited three water-coloured photographs out of a collection of 240, representing all the tribes of the Russian empire.—Dr. J. G. Garson read a paper on the physical characteristics of the Lapps; and by the permission of the authorities of the Alexandra Palace, the family of Lapps now being exhibited there were present in the room with their sleigh, reindeer skins, and dog. The group consists of three men, two women, and two young children. The average height of the men is 5 feet 1½ inches, that of the women 4 feet 11½ inches. The chief characteristics of the Lapps may be said to be their low stature, round heads, and large cranial capacity.—Prof. Keane read a paper on the Lapps: after glancing at their origin, ethnical relations and nomenclature, explaining the perplexing terms Lapp, Finn, Same, &c., the Professor proceeded to describe their present habitat, their national and political divisions, and population; not more than about 30,000 Lapps remain, and their number appears to be diminishing. Their social usages were then described, and allusion made to their reindeer, dogs, sledges, snow-shoes, and tents, and the paper concluded with an account of their religion, education, present condition, and future prospects.—A paper by Dr. H. Rink on Eskimo dialects was taken as read.

EDINBURGH

Mathematical Society, June 12.—Dr. Thomas Muir in the chair.—Prof. Tait gave an address on the detection of amphicheiral knots, with special reference to the mathematical processes involved.

PARIS

Academy of Sciences, June 8.—M. Bouley, President, in the chair.—Action of chloroxicarbonic ether on the cyanate of potassium, by MM. Wurtz and Henninger. In an accompanying note it is stated that this important posthumous monograph was mostly prepared in 1875, but that its publication was delayed by the authors in order to complete their researches on various points. After the death of M. Wurtz the work was continued by M. Henniger, who was about to publish the results when he also fell a victim to his arduous labours. In its present form the paper has been prepared and edited by M. Edouard Grimaux.—Memoir on the temperature of the atmosphere and ground at the Paris Natural History Museum during the years 1883 and 1884, by MM. Edmond Becquerel and Henri Becquerel. This memoir forms a continuation of the researches begun twenty-two years ago at the Museum by M. A. C. Becquerel, by means of the thermo-electric apparatus invented by him.—On the geographical distribution of animal and vegetable species as affected by the climatic conditions, the character of the soil, the disposition of land and water, the progress of culture, and other outward influences of the environment, by M. Emile Blanchard.—Propagation of the earthquake shock felt in Andalusia on December 25, 1884, a rectification, by M. F. Fouqué.—On a new order of metallic spectra, by M. Lecoq de Boisbaudran.—Note on a new vegetable type from the lower coralline formations of Auxes, in the neighbourhood of Baune, Côte d'Or, by M. G. de Saporta. This type, by the author named Changarniera, from its first observer, appears to be of lacustrine origin, and to bear a certain relation to the Rhizocaulon from the freshwater chalk-formations of the South of France, still surviving in Provence. It may, perhaps, represent one of those proangiosperm types, the existence of which has only begun to be suspected by botanists.—Note on some recently-discovered documents connected with the infancy of Jean Le Rond d'Alembert, by M. L. Lallemand. These inedited records show that, contrary to Condorcet's statement, d'Alembert was sent to the Maison de la Couche, and placed with a nurse for six weeks in a Picardy village, after which he was consigned to the charge of Jacques Molin (Dumoulin), one of the most distinguished physicians of the time.—On a method of rapidly analysing all the nitrogen contained in substances in the organic, ammoniacal, and nitric state, by M. A. Houzeau.—On a method of employing the sextant in such a way as to obtain by a single observation the simultaneous altitudes or angles of two stars, of a star and the moon, or of a star and the sun, by M. Gruey.—On the convergence of a continuous algebraic fraction, by M. Halphen.—Remarks on the radiations emitted by incandescent carbons, such as those prepared for use in lighthouses for the production of voltaic arcs, by M. Félix Lucas.—Remarks on the apparatus usually employed for the measurement of continuous and other electric currents, by M. Mascart.—A thermo-chemical study of electric accumulators, by M. Tscheltzow.—Note on the action of silver, copper, iron, and some other metals on a mixture of acetylene and air, by M. F. Bellamy. The author's experiments show that in the burner these metals, and especially copper, act on acetylene in the same way that platinum does on hydrogen.—Note on the sulphurets of cerium and lanthane, by M. Debray.—On a new reaction for digitaline, by M. Ph. Lafon. This reaction, which is extremely sensitive, will enable the chemist to distinguish more sharply than has hitherto been possible between the numerous products employed in therapeutics under the general name of digitaline.—Note on aseptol (orthoxiphenylsulphurous acid), by M. E. Serrant. For this substance (so named by the author from the Greek negative particle ἀ and σηπτόν, corruption) it is claimed that it will be found three times superior to phenic acid as a practical antiseptic.—On electric alcoholic fermentation, by M. Em. Bourguelot.—Remarks on the tail of the human embryo, by M. H. Fol. From his researches the author is satisfied that during the fifth and sixth weeks of its development the human embryo is furnished with a tail in the strict anatomical sense of the term. Being destitute of all physiological use, this organ must be classed with all other rudimentary members.—On the natural evolution of the cantharides, by M. H. Beauregard. The results are here embodied of three years' research, during which the author has succeeded in clearing up many obscure points connected with the physiological life and functions of these insects.—Note on the extraction and composition of the gases contained in the leaves of plants, by MM. N. Gréhaut and Peyrou.

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THURSDAY, DECEMBER 31, 1885

TERTIARY VERTEBRATA OF THE WEST

Report of the United States Geological Survey of the Territories. F. V. Hayden, United States Geologist-in-Charge. Vol. III. "The Vertebrata of the Tertiary Formations of the West." Book I. By Edward D. Cope. (Washington, 1883-1884.)

THE American Government has in many ways shown the importance which it attaches to the diffusion of scientific knowledge; but in nothing has this been more clearly seen than in the care with which the results of the Geological Surveys have been published, and the liberality with which these works have been distributed; so that geologists on this side of the Atlantic are well acquainted with the magnificent quarto volumes in which the Reports of the Geological Survey of the Territories have been published. A number of these volumes had already appeared under the directorship of Dr. F. V. Hayden, when, in the year 1882, their publication was committed to the charge of Major J. W. Powell, Director of the United States Geological Survey. The work now before us is the first Report of the Survey of the Territories published since this change, and will take its place as the third volume of the series. While fully equal to the previous reports in the care bestowed upon the drawing and printing, it is by far the largest volume which has yet appeared, comprising, as it does, more than a thousand pages of letterpress and upwards of one hundred lithographic plates.

Prof. Cope began this work in 1872, and since then it has been carried on both in the field and in the study. It was originally intended that the Vertebrata of the "Cenozoic" and "Mesozoic" formations should form the third and fourth volumes of the Reports, but such a large amount of material has been obtained that it has become necessary to limit the work to the description of the "Cenozoic" Vertebrata, and this is to be divided into four parts, thus:—

Part I. Puerco, Wasatch, and Bridger Faunæ (Eocene).

Part II. White River and John Day Faunæ (Low. and Mid. Miocene).

Part III. Ticholeptus and Loup Fork Faunæ (Upper Miocene).

Part IV. Pliocene.

The present volume includes Part I. and Part II. as far as the Carnivora, the number of species described being 349, included in 125 genera, no less than 317 species having been determined by Prof. Cope.

The explorations, resulting in the acquisition of this splendid series of fossil Vertebrata, were conducted chiefly by the author himself, assisted by an efficient staff, and were carried on with much trouble and personal risk, not only on account of the inhospitable country in which part of the explorations had to be made, but also because of the hostility of the Cheyenne Indians, who, in certain regions, were during this time continually committing depredations and murders. No little credit is due to Prof. Cope and his able coadjutors for the manner in which this work was carried to so successful an issue in the face of many difficulties.

Before entering upon the description of the fossils, a short account is given of the Tertiary formations in which they were found, and an interesting and valuable comparison is made with the strata of the same age in Europe. A significant circumstance, with which geologists are to some extent already familiar, is the different story, regarding the age of these beds, told by the plants and mammals. The determination of the age of the formations known as the Loup Fork, White River, Bridger, Wasatch, Green River, and Laramie Beds, arrived at by Prof. Cope from a study of their higher vertebrate faunæ, does not agree with the conclusions of Mr. Lesquereux derived from his examination of the plant remains. The table given at p. 44 shows, in each case, the Flora a whole period in advance of the Vertebrata; for example, while the Laramie plants have an Eocene facies, the Vertebrata indicate an Upper Cretaceous age; and the fauna and flora of each of the other formations show a similar discrepancy.

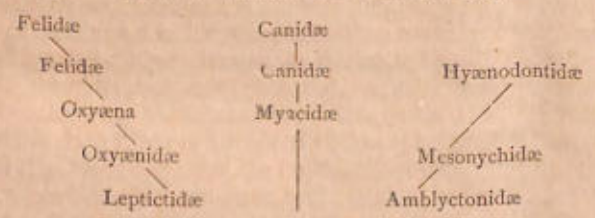
The numerous *Bulletins* and reprints with which Prof. Cope has liberally supplied us during the last few years have made us to some extent acquainted with the progress of the laborious task which he has undertaken, and with the names proposed for some of the new types of animals which have been discovered. Even with this knowledge, however, one is perplexed, on first opening the book, with the array of new names. The overwhelming amount of material which had to be dealt with, including such a multitude of new forms, no doubt made it necessary to establish many new genera and species, and these would require, in some instances, to be placed in new groups; but, notwithstanding this, it will probably be felt by many palæontologists that it would have been better in some instances to extend the limits of a group rather than to make new ones. Be that as it may, Prof. Cope has laid us under no little obligation by giving us such a clear and systematic account of his herculean labours.

In the author's preface he touches upon the troublesome question of the rules of nomenclature. While agreeing with the law of priority, as generally understood, he gives half a dozen rules which have been adopted by a number of American biologists. The main principle underlying all these rules is, that a generic or specific name given by any author, without a sufficient description or definition, is not entitled to recognition by subsequent writers. To this principle no naturalist will be likely to take exception; but, unfortunately, the manner in which this rule has been applied by some authors has produced a result which it is most desirable to prevent, that is, an unnecessary multiplication of names. To take an instance, a writer (A.) describes a number of new species, giving them a generic name, without any definition, and, to quote Prof. Cope, "In these cases it is left to the reader (B.) to discover their characters. Should he do so, he becomes the real discoverer of the genus, and, as such, is entitled to name it." No doubt Mr. A. should have characterised his genus, and his name is *not entitled to be received;* but if Mr. B. is a true man of science, he will forego his right and "habilitate the *nomen nudum*," rather than burden his brother-workers with another addition to their load of synonyms, which is already a burden almost too heavy to be borne.

This volume is essentially a detailed description of

genera and species, and as such is an extensive and invaluable mine of information, wherein palæontologists may work with profit for many years to come. But besides the more special descriptions, there is much of deep interest to the naturalist and evolutionist, a flood of light being thrown on the early Eocene forms, which were probably the progenitors of our existing mammals.

The Saurian genus *Champsosaurus*, hitherto known only from Cretaceous deposits, has now been found in the Puerco Tertiary series. The remarkable marsupial genus *Plagiaulax*, was originally described by Falconer from British Purbeck beds; within the last few years an almost identical genus has been met with in Tertiary strata in France; and now closely allied forms are made known to us from the American Tertiary groups. It is, however, among the higher mammalia that the most remarkable discoveries have been made. The finding of forms, less specialised than those living at the present day, has enabled Prof. Cope to trace what he believes to be the line of descent of some of the groups of living mammals. The determination of the characters of a considerable number of new genera and species, more or less closely allied to the *Insectivora*, has led to a new classification. It is proposed to include in a new order, called the *Bunotheria*, the sub-orders:—(1) *Creodonta*, (2) *Mesodonta*, (3) *Insectivora*, (4) *Tillodonta*, (5) *Taeniodonta*, and (6) *Prosimiæ*? The *Creodonta* come nearest to the *Carnivora*, while the *Prosimiæ* come nearer to the *Quadrumana*, groups (4) and (5) being distinguished by the possession of incisor teeth with persistent pulps. It is among the Eocene *Creodonta* that Prof. Cope finds the ancestors of the *Felidæ* and *Canidæ*. "In distinguishing between the ancestors of the *Felidæ* and *Canidæ*, we naturally seek to recognise in each an anticipation of the leading characters in the dentition which distinguish those families to-day" (p. 263). In the *Felidæ* we should expect a gradual abbreviation of the true molar series from behind. The *Canidæ*, on the other hand, not only retain the true molars, but have them also of a tubercular character. "Estimated by these tests the *Myacidæ* are clearly the forerunners of the *Canidæ*, and the *Oxyænidæ* of the *Felidæ*." The following diagram will show the families through which these relations are traced (p. 264):—



Unfortunately the new names prevent our fully appreciating these affinities, which can only be properly understood when the characters of these groups have been carefully studied. The forms allied to *Canis* which have been met with in the Lower and Middle Miocene are all said to be generically distinct from *Canis*, while those from the Upper Miocene pertain to the same genus. The many new species of *Carnivora* have suggested to Prof. Cope a new grouping for the *Fissipedia*. These are in the first place divided into two subdivisions:—

(1) "External nostril occupied by the complex maxilloturbinal bone; ethmoturbinals confined to the posterior part of the nasal fossa; the inferior ethmoturbinal of reduced size . . . *Hypomyceteri*.

(2) "External nostril occupied by the inferior ethmoturbinal and the reduced maxilloturbinal . . . . *Epimyceteri*."

No. 1 includes the families *Cercoleptidæ*, *Procyonidæ*, *Mustelidæ*, *Æluridæ*, *Ursidæ*, *Canidæ*.

No. 2 the *Protelidæ*, *Arctictidæ*, *Viverridæ*, *Cynictidæ*, *Suricatidæ*, *Cryptoproctidæ*, *Nimravidæ*, *Felidæ*, *Hyænidæ*.

The species of *Carnivora* described are from the Miocene, and are all referable to the *Canidæ* and *Nimravidæ*, the first being divided into eight genera, all of which are represented except *Canis*; they have much resemblance to our dogs and foxes, and are separated chiefly by the modifications of their teeth. The second includes nine extinct genera, all closely allied to the *Felidæ*, but differing in having an alisphænoid canal and post-glenoid foramen. In some of them the dental formula is the same as that of the *Felidæ*; but in others there is an increase in the number of the molars and premolars. It is these variations which are used as generic distinctions. Some of the genera, such as *Pogonodon*, have the canine teeth so largely developed as to make a near approach to the sabre-toothed tigers.

The changes which are proposed in the names and grouping of the herbivorous animals are not less numerous or less radical than those among the flesh-eaters, to which allusion has been made above. The order *Ungulata*, as it is now generally understood, is to be divided into four orders, founded on characters of the carpus and tarsus; these are as follows:—

(1) *Taxeopoda* (including sub-orders *Hyracoidea*, *Condylarthra*, and *Toxodontia*?).

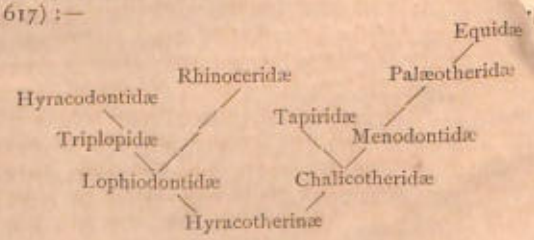
(2) *Proboscidea*.

(3) *Amblypoda* (including *Pantodonta*, *Dinocerata*, and *Talligrada*).

(4) *Diplarthra* (including *Perissodactyla* and *Artiodactyla*).

The necessity for some modification of this classification is already pointed out by Prof. Cope himself, for on p. 383, in speaking of the almost perfect skeletons of *Phenacodus primævus* and *P. Vortmani*, which genus is placed in the *Condylarthra* (Order 1), he says:—"The unexpected result is, that this genus must be placed in a special group of an order which includes also the *Proboscidea*."

Not the least important outcome of these discoveries in the Eocene deposits is the reconstruction, from numerous specimens, of the genus *Hyracotherium*; and consequent upon this the knowledge that it is, as Prof. Cope thinks, the earliest ancestor of the *Perissodactyla*. The following genealogical tree will show this relationship (p. 617):—



The *Hyracotherinæ* are here made the parent stock from which are supposed to have arisen, on the one side, the horses, through the Palæotheria; the tapirs being an offshoot from an ancient group, the Chalicotheridæ. On the other side the rhinoceroses have arisen from the Lophiodonts, from which also the Hyracodonts are to be traced.

Time alone will show whether the systems of classification proposed by Prof. Cope are founded on sufficiently important characters to render them permanent. It is probable that naturalists will hesitate before accepting such sweeping changes, especially as they necessitate the adoption of so many new ordinal names. However, it will be well to wait until we have had time to make ourselves thoroughly acquainted with the details of this work, before criticising that which is the result of years of patient labour. We are certainly under deep obligation to the author for his careful and systematic marshalling of the multitude of facts with which he has had to deal; and congratulate him, as well as the directors of the two Surveys, on the successful completion of this first half of the work, which will be a lasting testimony to the zeal and devotion of all who have shared in the labour of its production, and an enduring monument to its author's scientific skill and untiring energy.

E. T. NEWTON

THE DEPTHS OF ALPINE LAKES

La Faune profonde des Lacs suisses. Par le Dr. F. A. Forel, de Morges, Professeur à l'Académie de Lausanne. (Bâle, Genève et Lyon: chez H. Georg, 1885.)

PROFESSOR FOREL, of Morges, already so well known by his numerous pamphlets and short notices on various points in the natural history and the physical geography of the great lake beside which he lives, has in the present work given us the results of the labours of many years, casting into one mass the many fragments and gathering together and correcting where needful the many interesting papers which alone he has hitherto published.

It is a small quarto volume of over 200 pages, with a table of contents and a long bibliographical list appended; it is a pity that there is no index, and the value of the work would have been greatly enhanced had it been illustrated with figures of the new or rare species, and especially with a map of the basin of one at least of the Alpine lakes. Though it professedly deals with the deep-water fauna of the Swiss lakes as a whole, and though frequent allusions and references are made to work done by Prof. Forel and others in a very large number of these and of other lakes, this memoir, as is natural, deals most fully with the fauna of one lake only—the Léman. Of the only other great lake on the northern slope of the Alps—the Bodensee—and of the great lakes of the southern slope—Verbano, Lario, and Benaco—we are told but little. This is, however, a matter of the less importance as the physical surroundings which have affected the fauna of the Léman are almost exactly repeated in the other lakes, and the little that is known of their deep-water life is very similar to what we know of that of the Léman. Of this—his own lake—Prof. Forel has given us a study which may be called complete.

The chief agents affecting the life of the lake are temperature and light: of less importance are the shape and capacity of its basin, the matters dissolved in or held in suspension by its waters, the movements—for the most part superficial—to which its waters are subject. And light is a far more important factor than temperature,—it is at a depth of 30 metres, at the depth that is to say at which chlorophyll-forming vegetation ceases that Prof. Forel draws the line separating the littoral and deep regions of the lake: the actinic action of light ceases at 50 metres in summer, at 100 metres only in winter, owing to the greater transparency of the waters at that season.

Speaking of the conditions of this deep region Prof. Forel says: "They all tend to calm, to rest, to absence of movement. Uniformity, monotony, equality, no motion, no variation, such are the general characters of this region, with which we can compare no other region but that of the deep sea." It is after having studied the flora and fauna of this region almost uninterruptedly for six years that he now gives us what he modestly calls a sketch of the results at which he has arrived.

But in order to be able properly to understand the deep-water life of the lake we must first be properly acquainted with the inhabitants of the upper waters, whether of the shore or of the open. To this end, the first half of the book is occupied with a careful account of the littoral and pelagic flora and fauna. The most interesting point in this section is the statement that the same species of pelagic Entomostraca are common not only to the Alpine lakes but to those also of Scandinavia and the Caucasus. They exist in enormous numbers, thousands of individuals may be captured in one sweep of the net, and they form a very important part of the food of fishes, giving to them, it appears, their characteristic fishy smell; but the species are few. The very wide distribution of these few species is probably brought about by migratory water-fowl.

The deep-water flora of the Léman finds its lowest limit at a depth of 100 metres, and consists entirely of Algæ, chiefly Palmellaceæ and Diatomaceæ, of which the latter are the most abundant in species, but the Palmellaceæ are the most important, forming in many places a felted carpet on the surface of the ooze, and thus giving a more solid bottom, on which animals may move or in which they may live.

The population is much denser in the upper part of the deep region than in the lower part, but even in the deepest part life is present; in the upper part hundreds of animals, dead or alive, may often be obtained at one haul. About 100 species (22 of which are new) constitute this fauna:—Fishes, 14; Insects, 3; Arachnida, 9; Crustacea, 16; Hydroidea, 1; Rhizopoda, 13; Cilioflagellatæ, 1; Gasteropoda, 4; Lamellibranchiata, 2; Annelida, 4; Nematoidea, 3; Cestoidea, 1; Turbellariæ, 18; Bryozoa, 1; Rotifera, 2.

The greater part of these species are evidently the descendants of the inhabitants of the shallow waters, and differ from them chiefly in being smaller and less brightly coloured; the eyes are wanting in *Gyrator coccus*, and have a tendency to disappear in other species; the shells

of the mollusks are thinner than is usually the case with those of the littoral zone; and *Fredericella Duplessis*, which is the representative of *F. sultana*, has so far varied from the littoral form that it is never found attached to solid bodies, such as pebbles or fragments of coke, but invariably plunged in the soft ooze after the fashion of a Pennatula.

But of two species of Crustaceans—*Niphargus puteanus* var. *Forelii*, an Amphipod, and *Asellus Forelii*, an Isopod closely related to *A. cavaticus*—Prof. Forel maintains that they are descended, not directly from the allied species of the littoral zone, but from the species *N. puteanus* and *A. cavaticus* which inhabit the subterranean waters, and are commonly found in the wells of nearly the whole of Europe. There is no doubt that *A. Forelii* is closely related to *Asellus aquaticus*, nor that *Niphargus puteanus* is equally closely related to *Gammarus pulex*; the question is merely whether the forms at present inhabiting the abysses of the Léman and other lakes are like *Fredericella Duplessis* directly descended, or indirectly descended, from the littoral forms. It was to the first of these views that Prof. Forel formerly inclined: he now gives his support to the second. And mainly for the following reasons. The modifications which *Niphargus puteanus* and *N. Forelii* have undergone are in all important respects the same; they differ at present only in such unimportant points as the number and length of hairs, setæ, and spines. It is unlikely that precisely the same changes would occur under such very different surroundings as those presented by subterranean waters and the deep waters of a lake. Again, *N. Forelii* is not confined to the Léman, and it is improbable that exactly the same variations should have arisen in different localities. And thirdly, since maintaining a lacustrine origin for *N. Forelii* would compel us to admit that it had varied so far from *Gammarus pulex* since the Glacial period, we can by supposing it to have a subterranean origin allow it a far longer time in which to have undergone modification.

"It is more simple, it is more in conformity with facts to admit that the *N. Forelii* of our lake-bottoms is descended from the *N. puteanus* of the underground waters. That is the conclusion to which I adhere. And I extend this same conclusion to *Asellus Forelii*, and seek its origin also in the *A. cavaticus* of the underground waters."

An interesting illustration of the manner in which animals can adapt themselves to their surroundings is to be found in the species of Limnea and in the larvæ of Diptera (Chironomis) which abound in the Léman. In the littoral zone the Limneas, having a pulmonary sac, are air-breathers; in the deep water, without any change of structure, their breathing is aquatic—their pulmonary sac is filled with water. The case of the Dipterous larvæ is more remarkable. We are told that they swarm in the deep water, and that their respiratory apparatus, consisting of tracheæ, is, like the sac of the Limneas, filled with water instead of air. Larvæ abound, but pupæ are very rare, if not altogether absent, and perfect insects are never seen rising from the surface of the deeper parts of the lake; moreover larvæ of all sizes and ages are found on the bottom at the same season. It would appear from the observations of O. Grimm (*Mém. Acad. imp. St. Pet.*, xv. No. 8, 1870), of St. Petersburg, that these larvæ never attain the perfect stage, but are capable of reproduction by *pædogenesis*.

I have no more space; I can only allude to the discovery of two species of Acanthopus, whose nearest relatives are marine Cythærideæ; to *Plagiostoma Lemani*, also with marine relations; to the remarkable absence in the deep water of Anodon and of Spongilla, both of them so common in the shallows. Let me conclude in Dr. Forel's words:—

"Others may perhaps regret the absence of the strange things which they had expected to meet with in these strange regions. For my part I have had the intense happiness of being the first to penetrate them, I have endeavoured to explain to myself one by one the mysteries which unfolded themselves to my gaze, and I admire and enjoy their harmony and their simplicity above all. Nature is beautiful and great because she is harmonious everywhere and in everything."

G. H. WOLLASTON

THE CRETACEOUS AND TERTIARY FLORAS OF THE UNITED STATES

The Cretaceous and Tertiary Floras of the United States. By Leo Lesquereux. (U.S. Survey of the Territories under F. V. Hayden, Vol. VII.)

AFTER an interval of nearly ten years, Dr. Hayden presents us with further contributions, by Lesquereux, to the Cretaceous and Tertiary floras of the United States. Those principally illustrated are from the Dakota, Laramie, and Green River groups. The author frankly admits at the outset, p. 4, that "the determinations of the plants are still, and must be for a long time to come, unreliable to a certain degree." This admission must be kept in mind in pronouncing on the merits of the book.

The Dakota beds rest on Permian, and contain a Cretaceous fauna associated with a very rich dicotyledonous flora. No one now doubts their Cretaceous age, although they cannot be correlated exactly, bearing in mind the flora, with anything in Europe. It appears from the revision these fossil plants have undergone, that they are much less closely related to existing genera than was previously supposed. Under such circumstances it seems a pity that less compromising generic names were not substituted for those, such as Sassafras, Acer, Quercus, Hedera, &c., as done in the case of Populites. The known flora of Dakota now consists of 5 ferns, 6 Cycads, a dozen Coniferæ, most of them very unsatisfactory, and no less than 162 Dicotyledons, chiefly remarkable for the large number of handsome palmate leaves among them. One of the most interesting genera, because determined from fruits as well as leaves, is Platanus, a genus also common to our own Lower Eocene of Reading, and thus of a high antiquity. Magnolia is another genus adequately determined, but the remainder rest mainly, if not entirely, on the characters furnished by detached leaves. The vexed question of the age of the Laramie or Great Lignitic series of America is again discussed, and a table given of all its species compared with those of Europe, especially the Eocene of Sézanne in the Paris Basin. As a result

the author still holds to the opinion that the formation is an Eocene one. A larger part of the work is occupied with descriptions of the Green River plants, chiefly from Florissant, an incredibly rich locality. This is prefaced by a lucid description of the beds, which exceed 300 feet in thickness, by Mr. S. Scudder. They are principally volcanic ash accumulated in one or more old lake-basins. These and most of the other fossiliferous rocks are situated towards the top of the Green River group, which is reckoned to be 2000 feet thick. The flora contains 228 species, of which 152 are from Florissant, and is referred by Lesquereux to the Oligocene. It was originally thought by him to be Miocene, but the detailed comparisons he has made between it and that described by Saporta from Aix, in Provence, prove that he is justified in putting its age further back. Indeed it bears a marvellous resemblance to that of Bournemouth, and had he been able to make comparisons he would perhaps have assigned it a still earlier date. It is a matter of the greatest interest to find in America a flora corresponding to those of Aix and Bournemouth, and not represented anywhere to the north. The last pages are occupied with descriptions of some new Miocene plants from various localities. The book is illustrated by fifty-nine coloured plates, and however we may differ as to the value of the determinations themselves, all will agree as to the great service rendered to science by the publication of such an important mass of data for future comparison. 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.*]

The Coal-Dust Question

ON several occasions during the last five years, Sir Frederick Abel has referred to the history of the coal-dust question, and to my connection therewith; and as his views on this subject do not altogether correspond with mine, I desire, with your permission, to state in this place how much, and in what particulars, I differ from him.

In his address to the Society of Arts, delivered on the 17th of November last, Sir Frederick says: "Several well-known French mining engineers published, many years after Faraday and Lyell wrote, observations and experimental results as new, which were simply confirmatory of those philosophers' original statements and conclusions, and to some extent this was also the case in still more recent publications in this country by Galloway and Freire-Marreco."

Faraday and Lyell's statements and conclusions were to the following effect:—

1. Fire-damp is not the only fuel in an explosion.

2. The coal-dust is swept up by the blast and is partially burnt.

3. (Speaking of Haswell Colliery explosion)[1] "There is every reason to believe that much coal-gas was made from this dust in the very air itself of the mine, *by the flame of the fire-damp*, which raised and swept it along, and much of the carbon of this dust remained unburnt only for want of air."

That is to say, the flame of the fire-damp is extended, and the effect of the explosion is aggravated by the presence of the coal-dust.

[1] *Phil. Mag.*, 1845.

The Committee of the Coal Trade, who replied to Faraday and Lyell's report in a letter dated February 7, 1845, do not appear to have thought those authors' remarks about coal-dust of sufficient importance to be noticed at all. Nor do the authors themselves seem to have attached any particular importance to them save as a record of a curious physical and chemical fact; for after making them they immediately turned, like all their predecessors and most of their successors, to the contemplation of imaginary magazines of fire-damp as a means of accounting for the explosion. Moreover, both of them lived for many years afterwards, during which one great explosion occurred after another, and yet we do not find that either of them ever lifted so much as the tip of his little finger to point to coal-dust as the probable cause of the catastrophes.

In 1855, M. du Souich, Ingénieur des Mines, said,[1] "A sort of crust of light coke, which could be gathered from the timber at various points, could only have originated from the coal-dust swept up in the working places and carried to a distance by the extremely violent air-current caused by the explosion. This dust being itself partially inflamed *could continue the effects of the fire-damp by carrying them further*" (*peut continuer les effets du grisou en les portant plus loin*).

In 1861,[2] M. du Souich and M. Estaunié again insisted on the same thing in similar terms.

In 1867,[3] M. du Souich again developed the same opinions.

In 1864,[4] Verpilleux de Reydellet, A. Burat, Poumairac'Baretta and other engineers emitted opinions similar to the foregoing.

In 1875,[5] M. Vital wrote, "Extremely fine coal-dust is a cause of danger in dry working places in which shot-firing is carried on; in well-ventilated workings it may of itself alone give rise to accidents; in fiery workings it increases the chances of an explosion, and when an accident does occur *it aggravates the consequences of the fire-damp flame*" (*coup de feu*).

In 1875,[6] MM. Desbief and Chansselle gave a short historical *résumé* similar to that of M. Haton, and quoted an opinion of M. Verpilleux which appears to resemble my own, but has never, so far as I am aware, been put prominently forward by the author nor supported by experimental or other proof, namely: "M. Verpilleux, who attaches great importance (*importance capitale*) to coal-dust, was one of the first to call attention to it; comparing a fire-damp explosion to the detonation of a gun, he went so far as to say that the dust represents the powder and the firedamp the priming."

In March, 1875, Sir Frederick, then Professor, Abel, addressing an audience at the Royal Institution on the subject of "Accidental Explosions," referred to explosions in mines, and mentioned the researches that had been made by Mr. R. H. Scott and myself up to that date. He also speaks of dust explosions in flour mills, &c.; but, as showing the small importance he attached to anything that had been previously said or done in regard to coal-dust, it is remarkable that he does not even refer to its existence.

I had been investigating the subject of great colliery explosions since the year 1870, but had been unable to discover any explanation of their occurrence wholly satisfactory to myself. At the commencement of my work I had read all, or nearly all, the English literature connected with it then extant, and amongst other things the report and article of Faraday and Lyell on the Haswell Colliery explosion, and the reply of the Committee of the Coal Trade;[7] but, so little impression did Faraday and Lyell's remarks about coal-dust make upon me at the time, that I afterwards forgot I had read them, and was only reminded of the fact by seeing it recorded in an old note-book of my own some time after the publication of my first paper. I retained the impression, however, for in the paper[8] referred to I wrote: "The accounts of colliery explosions published in this country hardly ever allude to the existence of coal-dust; and when they do so, in one or two cases [it should have been one case only] it is for the purpose of suggesting that the gases disengaged from it by the heat of the fire-damp flame would no doubt be ignited and tend to increase the force of the explosion."

It did not for a moment occur to me that this, which is Faraday and Lyell's view, could ever be accepted as an explanation of the phenomenon I was trying to elucidate.

[1] "Rapport de M. Haton de la Goupillière: Des Moyens propres à prévenir les Explosions du Grisou," 1880.

[2] *Ibid.* [3] *Ibid.* [4] *Ibid.*

[5] *Annales des Mines*, 1875.

[6] *Comptes rendus des Réunions mensuelles de Saint Etienne*, June, 1875.

[7] *Iron*, June 1, 1874. [8] *Proc. Roy. Soc.*, 1876.

In the beginning of the year 1875 I removed to South Wales, and soon discovered that all the collieries in which great explosions had occurred were dry and dusty. My previous experience was almost wholly confined to damp mines, in all of which, with one exception (Nitshill), there was no coal-dust, and in none of which, with the same exception, a great explosion had ever occurred. The impression referred to above probably exercised a certain influence at that time in helping me to form the conception of what I believe to be the true explanation of great colliery explosions. In the words of my first paper[1] it is as follows: "If it could be shown that a mixture of air and coal-dust is inflammable at ordinary pressure and temperature, there would be no difficulty in accounting for the extent and violence of many explosions which have occurred in mines in which no large accumulations of fire-damp were known to exist; for it is only necessary to suppose that a violent gust of wind (originated, for example, by the explosion of a small accumulation of fire-damp) had swept through the adjoining galleries, raising a cloud of dust into the air, and then all the other phenomena would follow in regular order. The flame of the originally inflammable mixture would pass into the newly-formed one, expanding its volume; the disturbance would be propagated over an ever-widening area, until that area might possibly become co-extensive with the workings themselves; and *the consequences would be the same as if the whole space had been filled with an inflammable mixture before the disturbance began.*"

I demonstrated by an experiment first made on the 3rd of July, 1875, that air containing less fire-damp than can be detected by the ordinary means of testing the air in mines, is rendered inflammable at ordinary pressure and temperature when fine dry coal-dust is added to it. This was the first step towards proving the truth of my theory.

In the same paper I also stated, "It is always possible that if coal-dust could be made fine enough and were thoroughly mixed with dry air in the proportion of about 1 pound to 160 cubic feet of air, the mixture might be inflammable at ordinary temperature, or, *if not*, it might at least be so nearly inflammable that an explosion begun in it, in a confined space, might be propagated through it."

In my second (1879) and subsequent papers to the Royal Society, I stated the further opinion, first, as the result of more elaborate experiments, and secondly, as the result of a careful personal investigation and consideration of all the circumstances attending the occurrence of several great explosions, that, "A fire-damp explosion occurring in a dry coal-mine is liable to be indefinitely extended by the mixture of air and coal-dust produced by the disturbance which it *initiates*." This was the final step.

Of this, Sir Frederick says:[2] "Mr. Galloway was certainly the first to enunciate the conclusion that a small proportion of fire-damp is essential to impart to a mixture of air and coal-dust the power of propagating flame, though *he afterwards abandoned this conclusion in favour of the one some time previously accepted by Marreco*, to the effect that fire-damp is altogether unnecessary for the conveyance of flame with explosive effect by a mixture of dry coal-dust and air."

In January, 1878, I commenced a series of articles in *Iron* on coal-dust explosions, hoping thereby to arouse an interest in the subject, and, amongst other items of information, I gave translations of Vital's and Desbief and Chansselle's papers. Seven of these articles had already appeared when, in April, 1878, Prof. Marreco (to whom I had myself sent copies of them) and Mr. Morison, read their first paper before the Chesterfield Institute. They say, "Before the writers had the opportunity of learning what had already been accomplished abroad, their attention was directed to the subject by a paper read by Mr. W. Galloway before the Royal Society, in which he related his experiment in producing explosion in a mixture of fire-damp and air impregnated with dust. The opinion expressed in that paper, viz., that coal-dust was explosive only in an atmosphere containing a minute proportion of fire-damp, induced the writers 'to still further extend the scope of the experiments, and endeavour to discover whether coal-dust could by any means be exploded in an atmosphere totally free from fire-damp."

The arrangement to carry out the experiments here spoken of was made between Marreco and myself in the end of 1875 or beginning of 1876, and was referred to in my first paper (1876) thus: "It would be premature to draw any positive inference from my experiments with gunpowder shots, as they are by no means so satisfactory as I could wish, and I am glad to be able to state that Prof. Marreco, of Newcastle-on-Tyne, intends to investigate this question with more substantial apparatus."

Returning to Sir Frederick's remark, I would say that I abandoned no previous conclusion "in favour of one some time previously accepted by Marreco." I then held, and still hold, what is now a universally accepted opinion amongst mining men, that a mixture of air and fire-damp, which is not inflammable at ordinary pressure and temperature, may be rendered inflammable by the addition of dry coal-dust, and I was prepared, as soon as proof satisfactory to myself was forthcoming, to extend the area of my opinion, so as to include a mixture of fine dry coal-dust and air in the same category. This latter proof alone was necessary to the firm establishment of the theory enunciated at the commencement of my first paper, and for that reason Sir Frederick's statement appears to me to be wanting in logical sequence.

Neither the statement made by Marreco and Morison, that they intended to "endeavour to discover whether coal-dust could by any means be exploded in an atmosphere totally free from fire-damp," nor the results of the experiments published by them, appear to me to warrant Sir Frederick in taking up this position; for, concerning these very experiments of Prof. Marreco's he had himself remarked in the year 1880:[1] "It does *not appear that* in the numerous experiments made at Harton Colliery by the exposure of naked flames in currents of air laden with coal-dust, and by firing small cannon (representing blown-out shots) placed in various positions in such air-currents, *any indication has been obtained of a propagation of flame by the coal-dust.*" How then could Marreco have concluded that "fire-damp is altogether unnecessary for the conveyance of flame with explosive effect in a mixture of coal-dust and air"?

Sir Frederick continues to say, regarding myself: "Even his latest publication on the subject tends in the same direction, and emphasises his desire to 'claim that no earlier author had gone the length of crediting coal-dust with the *rôle* of principal agent, and relegating fire-damp to a secondary position.' The more recent results of other writers in this direction have, however, conclusively demonstrated that this is far too great a length to go, and that while on the one hand a very fine dry and highly inflammable coal-dust may, when raised and mixed with air by the force of a blown-out shot, become inflamed, and may then carry flame to considerable distances with a rapidity and violence of action similar to that of a fire-damp explosion, the extent to which, on the other hand, flame is propagated under corresponding conditions by most descriptions of coal-dust in the complete absence of fire-damp is very limited."

Sir Frederick and those whose opinions he here quotes appear to have omitted to take one element into consideration which has an important bearing upon the case. To this I may have occasion to refer more particularly at an early date.

W. GALLOWAY

[1] *Proc. Roy. Soc.*, 1876.
[2] *Journal Soc. Arts* No. 20, 1885, p. 23.

[1] "Report on the Results of Experiments made with Samples of Dust collected at Seaham Colliery, &c.," 1880.

Sunset-Glows

I WISH to call the attention of observers to a peculiar phenomenon which has been frequently noticed by me lately in connection with these sky-scenes. A very bright after-glow was visible here on October 27 last. I believe the date is correct, although I have unfortunately mislaid my day-book; the facts, however, I can vouch for otherwise, as they were detailed at the time. At 5 p.m. a heavy bank of cumulus was to be seen extending along the south-western sky-line, about 5° above and closely parallel to the horizon. High over this bluish bank of cloud rose the yellow haze of departing sunlight. This diffused after-glow was plainly intersected by numerous (I counted twenty-two) delicate streaks of nebulous stratus. These intersecting lines (they were scarcely "bands") were horizontal and parallel, piled up, as it were, above one another as high as 25° from the sea-line. The lowest hung apparently about half a degree above the gilded upper edge of the dark cumulus. On November 4, just before sunset, I exposed a gelatine plate, and succeeded in obtaining a photograph, in which seven of these narrow horizontal cloud-streaks can be faintly seen. On December 1 the following note was made:—4.20 p.m. Wind light,

N.N.W. Sunset-glow intersected by five horizontal dark cloud-streaks in the west. On the 2nd inst., at 4.20 p.m., five cumulo-strati were visible in the west, separated by parallel and horizontal orange-coloured bands. Above these were numerous (probably twenty) delicate dark lines traversing—also horizontally—the upper roseate after-glow. On the 10th and 11th inst., somewhat similar phenomena were visible here. On the 15th inst., with a light southerly air, eleven cloud-bands were seen by me at 4.30 p.m. In this case only, they were not parallel to the sea-line, but followed the direction of the west-north-west horizon. I have seen the same appearances once or twice since the last date. The above phenomena are new to me, and I have not met with any detailed account of them elsewhere. I have therefore ventured to address you on the subject. Can these cloud-streaks represent stratified air-dust in the upper regions of our atmosphere? W. AINSLIE HOLLIS

Hove, Brighton, December 26

Iridescent Clouds

THERE was a very striking display of iridescent clouds this afternoon. I noticed it first at about 3.40 p.m. The prismatic colours were pretty strongly marked, and the intense pearly brilliance of the delicate cirri was most striking. It is still visible (4.40 p.m.), though, of course, its lustre is much diminished. A gale is blowing from the west, and there has been an orange after-glow. Similar phenomena were described in your columns about this time last year. They were well seen in this part of the country. EDWARD GREENHOW

Earsdon, Newcastle-on-Tyne, December 28

YESTERDAY, clouds very similar to those seen a year ago made their appearance, and there were a few of them again this morning. I first noticed them at 11.30 a.m., and they were extremely magnificent after sunset, showing three or four spectra of colour, and they were especially striking about 4.10 p.m., when they appeared very bright against the purple glow of the sky. Their chief difference from the clouds last December was that they were not bounded by straight lines, and that there was no special amount of blue in the colouring, as was usually the case a year ago. The chief colours were pink and green.

Sunderland, December 29 T. W. BACKHOUSE

Ventilation

IN reply to the query of J. F. Tennant, there can be no doubt that the cause of the failure of the ceiling ventilators is a deficiency of fresh-air supply to the room. An ordinary chimney with a fire will, if unchecked, draw an amount of cold air into the room which would make the temperature about the same as that of the outside air, and without enormous volumes of warmed air it is, I think, impossible to expect any service whatever from the system of ventilation from ceiling-flues, as recommended by the writer of the article referred to. Since writing my first letter I have seen a regenerator lamp attached to one of these ceiling-flues, and the down-draught was so strong and persistent as to reverse the natural current of the lamp, rendering its use impossible. The air-inlet to my own rooms consists of a channel in the wall of every room opening into ten one-inch holes at the fireplace, but this, of course, is utterly inadequate to supply one-tenth of the air required by the flue, and the ventilator and the ventilating-shaft supplement this supply by working the wrong way. THOS. FLETCHER

Warrington

A VERY common source of trouble with respect to ventilation is the absence of any arrangement for the supply of air to fires. So long as a fire draws on the general atmosphere of the room it is supposed to warm for its supply of oxygen, there must be the "draughts" so often complained of, and people are warm on the side next the fire, and cold on the other. I should suppose this is what happens in Mr. Fletcher's case, described in his letter in NATURE (pp. 153-4). If so, there is simply a sort of "tug-of-war" between the longer chimney-flue and the shorter ventilation flue, with the additional advantage on the side of the former that the column of air ascending the chimney is necessarily much warmer than that which should ascend the ventilation flue. If, however, Mr. Fletcher will have a couple of holes bored in his floor, one on each side of the fireplace, so as to supply air directly to the fire, the "pull" of the fire on the air of the room will cease, the room will be warmer, and his ventilation flue should work satisfactorily. I warm thoroughly a room with considerably over 2000 square feet of floor area by means of three small stoves. When first used the stoves were inefficient, as there was a draught all round each towards it. A common rain-water pipe "bend," inserted in the floor immediately in front of the aperture of each stove for admitting the air-supply, stopped the draughts, and at least doubled the efficiency of the stoves as warmers. With the help of Tobin tubes there is now a gentle current of warmer air *from* each stove. The heated and vitiated air escapes through ventilators fixed in the ridge of the roof. W. WILKINSON

Eldon, Bishop Auckland, December 23

Friction and Molecular Structure

IN your number of December 17 (p. 154) is a letter signed by Mr. E. Geoghegan, referring to the effect of moderate friction on the molecular structure of glass lamp-chimneys. This I have very frequently observed, and it would be very interesting to have suggestions as to its cause and means of prevention. I often read under one of Sugg's Argand gas-burners, the chimney of which almost invariably breaks on first heating after cleaning. First of all, washing was tried, to remove the mottled milky stain which forms on the glass, and then rubbing with a silk cloth or cotton rubber, but there does not seem to be much difference in the result, as the glasses, the best I can obtain, generally break. C. K. BUSHE

Bramhope, Old Charlton, Kent, December 25

The Longevity of Insects

WITH reference to the longevity of insects, it is worth while to record that we kept a ladybird from the September of one year to the September of the following. She was a handsome specimen of the seven-spotted ladybird, and her eggs, which were laid in the winter, after passing through the miniature crocodile stage, produced perfect insects in February. It is curious to watch the imago emerging from its dusky case; at first no spots are visible on its buttercup-yellow "shards," which contrast strongly with the jet-black legs and underneath; but in a very few hours the first brilliancy has gone, the spots appear faintly, and in a few days the final red with the black spots is established. E.

December 28

SOUTH AMERICAN BIRD-MUSIC

MR. BURROUGHS, an American naturalist, in his "Impressions of some British Song Birds," has said:—"Many of the American songsters are shy wood-birds, seldom seen or heard near the habitations of men, while nearly all the British birds are semi-domesticated, and sing in the garden and orchard. This fact, I had said, in connection with their more soft and plaintive voices, made our song-birds seem less to a foreign traveller than his own." These words apply with much greater force to the birds of South America, the species being much more numerous and less well known than in the northern portion of the continent; while the true songsters are relatively fewer, owing to the presence of several large songless families, such as the tyrants, humming-birds, and others.

The South American songsters certainly do not, like those of Europe, mass themselves about the habitations of men, to sing there as if sweet voices were given to them solely for the delectation of human listeners; they are pre-eminently birds of the wild forest, the marsh, and the savannah; and the ornithologist or collector from Europe, whose principal object is to make a large collection, has

little time to make himself acquainted with the accomplishments of the species he desires above all things to shoot. Nor is this all. Doubtless there remains in the minds of most people something of that ancient notion that brilliant-plumaged birds utter only harsh, disagreeable sounds; while the sober-toned songsters of temperate regions—especially those of Europe—have the gift of melody; that sweet songs are heard in England, and screams and grating notes within the tropics. Only we know now that the obscure species there are greatly in excess of the brilliant ones. It is quite possible, however, that the tropics, so rich in other respects, though by no means the realms "where birds forget to sing," do not excel, or even equal, the temperate regions in the amount and quality of their bird melody. Mr. im Thurn only echoes the words of many English travellers in the tropics, when he says, in his recent work on British Guiana:—"The almost entire absence of sweet bird-notes at once strikes the traveller who comes from thrush and warbler-haunted temperate lands." Mr. Bates, on this subject, says:—"The few sounds of birds are of that pensive and mysterious character which intensifies the feeling of solitude rather than imparts a sense of life and cheerfulness."

On the question of tropical bird-music much remains to be said by future travellers; but South America is not all tropical, and travellers visiting the southern temperate portion of that continent might have looked to find there melodists equal to those of Europe and North America; for even assuming that to utter agreeable sounds a bird, wherever found, must be fashioned after the pattern of some European form, we find that the typical songsters of the north—the thrushes, wrens, warblers, finches, &c.—are well represented in the Plata, Chilian, and Patagonian regions. As a fact, the best songsters there belong to the wide-ranging American genus *Mimus*, while in the more tropical Icterine family there is great variety of language, and some exceedingly sweet voices.

Of the great naturalists of recent times who have depreciated South American bird-music, I will mention Darwin only, as very great importance must always be attached to his words, even when he fails to show his usual discrimination. He says of the common *Mimus calandria*:—"It is remarkable from possessing a song far superior to that of any other bird in the country; indeed, it is nearly the only bird in South America which I have observed to take its stand for the purpose of singing." He then adds that the song is like that of the sedge warbler.

There are many better singers than the *M. calandria*; and as to its being nearly the only bird that takes its stand for the purpose of singing, there are, in the Plata district alone, a greater number of birds with that habit than in England; though, taking the number of species in the two countries, the Plata singers are relatively fewer. It is equally beside the mark to compare the sedge warbler with the Calandria, the performance of the former bird resembling that of the other only as a slight sketch may be said to resemble a finished painting.

Darwin does not say much about the singing of birds, and appears to have taken but little interest in the subject, possibly because this species of natural melody gave him little or no pleasure; otherwise he could scarcely have written of the Diuca Finch that "the male during incubation has two or three pleasant notes, which Molina, in an exaggerated description, has called a fine song." The fact is, the old Chilian naturalist scarcely does justice to the song of the Diuca, which is mellower in sound than any other finch-melody I am acquainted with. Of his account of the singing of the Thenca mocking-bird, the Thili, the black-headed finch, Loyca, and various other species, Darwin says nothing.

Not all the European writers whose words carry weight, however, have turned a deaf, or, at any rate, a very unappreciative ear to the bird-music of the great bird-continent. Azara is a notable exception. He was not a mere collector, nor was he even a naturalist in the strictest sense of the word; but, made fit for his task by a keen faculty of observation, and an insatiable craving for knowledge of all kinds, he went into the forest to watch the birds and write the history of their lives. In Spain he had been familiar from childhood with the best songsters of Europe, and in Paraguay he paid great attention to the language of the species he noticed. He makes mistakes sometimes, when speaking of the nesting or other habits, but when describing their songs, he records his own impressions only. With the works of his contemporary, Buffon, he only became acquainted after having completed his own observations; and the voluminous strictures on the French naturalist, which burden, and to some extent spoil, the otherwise delightful "Apuntamientos," were only inserted after his own descriptions had been written.

In his introductory pages, entitled "De los Paxaros en General," he refers to Buffon's well-known opinion concerning the inferiority of American songsters, and says:—"But if a choir of singers were selected in the Old World, and compared with one of an equal number gathered in Paraguay, I am not sure which would win the victory." In another place, in allusion to the same subject, he says:—"They are mistaken who think there are not as many and as good singers here as in Europe."

To return for a moment to Mr. Bates's words, already quoted, bird-music of that "pensive and mysterious" character he mentions is to many minds more pleasing than the loud, cheerful, persistent singing of many highly-esteemed British singers, like the chaffinch and song-thrush.

Mr. Bates also heard in the Amazonian forest, "another bird that had a most sweet and melancholy song, uttered in a plaintive key, commencing high, and descending by harmonic intervals."

Of the common house-wren of the Plata, Azara says that its song is "in style comparable to that of the nightingale, though its phrases are not so delicate and expressive; nevertheless, I count it amongst the first songsters." He speaks even more highly of the voice of the Todo Voz (*Cistothorus platensis*), which greatly delighted him with its sweet, varied, and expressive melody. The members of this melodious genus, and of the allied genera, are found throughout South America, from Panama to Patagonia, and we know from others besides Azara that their music does not dissolve away in the tropics, or turn to harsh sounds. Mr. Wallace heard a Cistothorus singing very sweetly on the shores of the Amazon, and D'Orbigny, in the "Voyage dans l'Amérique Méridionale," thus describes the singing of the *Thryothorus modulator*, which he heard in Yungas, in Bolivia:—"Perched on a bough overhanging the torrent, its rich melodious voice seemed in strange contrast to the melancholy aspect of its surroundings. Its voice, which is not comparable with anything we have in Europe, exceeds that of the nightingale in volume and expression, if not in flexibility. Frequently it sounds like a melody rendered by a flute at a great distance; at other times its sweet and varied cadences are mingled with clear piercing tones or deep throat-notes,—in one word, a grave music composed of the purest sounds. We have really no words adequate to express the effect of this song, heard in the midst of a nature so redundant, and of mountain scenery so wild and savage."

It might be thought that in this description allowance must be made for the enthusiasm natural to a Frenchman, but Mr. Bates, certainly the most sober-minded naturalist that ever penetrated the Brazilian forests, gives a scarcely less fascinating account of a melodist closely allied to D'Orbigny's bird, if not identical with it. "I frequently heard," he says, "in the neighbourhood of these huts the realejo or organ-bird (*Cyphorhinus*

cantans), the most remarkable songster by far of the Amazonian forest. When its singular notes strike the ear for the first time the impression cannot be resisted that they are produced by a human voice. Some musical boy must be gathering fruits in the thickets, and is singing a few notes to cheer himself. The tones become more fluty and plaintive; they are now those of a flageolet, and, notwithstanding the utter impossibility of the thing, one is for the moment convinced that some one is playing that instrument. . . . It is the only songster which makes an impression on the natives, who sometimes rest their paddles whilst travelling in their small canoes, along the shady by-paths, as if struck by the mysterious sound."

Outside of these pre-eminently tuneful groups—thrushes, warblers, finches, &c.—there are many species belonging to groups considered songless which nevertheless do sing, or have, at any rate, some highly musical notes. Dendrocolaptine birds are not, strictly speaking, songsters; but they are loquacious, and fill the woods with sound, often pleasant and laughter-like in character; and in many species the male and female combine their voices in a pretty kind of chorus. In the well-known oven-bird this is very striking, the male and female singing a ringing joyous duet in different tones, producing an harmonious effect. D'Orbigny notices this harmonious singing of the *Furnarius*. The hirundines in many cases have voices utterly unlike those of Europe, which as a rule only emit a squeaking twitter. They have, on the contrary, rather thick tones, in many cases resembling the throat-notes of the skylark, and some have a very pleasing set song. The human-like tones of some of the pigeons, the plaintive fluting of the Tinamous, even the notes of some kingfishers and cuckoos, contribute not a little to the bird-music of South America. Waterton's words about the "songless" bell-bird are well known, and, allowing that he goes too far when he says that Orpheus himself would drop his lyre to listen to this romantic sound, it is still certain that there are hundreds of species, which, like the bell-bird of the Orinoco forests, utter a few delightful notes, or produce a pleasing effect by joining their voices in a chorus. Thus, Mr. Bates speaks of the *Monasa nigrofrons*—a barbet:—"This flock of Tamburi-para were the reverse of dull: they were gamboling and chasing each other amongst the branches. As they sported about they emitted a few short tuneful notes, which altogether produced a ringing musical chorus that greatly surprised me."

But even leaving out all these irregular melodists; also omitting the tanagers, the tyrants, and their nearest allies; the Dendrocolaptidæ and Formicaridæ, and the humming-birds—these few families I have mentioned comprising about 1800 species—there would still be a far greater number of regular songsters than Europe can show, so great is the bird-wealth of South America; and concerning the merits of their music I can only say that Azara and D'Orbigny did not hear the best singer—the *Mimus triurus*. It would have been strange indeed if in that portion of the globe, so inconceivably rich in species, and where bird-life has had its greatest development, the faculty of melody had not been as highly perfected as in other regions.

A very long time has passed since Azara made that remark about a choir of song-birds selected in Paraguay, and our knowledge on this subject—possibly because it has been thought unimportant—has scarcely been added to since his day; but it seems to me that when the best singers of two regions have been compared, and a verdict arrived at, something more remains to be said. The species which "formally take their stand for the purpose of singing" sometimes delight us less than others which have no set song, but yet utter notes of exquisite purity. Nor is this all. To most minds the dulcet strains of a few favoured songsters contribute only a part, and not always the largest part, of the pleasurable sensations received from the bird-voices of any district. All natural sounds produce, in some measure, agreeable sensations: the pattering of rain on the leaves, the lowing of cattle, the dash of waves on the beach, the "springs and dying gales" of a breeze in the pines; and so, coming to birds, the clear piercing tones of the sand-piper, the cry, etherealised by distance, of a passing migrant, the cawing of rooks on the tree-tops, afford as much pleasure as the whistle of the blackbird. There is a charm in the infinite variety of bird-language heard in a sub-tropical forest, where birds are most abundant, exceeding that of many monotonously melodious voices; the listener would not willingly lose any of the many indescribable sounds emitted by the smaller species, or the screams and human-like calls, or solemn, deep booming or drumming of the larger kinds, or even the piercing shrieks which may be heard miles away. The bird-language of an English wood or orchard, made up in most part of melodious tones, may be compared to a band composed entirely of small wind-instruments with a very limited range of sound, and which produces no storms of noise, eccentric flights, or violent contrasts, or anything to startle the listener—a sweet but somewhat tame performance. The sub-tropical forest is more like an orchestra in which a countless number of varied instruments take part in a performance in which there are many noisy discords, while the tender, spiritual tones heard at intervals seem, by contrast, infinitely sweet and precious.

W. H. HUDSON

FORESTRY

THE report of the proceedings of the Select Committee on Forestry which sat during the past summer does not, perhaps, throw any more light on the condition of forestry in this country than was possessed before the appointment of the Committee, for the substance of the evidence given is for the most part to be found in the various works and reports on forestry that have appeared from time to time during the past few years; nevertheless the evidence of such men so well versed in forest conservancy, especially with regard to India, as Dr. Cleghorn, Col. Michael, Col. Pearson, and Mr. W. G. Pedder is of much value, as it brings together in a collected form information that has hitherto been much scattered.

The subject of forest produce is one that is but little understood or even thought of by people in general. It is supposed by most people to relate only to the supply of timber, which indeed of itself is of very great importance; but when we consider the other products—such as gums, resins, oils, fibres, and such like—the enormous money value becomes more apparent, as well as the great importance of the forests as sources of many absolute necessities of life. The evidence of Col. Michael fully illustrates this and is especially valuable from this point of view. Taking the subject of Indian timbers alone, the value of teak was fully set forth when it was shown to be unequalled for the backing of ironclads and for ship-building generally, as offering the greatest resistance of any known woods. Questioned as to whether teak was capable of being brought into this country as a commercial article at a remunerative profit, Col. Michael replied that, judging from the price realised for some logs sold at the Forestry Exhibition at Edinburgh and from other information obtained, no doubt existed that the trade in teak might become a very remunerative one. It was shown further that in 1883 647,000*l*. worth of teak was imported into England; but Col. Michael also touched upon what, if put upon a proper footing, might equally, or perhaps more so, become a source of revenue to India and a boon to this country—namely, the introduction of the more ornamental woods for cabinet purposes. There is, of course, always a steady demand for British-grown

timbers such as oak, elm, ash, maple, &c., but these have to be supplemented by foreign woods of a more ornamental character, and of these mahogany, rosewood, ebony, satinwood, and such like are the best known. From amongst Indian timber trees a long list might be made of woods which are now almost unknown out of their native country—such, for instance, as the East Indian cedar (*Cedrela toona*), which is a reddish-coloured wood with a splendid wavy or feathery figure; the tree is also found in Australia, where the wood is highly valued; the padouk (*Pterocarpus indicus*), the deep-red-coloured wood of which attracted so much attention at the Edinburgh Exhibition last year; the Malabar Kino tree (*Pterocarpus marsupium*), also a finely-marked deep-red wood, several species of *Terminalia*, durable woods of a brown colour with darker brown markings. Many others might be mentioned, but the most beautiful of all the Indian woods for its ornamental character is the Chittagong wood (*Chickrassia tabularis*). This is of a brown colour, with transverse lighter silvery-brown wavy markings, which impart to it a varying depth of light and shade, which, when polished, imparts a peculiar and charming lustre. All these woods take a high polish, and would be invaluable for cabinet-work. Fine specimens of these and many others are in the collection of Indian timbers exhibited in the No. 3 Museum at Kew.

On the question as to the durability of the Scotch fir (*Pinus sylvestris*) Col. Pearson gave an opinion which is worth quoting. He says:—"I think myself that as the value of the foreign imported timber increases, as it must do as the quantity diminishes, people will come to appreciate more the Scotch fir, because I know many barns which have been boarded with Scotch fir for twenty years, and which are standing perfectly well: but it is convenient to get the imported boards ready sawn out, and where the people can get them cheap they do not pay attention to the Scotch and home-grown timber. But, speaking for myself, I should say that Scotch fir is a perfectly good wood as long as it is sufficiently mature, and I think, as foreign wood becomes dearer, as it will in a few years, English timber and Scotch timber will become of a value which it has not now."

On the general subject of the proposed Forest School Col. Pearson expressed himself in favour of a Chair of Forestry at the Edinburgh University, but he further stated that he had no actual faith in lectures in the school unless illustrated by practical instruction. "If," he says, "you tell a man in the lecture room that such and such consequences will take place, and do not show him the consequences on the spot, he does not believe anything about it; it goes in at one ear and out at the other; he will think it all nonsense; but if you want to impress your teaching upon him, you must take him out into the forests and show him the operations of Nature." Regarding the extent or scope of the School, Mr. Thiselton Dyer, in reply to Sir Edmund Lechmere whether he would not make the School of Forestry applicable to India and the Colonies as well as to our own country, said, "I should like to get all the fish possible into the net, and if we had such a school, to make it as useful as possible. I think it is surprising, considering how large is the interest of the English race in forestry, that except in India we have taken no kind of active interest in the subject: although we own more forests in the world than any other race, we are at present, except in the most piecemeal fashion, absolutely washing our hands of the whole business." Mr. Dyer, in his evidence, further pointed out by way of illustration a few of what are usually called the minor industries of forest produce, which in the aggregate become of considerable national importance.

It is to be regretted that the Committee was not nominated at an earlier period of the session. The first sitting was on July 14, and at the two subsequent sittings on July 21 and 24, witnesses only were examined. The report of the Committee refers to the impossibility of concluding their investigations during the Session, and "recommends that a Committee on the same subject should be appointed in the next Session of Parliament."

JOHN R. JACKSON

OBSERVATIONS ON THE RECENT CALCAREOUS FORMATIONS OF THE SOLOMON GROUP, MADE DURING 1882-84[1]

ON account of the treacherous character of the natives of the Solomon Group, no extensive geological observations have ever been made in these islands from the period of their discovery by the Spaniards three centuries ago. For this reason my excursions in these regions were not free from personal risk; in many places they were considerably curtailed, and in some islands they had to be abandoned altogether.

This archipelago includes seven or eight large islands, some of which are from seventy to eighty miles in length, and the highest from 8000 to 10,000 feet in height. Besides these, there are a great number of smaller islands and islets, some of volcanic and others of recent calcareous formations. Restricting my remarks to those islands which are wholly or in part composed of these calcareous rocks, I may observe that, although only able to become acquainted with a small portion of the Solomon Group, the islands which I examined represent the different types of islands that there exist.

In this, the largest of the Pacific groups, I not only found existing fringing-reefs, barrier-reefs, and atolls, but I discovered pre-existing reefs of these three chief classes which have been recently elevated to a height often of several hundred feet above the sea. My observations on these recently-elevated reefs and their foundations have enabled me to approach the problem of the formation of coral reefs by the inductive rather than by the *a priori* method: for it is evident that in passing from the consideration of a probable cause of the formation of existing reefs to the examination of ancient reefs that have been raised with their foundations above the sea, we enter a domain of greater certainty. I purpose in this abstract to state concisely the principal characters of the islands which are wholly or in part of calcareous formations; then to draw four limited inferences from these facts of observation without reference to any particular views that may be held on the subject of the origin of coral reefs; and finally to compare such conclusions with the prevailing views on that subject.

In the first place there are numerous small islands and islets less than a hundred feet in height, which are composed in mass of coral limestone. Of this class Stirling Island may be taken as an example. In the bold cliffs, which form the weather coast of this small island, there are numerous imbedded masses of the reef-building corals, many of them measuring four feet across, the majority of them in the position of growth, but some of them inverted.

The island of Ugi, which is six miles in length and about 500 feet in height, may be taken as a type of the next class. Its geological structure may be briefly described as composed in bulk of a soft earthy bedded deposit, possessing the characters of the "volcanic muds" of the *Challenger* soundings, containing numerous Foraminifera, and encrusted near the coast by coral limestone, which almost disappears in the higher regions. The greatest thickness of the coral limestone that I found in this island was between 90 and 100 feet. As one ascends the higher slopes of the island the coral limestone thins away, and

[1] By H. B. Guppy, M.B., F.G.S., late Surgeon of H.M.S. *Lark*. [Abstract of a paper read before the Royal Society of Edinburgh, on June 15th, 1885, being communicated by Mr. John Murray.]

only occasional fragments occur in the red argillaceous soil. The greatest elevation at which I found the coral rock was about 425 feet above the sea. The soft Foraminiferous deposit, which forms the mass of the island, is regularly bedded, the dip varying usually between 10° and 15°, but it may rise to as much as 35°. Entire shells are rarely found in these beds, the Foraminiferous tests being usually the only organic remains visible to the naked eye.

The island of Treasury affords an example of the next type of island. It is oval in shape, has a length of nine miles, and rises about 1150 feet above the sea. Here we have exposed the nucleus of volcanic rock which has been covered over by soft bedded deposits that resemble, like those of Ugi, the muds found in the *Challenger* Expedition to be at present forming around oceanic volcanic islands, whilst the coral limestone only attains any thickness near the coast, and is wanting altogether in the higher regions of the island. At elevations exceeding 400 feet above the sea the coral rock generally disappears from the surface. Above this height it is only found occasionally, 900 feet being the greatest elevation at which I found a fragment. The thickness of the coral limestone does not exceed 100 feet. The soft deposit, which is regularly bedded, the dip varying between 10° and 30°, displays a greater variety in its characters than the similar deposit in the island of Ugi. As a rule it presents to the naked eye no other conspicuous organic remains than the white specks of the more minute Foraminiferous tests and the larger microscopic tests of such species as *Cristellaria calcar*, *C. mamilligera*, and others; but in some localities this deposit becomes highly fossiliferous, when it assumes a more compact texture, and displays to the eye fragments of corals with Pteropod and Lamellibranchiate shells. As shown in the accompanying diagram, the structural history

Ideal section of an island displaying the originally-submerged volcanic peak, the overlying soft deposits, and the encrusting coral limestone.

of this island of Treasury may be readily inferred. An ancient submerged volcanic peak, having been covered by a thickness of some hundreds of feet of deposits, for the most part resembling the muds now being formed around volcanic islands, has by this means and by the movement of elevation been brought up to the zone of reef-building corals. After the coral reefs had become established, the whole structure experienced an upheaval of nearly 1200 feet.

In the island of Alu, the principal of the Shortland Islands, another type of structure is exhibited. This island, which has a breadth of eleven or twelve miles and an elevation of about 500 feet, is composed in its north-west portion of ancient and originally deep-seated volcanic rocks (mostly quartz-diorites), while the greater part of it, together with the off-lying lesser islands and islets, is made up of more recent calcareous formations. In describing its structural history I shall be describing its structure. We have the original land of volcanic formation in the north-west part of the island, from which, as from a nucleus, line after line of barrier-reef has been advanced in a south-easterly direction based on a foundation of Pteropod and Foraminiferous muds, and forming ultimately, as the upheaving movement continued, the large island of Alu, which yet preserves in the ridges of its interior these ancient barrier-reefs now removed far from the coast and elevated some hundreds of feet above the present sea-level. The soft deposit underlying the elevated reef-masses contains in abundance the shells of Pteropods and bivalves, the otoliths of fish, the tests of pelagic and bottom-living Foraminifera, and some simple corals of deep-sea genera. The overlying coral limestone sometimes assumes a chalk-like character, and in the interior of the island it may give place to a Foraminiferal limestone. The characters of these different rocks are described in the second part of this paper. The thickness of the coral limestones in this island is probably under 100 feet. When it caps the upraised island barrier-reefs it does not exceed forty feet; but these regions have been subjected to great denudation.

In the small island of Santa Anna, which is two and a half miles in length, we have an upraised atoll that displays within the small compass of a height of 470 feet the several stages of its growth. There is, in the first place, the originally submerged volcanic peak; then the investing soft deposit which, according to Mr. Murray, has the characters of a deep-sea clay; and over all the ring of coral limestone that cannot far exceed 150 feet in thickness. The interior of this upraised atoll is a closed basin containing a fresh-water lake, the bottom of which lies about a hundred feet below the present sea-level: so the island may be roughly compared to a bowl of fresh water floating on the sea. In the vicinity of the locality where the deep-sea clay was exposed, Lieut. Malan observed a concretionary block of manganese peroxide between one and two cubic feet in size, which, according to Mr. Murray, who examined a typical fragment, is quite similar in characters to the smaller masses obtained in deep-sea soundings. The structural history of this island may be briefly summed up. A submarine volcanic peak, having been invested by a deep-sea clay, was brought up by upheaval to the coral zone. An atoll was established on it, and the wholewas subsequently raised to a height of nearly 500 feet above the sea.

Lastly, I come to the large mountainous islands, of which St. Christoval may be taken as the type. This island is more than seventy miles in length, and about 4100 feet in height. It is composed in mass of ancient volcanic rocks, which are flanked on their lower slopes by recent calcareous formations. A fawn-coloured crystalline limestone, containing reef débris, lies directly on the volcanic rock, and is itself overlain by the coral limestone. I did not find these calcareous rocks above 500 feet above the sea; so great has been the denudation of this island that these calcareous formations constitute a much thinner crust than that which came under my notice in the smaller and more recent islands.

Such being the facts, I come now to the four general conclusions, which are as follows:—

1. *That these upraised reef masses, whether atoll, barrier-reef, or fringing-reef, were formed in a region of elevation.*

This is self-evident. The last upheaval that occurred, of which I found proofs in different parts of the group, was to the extent of about five feet; but at the present day there are signs of this movement being still in operation, and, for the purposes of future observation, I have established datum-marks in different islands. This, therefore, being a region of elevation, it is apparent that that portion of Mr. Darwin's theory of coral reefs which ascribes the formation of atolls and barrier-reefs to a movement of subsidence cannot be applied to the islands of the Solomon Group, since we here find upraised atolls and barrier-reefs associated with existing reefs of the same description. This conclusion accords with the results obtained by Prof. Semper in the case of the Pelew Islands, and by Prof. A. Agassiz in the case of the Florida reefs.

2. *That such upraised reefs are of moderate thickness, their vertical measurement not exceeding the limit of depth of the reef-coral zone.* Amongst the numerous islands which I examined I never found one that exhibited a greater thickness of coral limestone than 150 feet, or 200 feet at the very outside. In fact, so great has been the denudation of these islands, where, according to my own

observations, there is an annual rainfall at the coast of 150 inches, that I rarely came upon a thickness of a hundred feet of coral limestone. One of the corollaries of the theory of subsidence is concerned with the great thickness of atolls and barrier-reefs. My observations in this region—and it is such regions that can alone afford such evidence—show that atolls and barrier-reefs can be formed with no greater thickness than they would possess in accordance with the depths in which reef-corals thrive, the vertical thickness of the reef not exceeding the depth of the reef-coral zone. . . . The only objection worthy of attention that had been advanced against the atoll-theory of Mr. Darwin was, in the opinion of Sir Charles Lyell,[1] the circumstance that, as far as was known, no bed or formation of coral of any thickness had been discovered. This objection, which was proposed by Mr. Maclaren in 1842, derives additional force at the present day in the light of my observations in the Solomon Islands.

3. *That these upraised reef-masses in the majority of islands rest on a partially consolidated deposit which possesses the characters of the "volcanic muds" which were found during the "Challenger" Expedition to be at present forming around volcanic islands.*

4. *That this deposit envelops anciently submerged volcanic peaks.*

These two latter conclusions corroborate in a remarkable manner the views, based on the observations of the *Challenger* Expedition, which Mr. Murray has advanced. I will cite the structures of two islands to illustrate these views. In the small island of Santa Catalina I found that the elevated reef was based on volcanic rock with the intervention of a thin brecciated conglomerate. In the island of Treasury I found the volcanic rock covered by a soft, partially consolidated volcanic mud, which attained a thickness of some 300 or 400 feet, and was itself incrusted on the lower slopes of the island by the elevated reef-mass. In the one island, the volcanic peak had been exposed to breaker-action before the reef-corals established themselves. In the other island, the submerged volcanic peak was first brought within the reef-coral zone by the deposition of layers of "volcanic mud" upon it, assisted by the movement of elevation.

With reference to my own bias on this subject, I may here add that during the first eighteen months I passed in the Solomon Islands I was only acquainted with the theory of subsidence, and that after having failed to make my observations harmonise with the theory of Mr. Darwin, I collected my facts with a very confused idea of the direction towards which they were tending. It was therefore a cause of great satisfaction to myself when I first became acquainted with the views held by Mr. Murray.

These calcareous rocks, in the examination of which Mr. Murray used the methods he employed in the case of the deep-sea deposits, may be grouped into two chief classes, according to the proportion of volcanic débris they contain.

The *first class* comprises those rocks which, being largely composed of volcanic débris mixed with the tests of Foraminifera, Pteropods, and other Mollusks, have a composition very similar to that of the volcanic muds at present forming around oceanic volcanic islands in the Pacific. These rocks contain both pelagic and bottom forms of Foraminifera, and four prevailing kinds of them may be distinguished.

1. A friable rock, containing from 5 to 20 per cent. of carbonate of lime, and displaying to the eye only the white specks of minute Foraminiferous tests, with a few of microscopic size, entire Molluscan shells being rarely embedded. The carbonate of lime consists of Coccoliths, Rhabdoliths, Gasteropod, and Lamellibranchiate shells, Echinoderm fragments, calcareous Algæ, and many pelagic and bottom forms of Foraminifera. The residue consists for the most part of the minerals felspar, magnetite, augite, hornblende, fragments of pumice, scoriæ, and other volcanic rocks, with many glassy fragments, and of a fine argillaceous matter which forms about a third of the rock-substance. Rocks of this character form the masses of Treasury and Ugi Islands.

2. A very friable rock, containing from 30 to 35 per cent. of carbonate of lime. These rocks resemble in their general composition the rocks of the previous group, but they differ in the circumstance that they inclose in great numbers the entire shells of Pteropods, Gasteropods, Lamellibranchiates, together with simple corals of deep-sea genera, and the otoliths of fish. There are contained in the residue, in addition to the mineral particles and fine argillaceous material, a great many glauconitic-like casts of Foraminifera. Rocks of this character largely compose Alu, the principal island of the Shortland Islands, and are exposed in the low hills in the rear of Choiseul Bay.

3. A hard, grey fossiliferous limestone, containing usually about 60 per cent. of carbonate of lime and much volcanic débris. Such a rock, which is exposed in the lower courses of the Treasury streams, is chiefly composed of the broken-down fragments of corals and Lamellibranchiate shells, with calcareous Algæ and a few Foraminifera.

4 Coarse-grained rocks composed of the fragments of volcanic and coral rocks in rounded grains. Occasionally larger fragments, together with shells, are imbedded. Such rocks occur on the northern slopes of St. Christoval near the coast.

The *second class* includes those rocks which are largely composed of coral, Molluscan shells, Foraminiferous tests, and calcareous Algæ, with but a small proportion of volcanic débris. The share that each of these four principal constituents takes in the building up of the rock differs widely, and on this basis the following groups have been made. Whether the rock is mainly formed of the massive corals, or whether it is composed of the fragments of such corals broken off by the waves and mixed with shells and other organisms in varying proportions, such a rock as must be forming on the outer slopes of reefs, or whether it is composed of the consolidated calcareous muds and sands which are found at the bottom of lagoons, it has in all cases the same coral origin. The variety in character exhibited in the following groups of coral limestones may be thus in a great measure explained.

1. Coral rocks, properly so-called, which are merely the massive reef-corals in different stages of fossilisation.

2. Coral rocks, which are chiefly made up of calcareous Algæ, fragments of Molluscan shells, corals, and Echinoderms, the interstices being filled up by the tests of Foraminifera and other small calcareous organisms. In the composition of such rocks, which form *the majority of the so-called coral limestones* in the Solomon Islands, coral fragments take only a secondary part. The percentage of carbonate of lime in these rocks varies between 90 and 95, the residue consisting of the common volcanic minerals, siliceous casts of Foraminifera and a fine argillaceous matter.

3. Chalk-like coral limestones, which contain about 95 per cent. of carbonate of lime, and are chiefly composed of the fragments of Molluscan shells, Echinoderms, corals, calcareous Algæ, and Foraminifera. These rocks, therefore, in their general composition resemble the rocks of the second group of coral limestones; but they differ conspicuously in their chalk-like appearance and in being more friable. They occupy the usual surface position of other coral rocks, although not being of common occurrence. I found them overlying the soft Foraminiferous and Pteropod deposit in the Shortland Islands, and they may be sometimes found forming the central elevated portions of existing reefs. One of the specimens of coral this rock contained, according to a determination made

[1] "Principles of Geology," 11th edit. vol. ii. p. 612

by Dr. Leonard Dobbin, a considerable amount of magnesia, and thus approaches a magnesian limestone.

4. Compact fawn-coloured crystalline limestones of a homogeneous texture, in which sometimes reef débris may be observed. These rocks, which are of common occurrence on the lower slopes of the large island of St. Christoval, where they overlie the volcanic rocks of the district, are apparently formed by the consolidation of the ooze found at the bottom of lagoons inside coral reefs.

5. Foraminiferal limestones, which are hard and compact in texture, and are chiefly made up of pelagic and bottom-living Foraminifera, and contain occasionally a few simple corals of deep-sea genera. They contain generally from 75 to 85 per cent. of carbonate of lime, the residue being formed of the common volcanic minerals, siliceous casts of Foraminifera and fine argillaceous matter. These limestones are found at the surface, and in the island of Alu they may be seen to overlie the soft Foraminiferous and Pteropod deposits.

Such are the calcareous formations which are of most frequent occurrence in the Solomon Islands. Three other highly interesting rocks came under my notice, but in each case only in one locality.

(*a*) A Rhynconella limestone. In one of the islets of the Shortland Islands I found a hard grey limestone composed of numbers of Brachiopod, Gasteropod, and Lamellibranchiate shells, with many simple corals of deep-sea genera, embedded in a calcareous matrix largely made up of the tests of Foraminifera (chiefly pelagic forms). The Brachiopod shells belonged to the same species of Rhynconella. Mr. Davidson is inclined to look upon it as the same as *R. Grayii*, a species hitherto represented by a single specimen discovered in the British Museum amongst other natural history objects from the Fiji Islands (?) collected by Mr. J. M'Gillivray more than thirty years since.[1] The simple corals, as Mr. Quelch informs me, belong to the deep-sea genera, Leptocyathus, Stephanophyllia, Odontocyathus, Flabellum, &c. The Gasteropod and Lamellibranchiate shells are, as I learn from Mr. E. Smith, of shallow-water habit. This limestone contained 75 per cent. of carbonate of lime, the residue being made up of the common volcanic minerals, reddish siliceous casts of Foraminifera, and fine washings.

(*b*) A friable earthy rock, which, from the small size of the minerals, the absence of bottom-living Foraminifera, and the scarcity of pelagic forms, resembles a deep-sea clay, and contains a thin coating of manganese between the small layers or folds of the rock. This deposit, which contains about 20 per cent. of carbonate of lime, occurs in the upraised atoll of Santa Anna underneath the elevated reef-mass. On the reef-flat in the vicinity of this deposit there was observed by Lieut. Malan, as already observed, a detached concretionary block of manganese peroxides, one to two cubic feet in size: a typical fragment that I brought home is, according to Mr. Murray, quite similar to smaller masses dredged by the *Challenger* and *Blake*.

(*c*) A hard Foraminiferal limestone, chiefly composed of pelagic Foraminifera. Of this rock, which was found at the surface in Treasury Island, Mr. Murray observes that the organisms, together with the minerals, are similar to those found in deposits of modern seas near volcanic islands at depths of from 500 to 800 fathoms. The Foraminifera are identical with those found in the surface-waters of the tropics at the present day.

With such data as the foregoing at my disposal, it might appear an easy matter to gauge the amount of elevation that has occurred in these regions in recent times. But so great has been the sub-aërial denudation in these islands that although the elevatory movements have brought up to our view a deep-sea clay, with its concretion of manganese, and a Foraminiferal limestone that was probably formed in a depth of from 500 to 800 fathoms, two rocks which occur in islands at opposite extremities of the group, yet, notwithstanding this great upheaval, the calcareous envelopes usually disappear from the slopes of the volcanic islands at heights of 500 or 600 feet above the sea, and never came under my observation in such islands at greater elevations than 900 feet. The rainfall in the elevated interior of the large islands cannot be much under 300 inches in the year, since my own observations place it at about 150 inches at the coast. Of the rapid degradation of the surface which these calcareous districts undergo during a heavy fall of rain, of as much as two to three inches in the same number of hours, I was a frequent witness. In a few minutes the whole hill-slope discharges a continuous sheet of muddy water, the rivulets swell to turbid streams, and the water rushes down the permanent courses with the roar of a mountain torrent. After the rain-storm has passed away, the band of muddy water that fringes the whole length of the coast, to a distance of one-quarter or one-third of a mile from the shore, indicates the loss of material which the land-surface has sustained.

From the general character of these calcareous formations it may be safely inferred that they will be found wherever there has been elevation during the recent period in regions where coral reefs are flourishing. Amongst other localities we may look to the West Indies, the Indian Archipelago, New Guinea (more particularly the south-coast), New Britain, New Ireland, the Santa Cruz Group, the New Hebrides, the Loyalty Islands, New Caledonia, and the Fiji and Tonga Groups, as likely to possess at the sea-border formations of a similar character. In the Solomon Islands, many other islands, such as Ulaua and Ronongo, will be probably found to be counterparts of the islands of Ugi and Treasury.

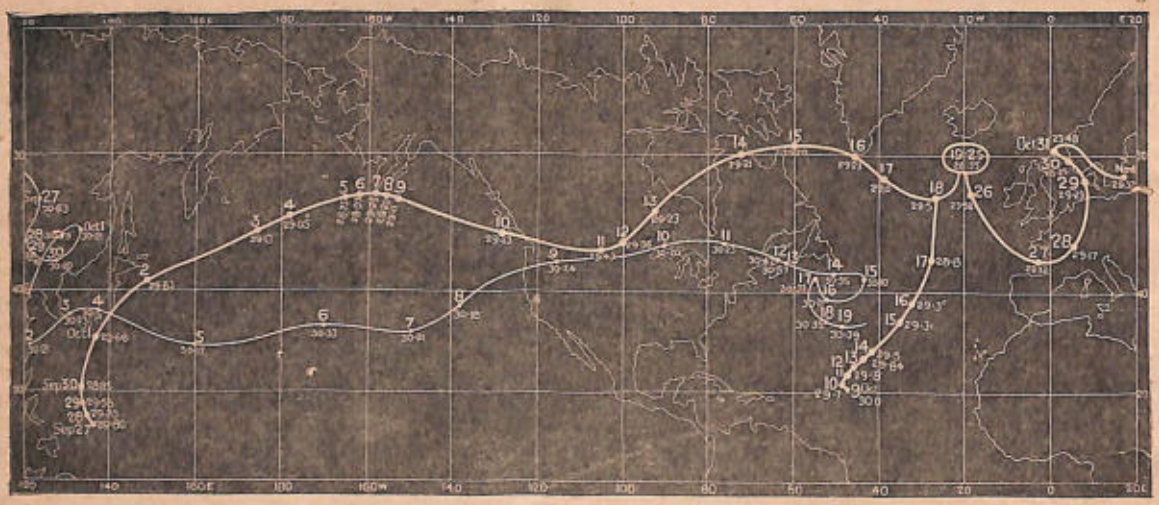
NOTE.—A reference should be made to the occurrence of worked flints of the palæolithic type in the soil of the cultivated districts of these islands. The natives say they have fallen from the sky, which reminds one of a similar superstition prevalent in the country districts at home as to the source of celts. I was never successful in finding where they came from originally, and would recommend future visitors to this group to pay attention to this point. They are said to occur together with a chalk-like rock on the beaches of Ulaua, an island which I was unable to visit. (For further information on this subject, *vide* some notes of my own read by Prof. Liversidge before the Royal Society of New South Wales, *Journal* for 1883, vol. xvii. p. 328.)

[1] Vide *Annals and Magazine of Natural History*, vol. xvi. p. 444.

TRACING A TYPHOON TO EUROPE

AT the meeting of the Royal Meteorological Society held on November 18, a paper by Mr. Henry Harries, on "The Typhoon Origin of the Weather over the British Isles during the second half of October, 1882," was read. The author had prepared daily charts of the North Pacific Ocean from September 26 to October 10, and by permission of the Meteorological Council the charts of the area between the western coast of America and Eastern Europe were utilised. The earliest evidence of the formation of the typhoon was on September 27, some distance east-south-east of Manilla. At first the movement was towards north-west, 5 miles an hour, but on September 30, when the storm-area extended to 1300 miles north-west of the centre, it curved towards north-east, crossed the south-eastern corner of Japan at 33 miles an hour, and attained a maximum rate of 51 miles per hour on October 2 to 3, after leaving the Japanese coast. In the neighbourhood of the Aleutian Archipelago the progress was very slow until the 9th, when it rapidly increased to 35 miles an hour, and entered Oregon on the 10th. The Rocky Mountains proved to be no obstacle to the progress of the typhoon, which crossed the range at 36¾ miles an hour, and, maintaining this rate, passed

across the Northern States into Canada. Thence it crossed Hudson's Bay and Labrador, into Davis Strait. Altering its course to south of east it passed the southern point of Greenland on October 16, and two days later, in lat. 55° N., long. 27° W., it was joined by another disturbance, which seems to have formed about October 9 in 20° N., 48° W. The junction of the two storms was followed by a complete cessation of progressive movement for a week (October 19 to 25), and it was during this period was formed as a subsidiary the gale which suddenly arrived over our south-eastern counties upon the morning of October 24, completely upsetting the Meteorological Office forecasts of the previous night The author quoted several records from ships, which went to show that this secondary storm had not formed until nearly midnight; and that reports from outlying coast-stations would not have enabled successful forecasts to be issued before 3 a.m. on the 24th. The 8 a.m. observations for the Daily Weather Report show that with the exception of Hurst Castle the winds on the northern side of the Channel were moderate, but along the French coast heavy gales were blowing. Ships' records indicate that off Start Point a moderate easterly gale began at 6.20 a.m. By 8 a.m. a whole gale from S.E. was blowing



Tracks of the Typhoon and Anticyclone of September and October 1882. The thick line shows the track of the typhoon, the thin line that of the anticyclone. The dates and the lowest and highest ascertained readings of the barometer for the day being given near the positions of the centres at Greenwich noon.

to south-west of Portland, while off the Start at 8.30 a.m. the wind veered to W.N.W. a strong gale. At 9 a.m. the wind off Portland veered to W. and blew with terrific violence. Further east, as far as the Downs, the wind had by noon changed to W. and S.W., and increased to a furious storm, with violent squalls and a terrible sea. As this gale passed away the primary moved into the Bay of Biscay and entered France on the 27th. As in Japan and America, its advance was marked by violent gales and destructive floods over a very extensive area—from Algeria northwards. The damage caused by the floods in England was serious, but trifling compared with the losses in Southern and Central Europe, the destruction being enormous. This typhoon was the principal contributor in making October, 1882, by far the worst within living memory. With this final effort it seemed to have expended its fury, and in crossing France and the Netherlands it gradually filled up. The last trace of the typhoon was in the Baltic on November 1, when it quietly dispersed, after covering over 14,000 nautical miles in thirty-six days, the longest track hitherto followed day by day.

THE NIVAL FLORA OF SWITZERLAND

IN the spring of 1883 (the last year of his life), the eminent Swiss naturalist, Prof. Oswald Heer, having finished his "Flora fossilis Arctica," resumed a work with which he had been long occupied before—viz. the preparation of a Nival Flora of Switzerland, in which he proposed to give an account of all the plants found above 8000 feet in that country, and a comparison of these with the Nival flora of other countries. This work, based on very abundant material, was nearly completed before the author's lamented death;—he anticipated being able to finish it in about eight days more had health allowed. The work has now been published in full (as he left it) in the *Nouveaux Mémoires de la Société Helvétique des Sciences Naturelles* (vol. xxix. part 1). The summary of results of this research, which were communicated at a gathering of Swiss naturalists in Zurich, we will here reproduce.

(1) We know at present in Switzerland 337 species of flowering plants which have been observed at from 8000 to 13,000 feet above the sea; 12 of these species have still been found above 12,000 feet.

(2) All these species are found in the lowest division of the Nival region, 8000 to 8500 feet. Above 8500 feet there is no species which is peculiar to this height.

(3) One-tenth of the species of the Nival region consists of species of lowland flora, nine-tenths of mountain plants. Most of the latter belong to the Alpine region, and about a quarter of the species has its greatest distribution over 8000 feet. These are the Nival plants in the narrower sense. While the lowland plants and the plants of the hilly and sub-Alpine region disappear at about 9500 feet, the Nival plants, with a few Alpine species, are the last children of the flora.

(4) The mountain mass of Monte Rosa has the richest Nival flora; which here rises higher than in the Rhætian Alps, and in the latter higher than in the Glärnisch Alps.

(5) The majority of the species are distributed throughout the whole region of the Alps; only a small portion is found exclusively in the east from Orteler to the Gothard, or in the west from the Gothard to Savoy.

(6) About half of the plants of the Nival region come from the Arctic zone, and very probably came over Scandinavia to our region in the Glacial period, since Arctic Europe has the largest number (140) of species

which our Nival flora has in common with the Arctic zone.

(7) This Arctic flora probably arose on the mountains of the Arctic zone, and stood in the same relation, in the Miocene period, to the flora of the Arctic lowland as the present Alpine flora to the flora of the Swiss lowland.

(8) The Miocene Arctic flora advanced to Europe in the Tertiary period, and the European Tertiary flora received from it the types which now characterise the temperate zone, viz. the pine-woods and foliage-trees with deciduous leaves. In course of time these dominated more and more over the tropical and sub-tropical forms, which were the original occupiers of these regions, and became the mother-plants of a portion of the present lowland flora.

(9) In the Glacial period the mountain plants of the Arctic zone descended into the lowland, and spread southwards with the glaciers. As in the Tertiary period the trees and bushes with deciduous foliage wandered southwards, so in the Glacial period did the mountain plants; and that this migration took place radially from the north is proved by the fact that not only in the snow region of our Alps nearly the half of the plant species consists of Arctic species, but also the American mountains, and on the other side the Altai, and even the Himalaya, have quite a number of such Arctic species, and have them in common with the Swiss Alps. We know that already in the Tertiary period, and also in the period of the Upper Cretaceous, a number of plants can be traced from Greenland on to Nebraska, in North America, and on the other hand to Bohemia, Moravia, and on to Southern Europe. Thus in the period of the Cretaceous formation, in the Tertiary, and in the present formation, we find the same phenomenon: that Europe with America has a number of species in common which were formerly indigenous in the Arctic zone, and therefore very probably went out from that as their original home. The same process is thus repeated in different ages; the plant-world of the high north has at all times exercised a great influence on the formation of the plant-covering of Europe.

(10) The endemic flora of the Nival region arose in our Alps. A principal centre of its formation seems to have been the Monte Rosa chain, in which probably, even during the Glacial period, extensive mountain masses of ice and *névé* were liberated.

(11) This flora received at the beginning of the Quaternary period its present character, and spread on the moraines of the glaciers into the lowland and into the mountainous regions of the neighbouring countries.

(12) Its mother flora had probably its abode in the Tertiary mountain country of Switzerland.

NOTES

We understand that the post of Assistant Director of the Royal Gardens, Kew, has been offered to Mr. D. Morris, M.A., F.G.S., the Director of Public Gardens and Plantations, Jamaica. The appointment is in the gift of the First Lord of the Treasury.

So much has been heard during the last few years of the services rendered to the science, industry, and commerce of the West Indies by the public gardens and Government plantations of Jamaica under the superintendence of Mr. Morris, that it is with surprise and regret that we learn that the future efficiency of these institutions is seriously threatened. A Select Committee, it appears, was recently appointed, under a resolution of the Council of Jamaica, "to consider the means of diminishing the expenses of the Government," and, among other suggestions and recommendations, it proposed that the Government cinchona plantations should be sold, and that the public gardens at Kingston should be handed over to the local authorities of that town to be maintained by them, instead of, as heretofore, by the Government, under the Director of Public Gardens. Committees appointed under these circumstances are generally more anxious to justify their existence by making recommendations than careful to inquire where they would be always possible or desirable. The cinchona plantations, thus threatened with extinction, were founded in 1868 by Sir John Peter Grant, and now consist of 150 acres under cinchona, with smaller areas under jalap, tea, and nurseries for timber and shade trees. According to the "Handbook of Jamaica," they distributed in five years to private planters 1200 ounces of cinchona-seed, 1,200,000 cinchona seedlings, 400,000 cinchona plants, besides large quantities of timber and shade trees for re-foresting purposes. The Kingston Gardens, which are to be taken from under Mr. Morris's control, are used as a depot for plants from the other establishments, and also as the centre of distribution of plants and seeds to all parts of Jamaica and of the West Indies; there is no doubt, therefore, that they fulfil important functions.

If there was a single department in the whole Government service on which West Indian economists should have refrained from laying their hands except by way of increasing its scope and efficiency, we should have thought Mr. Morris's department that one. For if the West Indian Islands are ever to emerge from the disastrous economical condition of the past thirty years, and regain their previous flourishing state, it will be by the labours of institutions such as the public gardens, and of men such as Mr. Morris. Their old staples are useless to them, for Europe can buy them cheaper in other markets, and they must find new ones, or plunge deeper into the mire of financial embarrassment and bankruptcy, public and private. This can only be done by experiments and careful observations which no one but a public department and skilled botanists can carry out. Happily the economic value of the gardens in Jamaica have been recognised by the highest authorities. The Royal Commissioners stated that the department was invaluable, and that it was in as good a state as the sums placed at Mr. Morris's disposal would allow. The Governor coincided in this testimony, and added that "Mr. Morris was untiring in his endeavours to induce persons to commence new industries calculated to develop the resources of the island, and to bring about a condition of prosperity which would go far to counterbalance the depression under which the sugar industry of Jamaica now labours." It may be hoped therefore, notwithstanding the report of the Committee on Government Economy, that the department may be permitted to pursue its "invaluable" work on the same lines and with undiminished means.

Mr. Samuel Birch, D.C.L., LL.D., F.S.A., Keeper of the Egyptian and Oriental Antiquities in the British Museum, died, on the 27th inst., in his seventy-second year. Dr. Birch had served in the British Museum for fifty years, during the last part of which he was in charge of the Egyptian and Assyrian antiquities, and it is with this department of Oriental scholarship that his name will ever be associated. His early writings of nearly fifty years ago dealt mainly with Chinese subjects, and one of his first duties at the British Museum was to catalogue the large collection of Chinese coins, and throughout the greater part of his life he manifested his interest in Chinese subjects by various publications. He was twice despatched to Italy on archæological missions on behalf of the Government, and in 1860 founded the Society of Biblical Archæology. His works on all departments of Egyptology fill many volumes, and extend over more than forty years, and at the time of his death he had in the press one work, while another, a new dictionary of hieroglyphics, was nearly completed.

No authentic information is to hand yet to explain the terrible and disastrous colliery explosion at the Mardy mine last week. The atmospheric pressure had been unusually high, and so far as we have been able to gather, coal-dust played an important part in the explosion. No doubt some facts as to the condition of the mine will come out at the inquest on January 12.

THE following are the arrangements for the Friday evening lectures at the Royal Institution before Easter:—January 22: Prof. Tyndall, F.R.S., Thomas Young and the Wave Theory; January 29: Sir William Thomson, F.R.S., Capillary Attraction; February 5: T. Pridgin Teal, F.R.C.S., The Principles of Domestic Fireplace Construction; February 12: Prof. Osborne Reynolds, F.R.S., Experiments showing Dilatancy, a Property of Granular Material, Possibly Connected with Gravitation; February 19: W. K. Parker, F.R.S., Birds, their Structure, Classification, and Origin; February 26: A. A. Common, F.R.S., Photography as an Aid to Astronomy; March 5: Prof. Alexander Macalister, F.R.S., Anatomical and Medical Knowledge of Ancient Egypt; March 12: Reginald Stuart Poole, Corresp. Inst. France, The Discovery of the Biblical Cities of Egypt; March 19: W. H. M. Christie, F.R.S., Astronomer Royal, Universal Time; March 26: Wm. Chandler Roberts-Austen, F.R.S., M.R.I., Chemist of the Mint, on Certain Properties Common to Fluids and Solid Metals; April 2: Howard Grubb, F.R.S., Telescopic Objectives and Mirrors—their Preparation and Testing; April 9: William Anderson, M.Inst.C.E., New Applications of the Mechanical Properties of Cork to the Arts; Apr[illegible]: Prof. Sir Henry E. Roscoe, M.P., F.R.S.

WE regret to learn that Dr. W. Sklarek, who founded *Naturforscher* eighteen years ago, and has conducted it since, has resigned the editorship of that well-known journal, which will now be published by the Laupp'schen Buchhandlung, Tübingen. Dr. Sklarek, we understand, will edit a new journal of a similar kind to be published in Brunswick.

IT is stated that experiments are being made at Prof. Lieben's chemical laboratory at Vienna, with a new gaslight invented by Dr. Auer. A cotton wick, saturated with an incombustible metal solution, is introduced into the flame of an ordinary Bunsen lamp, the result being a light similar to the incandescent electric light.

MR. LESLIE STEPHEN'S "Life of Henry Fawcett," just published by Messrs. Smith, Elder and Co., contains two very characteristic letters from Darwin, which now see the light for the first time. Mr. Stephen refers to the deep impression made on Fawcett's mind by the "Origin of Species." He became an enthusiastic Darwinian, and in December 1860 published an article in which "he states with his usual firmness the true logical position of Darwin's theory; distinguishing carefully between a fruitful hypothesis and a scientific demonstration; exhibiting the general nature of the argument and the geological difficulty with great clearness, and taking some pains to prove that religion is in no danger from Darwinism." This led to a correspondence with Darwin, and in one of the letters the latter, after referring to his satisfaction at hearing that Mill considered his book a piece of thorough logical argument, adds:—"Until your review appeared I began to think that perhaps I did not understand at all how to argue." In a second letter, dated September 18, 1861, thanking Fawcett for a paper of his read before the British Association, Darwin writes:—"You will have done good service in calling the attention of scientific men to means and laws of philosophising. As far as I could judge by the papers, your opponents were unworthy of you. How miserably A talked of my reputation, as if that had anything to do with it. How profoundly ignorant B [who had said that Darwin should have published facts alone] must be of the very soul of observation! About thirty years ago there was much talk that geologists ought only to observe and not theorise; and I well remember some saying that at this rate a man might as well go into a gravel-pit and count the pebbles and describe the colours. How odd it is that any one should not see that all observation must be for or against some view if it is to be of any service!" Referring to his health Darwin says he is one of those miserable creatures who are never comfortable for twenty-four hours; "and it is clear to me that I ought to be exterminated." Again he says that to him "observing is much better sport than writing." Referring to the timidity with which men of science received his theory, he wrote: "The naturalists seem as timid as young ladies should be, about their scientific reputation." The whole of the correspondence at this time (1860-61) between Darwin and Fawcett, of which Mr. Stephen only gives the two letters here quoted, should be of very great general interest.

THE Vienna Correspondent of the *Times* reports that Dr. Gautsch, the new Minister of Public Instruction in Austria, has prohibited the use of paper ruled in square or diagonal lines within all public schools. The reason of this is that such paper has been found to injure the eyesight of pupils. It has been largely used hitherto in primary schools to facilitate writing and arithmetic lessons; but in future only paper plain or ruled in straight lines is be used.

A STRIKING case of vital resistance in fishes has been lately reported by M. Douaret de Bellesme, Manager of the Aquarium of the Trocadéro in Paris. On November 18 a fishmonger, M. Heydendare, received from Gonda (the centre of fisheries in the region about Rotterdam) a large consignment of fishes packed and preserved in ice. They could not have been caught later than the 16th, and were probably caught on the 15th. On unpacking, a jack was seen to move its gills slightly, and the idea occurred to wash it with fresh water, and immerse it in a vessel. In a few hours the fish was in its normal state, and very lively. M. Heydendare sent it to the Trocadéro Aquarium, where it is to be seen now; it is a fine animal, about 2 feet 4 inches long. Here, then, is a case of a fish out of water more than forty-eight hours (probably three days), packed with little care, along with dead fish and pieces of ice—travelling thus 280 miles, and coming to life again. The lowering of temperature was doubtless very favourable to maintenance of the vital functions.

THREE tall chimneys belonging to Kunheim and Co., Berlin, were lately destroyed by means of gun-cotton. The largest was about 147 feet high, and 10 feet diameter at the base. In order that it should fall outwards from the city, the charge of gun-cotton (about 57 lbs.) was attached in portions to the side next the city, and to the adjacent sides. All three were exploded simultaneously with a magneto-electric apparatus. The chimney, instead of falling obliquely, collapsed vertically, and on inspection the four walls of the pedestal were found to have been driven outwards. The bricks were all detached from each other, and nearly all entire. The debris was thrown a very little distance. The two other chimneys, treated similarly, fell as was expected, *i.e.* obliquely away from the city. One of them, in falling, broke in two about the middle.

RECENT issues of *Globus* contain two most interesting articles on the investigations into the antiquities of the Island of Bornholm, carried on for a considerable period by its former chief official, Herr Wedel. The Stone Age is extensively represented, although kitchen-middens appear to be wholly absent, by graves, stone coffins, and other objects. The first contain unburnt, as well as the remains of cremated, bodies, but the

latter are found under such circumstances as to lead to the conclusion that they belong to a later period. With the exception of stone chisels, all the objects usually found in graves belonging to the Stone Age are found, such as axes, arrow-heads, and the like. Amber ornaments also frequently occur. The stone coffins, which are sometimes very large, are also numerous, and in the mounds with them are frequently found the bones of cremated bodies. On this question, Herr Wedel comes to the conclusion that cremation in Bornholm must have been introduced towards the close of the Stone Age. Most of the objects were apparently made in the island itself; but it is not improbable that the larger flint-articles, or possibly the blocks from which they are made, come from places where flint is more plentiful than in Bornholm. Traces of houses belonging to this age have also been found. On the whole, the island during this period does not appear to have been thickly populated; the people moved hither and thither, and appear to have had domestic animals. The remains of the Bronze Age are also very numerous and interesting; of these a full account is given, and it is interesting to notice that, during this period, cremation appears to have been the usual method of disposing of bodies of the dead. Similarly, the finds belonging to the Iron Age are described, and, in conclusion, the writer says that in Bornholm we can trace, without important breaks, human development from the Stone Age down to historic times. Nothing appears, he says, in this long history to show that there was any sudden alteration in the growth of civilisation such as might be caused by the influx of a new tribe. Such an influx, had it taken place, would certainly have left recognisable marks behind it; and, indeed, the thick population of the island in the Bronze and earlier Iron Ages left no opportunity for the settlement of any external people in Bornholm.

THE method of placing electric lamps in front of locomotives to illuminate the line, has been tried on many lines, but apparently has not found much favour. Recent experience in Russia appears to show that financial considerations are not alone unfavourable to the system. On the railway between St. Petersburg and Moscow several locomotives were fitted with electric lamps. For a time they gave great satisfaction, lighting the way more than a kilometre in front. But the *employés* began to complain of the contrast between the lighted and the unlighted surfaces painfully affecting the eyes; and doctors ere long reported that there had been several cases of grave injury to the eyes in this way. Hence the lamps were abandoned. The directors have not, however, given up the idea of better illumination of the line, and they now contemplate placing electric lamps so as to illuminate about 1 kilometre on either side of the station.

THE best plant at present known for consolidating, by the interlacing of its roots the loose soil of a newly-made embankment is, according to M. Cambier (of the French Railway Service), the double poppy. While the usual grasses and clovers need several months for the development of their comparatively feeble roots, the double poppy germinates in a few days, and in two weeks grows enough to give some protection to the slope, while at the end of three or four months, the roots, which are 10 or 12 inches long, are found to have interlaced so as to retain the earth far more firmly than those of any grass or grain. Though the plant is an annual, it sows itself after the first year, and with a little care the bank is always in good condition.

ACCORDING to an official statement issued by the Japanese Government, there occurred 553 earthquakes during the nine years and six months preceding December 1884, averaging one earthquake for every six days and six hours. This must, however, refer to the capital and the surrounding district only, and earthquakes of great violence can alone be counted, for Prof. Milne was able to trace an average of an earthquake per day in Nagasaki, in the extreme south of the Japanese archipelago. The official statistics, on the other hand, may possibly be compiled from the returns of local officials all over the country, in which case only those shocks which caused loss of life or damage to property would be included. If this hypothesis is correct, we should have an average of more than an earthquake per week which was so violent that it caused injuries to life or property sufficiently serious to attract the attention of the local authorities, and, in their judgment, to require a report to the central Government.

M. HERZEN contributes to a recent number of the *Revue Scientifique* an account of certain experiments which he made recently on the thermic sense in animals. His observations on man had already led him to the conclusion that impressions of heat are conveyed to the brain by the gray substance of the spinal marrow. Animals, he found, on the other hand, do not react under the impressions of moderate heat, and when the latter is excessive the reaction is one of pain, not of the specific sensation of heat. On the contrary, however, cold operates on them actively, and M. Herzen succeeded in demonstrating by his experiments that impressions of cold in animals are really conveyed by the medullary rays which transmit the impressions of touch. The various experiments which are briefly described in the article satisfied him that the cortical lesions which destroy sensibility to touch also destroy that of cold, and, when the first is preserved, the latter likewise remains; and that, in brief, impressions of contact and of cold are transmitted in the same way to the same regions of the cortical layer of the hemispheres.

IN a recent article on the work of the Asiatic Society of Bengal, originally founded by Sir William Jones, during the first century of its existence, we referred to the division of its publications into literary and scientific, the numbers of the *Journal* of the Society in each case being quite distinct. We have now before us the scientific numbers of the *Journal* for the past year, and they show remarkable activity. It should be remembered that there are independent societies in Madras and Bombay, so that the Bengal Society's publications represent the work of one Presidency only. Amongst the scientific papers published during the year are the following:—The theory of the winter rains in Northern India, by Mr. Blanford, the President of the Society, and the Meteorological Reporter to the Government of India; descriptions of some new Asiatic diurnal *Lepidoptera*, chiefly from specimens contained in the Indian Museum in Calcutta, by Mr. Frederic Moore; a new species of *Simulium* from Assam, by Dr. Becher, of Vienna; variations of rainfall in Northern India during the sun-spot period, by Mr. Pearson, the Meteorological Reporter for Western India; a description of a new Lepidopterous insect belonging to the Heterocerous genus *Trabala*, by Mr. Moore; *Phyllothelys*, a remarkable genus of *Mantodea*, from the Oriental region, by Prof. Wood-Mason; notes on the Indian *Rhynchota*, by Mr. Atkinson; a list of Lepidopterous insects collected in Cachar, by Mr. Moore (the first part, dealing with *Heterocera*, has alone been published so far); revised synopsis of the species of *Charadodis*, a remarkable genus of *Mantodea*, common to India and tropical America, by Prof. Wood-Mason; and finally, an account of the two remarkable south-west monsoon storms in the Bay of Bengal in 1883, by Mr. Eliot, the Meteorologist to the Bengal Government. It should be added that these papers are, where necessary or desirable, copiously illustrated.

IT is interesting to note that the various species of Salmonidæ at the Aquarium, South Kensington, have been recently spawned by artificial means, the sea trout being crossed with the Gilleroo

and Levenensis trout. A very large yield of ova was obtained, all of which presented signs of healthiness and complete impregnation. Although the fish spawned have been in captivity for four years, they shed their eggs with the same ease as those subjected to natural conditions.

A LARGE number of Salmonidæ eggs are being incubated at the Buckland Museum. It will be remembered that fish-hatching operations were carried out extensively here by the late Frank Buckland, but after his death they subsided, and until this year the apparatus used by him were not called into use. The re-introduction of this feature will afford much gratification to visitors, and especially to those having the interest of the great naturalist's collection at heart. Besides, the authorities have, by this act, shown their sympathy with fish-culture, and have also set an example which might be emulated by the public elsewhere. It may not be generally known, but the Museum does not contain nearly all the exhibits comprised in the Buckland Collection, which cannot be adequately shown to the public in the limited space allotted to the exhibits.

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It had been generally assumed, prior to Prof. Langley's bolometer researches, that our atmosphere was most transparent to the visible portion of the spectrum. Prof. Langley has shown, on the contrary, that the coefficient of transmission steadily increases towards the extreme infra-red, up to the point $\lambda = 3\mu$, where the solar spectrum ceases to give any further evidence of its existence. The present research seems to show that this sudden termination of the spectrum is not due to our atmosphere, for Prof. Langley has been able to form a heat-spectrum from the lunar rays, which he is able to trace considerably further in the longer wave-lengths than that of the sun. This lunar spectrum shows two maxima, one fairly corresponding with "the solar curve maximum, the second indefinitely lower down in the spectrum, corresponding to a greater amount of heat at a lower temperature." This latter portion of the spectrum Prof. Langley considers as being clearly due to the moon itself, and as revealing its real temperature. This temperature, he concludes from his study of the spectra of cold bodies, is lower than that of melting ice. In a further paper read before the National Academy in November last, Prof. Langley states that a comparison of the spectra obtained from the moon in summer with those obtained in winter, shows that a much greater amount of heat is received in the latter season than the former, a difference probably due to the greater amount of aqueous vapour in our atmosphere during summer. He also mentions that he has made the first attempt to determine the temperature of space by direct experiment.

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28, 6 30·0	... 19 59 3	... 4 31·6 N.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1886 JANUARY 3-9

(For the reckoning of time the civil day, commencing at reenwich mean midnight, counting the hours on to 24, is here nployed.)

At Greenwich on January 3

an rises, 8h. 8m.; souths, 12h. 4m. 48·8s.; sets, 16h. 2m.; decl. on meridian, 22° 48′ S.: Sidereal Time at Sunset, 22h. 55m.

oon (New on January 5) rises, 6h. 7m.; souths, 10h. 36m.; sets, 15h. 3m.; decl. on meridian, 18° 12′ S.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	6 17	10 28	14 39	20 41 S.
Venus	10 6	15 6	20 6	12 23 S.
Mars	22 13*	4 46	11 19	5 45 N.
Jupiter	23 32*	5 31	11 30	0 59 S.
Saturn	15 14	23 24	7 34*	22 33 N.

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

Phenomena of Jupiter's Satellites

Jan.	h. m.		Jan.	h. m.	
4	1 13	IV. ecl. reap.	6	6 58	I. occ. reap.
4	1 29	II. ecl. disap.	7	1 51	I. tr. ing.
4	6 44	II. occ. reap.	7	4 6	I. tr. egr.
5	6 29	III. ecl. disap.	8	1 26	I. occ. reap.
5	7 23	I. tr. ing.	9	1 11	III. tr. ing.
6	1 46	II. tr. egr.	9	4 0	III. tr. egr.
6	3 31	I. ecl. disap.			

he Phenomena of Jupiter's Satellites are such as are visible at Greenwich.

Saturn, January 3.—Outer major axis of outer ring 46″·6; uter minor axis of outer ring 20″·5; southern surface visible.

Jan. h.
9 ... 2 ... Mercury at greatest elongation from the Sun, 23° west.

Variable Stars

Star	R.A. h. m.	Decl. ° ′		h. m.	
δ Cephei	0 52·2	81 16 N.	Jan. 3,	1 5	*m*
N Virginis	13 20·2	2 47 S.	,, 4,	9 30	*M*
Libræ	14 54·9	8 4 S.	,, 5,	18 13	*m*
U Coronæ	15 13·6	32 4 N.	,, 6,	3 41	*m*
R Serpentis	15 45·4	15 29 N.	,, 5,		*M*
U Ophiuchi	17 10·8	1 20 N.	,, 5,	4 45	*m*
			,, 6,	0 53	*m*
			,, 6,	21 1	*m*
β Cephei	22 24·9	57 50 N.	,, 6,	17 0	*m*
δ Aquarii	22 51·0	20 57 S.	,, 6,		*M*

M signifies maximum; *m* minimum.

Meteor Showers

Meteors have been observed during this week in former years rom the following radiants:—Near *β* Aurigæ, R.A. 93°, Decl. 43° N.; R.A. 145°, Decl. 5° N.; R.A. 150°, Decl. 67° N.; and R.A. 181°, Decl. 35° N.

GEOGRAPHICAL NOTES

THE current number of *Petermann's Mittheilungen* contains an account of Herr Menge's second journey in the Somali Peninsula, accompanied by an excellent map showing the courses of both journeys. The traveller's meteorological observations and measurements, worked out by Dr. Schmidt of Gotha, are appended to the paper. Dr. Paulitschke's account of his journeys to Harar and amongst the Northern Gallas is concluded in this number. It contains a mass of interesting information of all descriptions with regard to this region. In an appendix a sketch is given of the scientific results of the journey, arranged under the heads—astronomical and magnetic observations, topography, anthropology and ethnography, and natural history.

THE *Bulletin* of the Paris Society of Geography just published (3e trimestre, 1885) contains the full text, with maps, of Dr. Heis's journeys amongst the Laos. M. Errington de la Croix, under the title of "Seven Months in the Tin Country," describes the method of working the tin-mines of Perak, in the Malay Peninsula. The only other paper in the number is one of great interest by M. Pinast on certain explorations of his in the State of Panama, especially in the regions around the Chiriqui lagoon, and the districts inhabited by the Guaymi Indians.

THE last Ergänzungsheft, or supplementary number of *Petermann's Mittheilungen*, is a lengthy account by Dr. Boas of his journeys during 1883 and 1884 in Baffin Land. It is divided into four main parts: an account of the journey from day to day, worked into a narrative; the history of past discoveries in the same region; geography; and, lastly, anthropo-geography. One appendix contains a long list of Eskimo place-names in Baffin Land, with their meanings; another gives a number of astronomical observations at various stations. The work is accompanied by two maps, one of Cumberland Sound and Cumberland Peninsula; the other represents the distribution of Eskimo tribes in Baffin Land.

THE current number of the *Proceedings* of the Vienna Geographical Society (Bd. xxviii. No. 11) contains a paper entitled "Shamanism in Upper Austria," by Dr. Zehden. The district specially referred to is the wide granite plateau which forms the watershed between Bohemia and Upper Austria, and the paper describes the old superstitions and practices still surviving amongst the comparatively primitive people who inhabit the district. The application of the term "Shamanism" to these in the bulk is curious, and somewhat questionable. Shamanism is the form of Buddhism ("Northern Buddhism") prevailing amongst the Mongols and Thibetans, the *Shaman*, or priest, being one who has overcome all his passions. It is said to be a word of Hindu origin. The Pope of this sect, which differs from the Buddhism of India and Ceylon more in state and power than in doctrine, is the Dalai Lama at Lhassa. It has an enormous literature, which is described as the dreariest in existence. Like every other form of religion, and perhaps more than most religions of civilised peoples, it has its superstitious practices and beliefs; but there appears no more excuse for transferring this name from Thibet and Mongolia to Austria, and applying it to superstitions there, than for calling the latter Babylonian, Chaldean, or something else that has no connection whatever with them. The number also contains further letters from Dr. Lenz, in charge of the Austrian expedition to the Congo.

A TELEGRAM was received in Berlin on the 27th inst., announcing the death of Dr. Büttner, a German explorer travelling in Bonnyland, in Africa. The deceased, like Livingstone, formerly engaged in missionary work in South Africa.

TEMPERATURE OF THE SURFACE OF THE MOON

IN a memoir on this subject presented to the U.S. National Academy of Sciences by Prof. S. P. Langley, the author concludes by reviewing as follows our sources of information, and weighing the imperfect and contradictory results each has brought us:—

(1) *Direct Measurement of Lunar Heat as compared with Solar.*—Our direct comparison indicates that we receive nearly the whole proportion of solar energy from the full moon that we should expect to get from a diffusive disk of the same angular aperture. This heat must in reality be partly diffused and partly radiated, and we do not know (from the present observations) in what proportions these two kinds enter. So far as the observation itself is reliable, we may, however, infer that our atmosphere is permeable to most of the lunar heat of either kind, but the method is unfortunately subject to such large sources of constant error, that we cannot derive great confidence from the apparent agreement of different observations or even of different observers. It may be said, however, to create a certain presumption that the earth's atmosphere is diathermanous to heat of lower wave-length than has been heretofore supposed, *and of lower wave-length than appears to reach us from the sun.*

(2) *Comparison of Moon's Heat with that of Leslie Cube.*—If we may draw any inference from this class of observations it is that the sunlit surface of the moon is not far from the freezing temperature, but not so far below as we might expect to find that of an absolutely airless planet.

(3) *Transmission of Lunar Heat by the Earth's Atmosphere.*—Our observations indicate a not materially greater co-efficient of transmission for lunar heat than for solar; and though their

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clusive. Though different strengths of current were tried, no change in the pupil occurred, unless when the current was so strong as to cause diffuse stimulation. In such cases both pupils would occasionally become dilated, as under sensory stimulation in general. The functional activity of the roots under investigation was shown by contraction of the thoracic muscles on the side of stimulation.

In the third experiment, however, results were obtained of such definiteness and uniformity as to indicate almost without further confirmation the origin of the dilator nerve of the iris.

In this experiment the spinal nerves were exposed from the sixth cervical to the eighth dorsal inclusive. The posterior roots were cut on the left side, and the anterior roots stimulated, while the eyes were carefully observed by two assistants—my pupils, Mr. Norvill and Mr. East. Dilatation of the left pupil occurred almost invariably on stimulation of the second dorsal root, whereas no change whatever could be perceived on stimulation of any of the other exposed roots. This was verified over and over again, and the several roots repeatedly compared with each other. The distance of the secondary coil in this experiment ranged from 20 to 18 cm.

Stronger currents not carefully insulated caused dilatation of both pupils wherever the stimulation was applied, an expression only of general sensory stimulation.

After death a careful dissection was made for me by Mr. Brooks, and the effective root, which was marked, proved to be the second dorsal. An examination with a lens showed that the fibres of the posterior root of this nerve had been completely severed.

The results of the third experiment were entirely confirmed by the fourth.

In this I exposed the spinal nerves from the seventh cervical to the fourth dorsal and cut the posterior roots on the left side.

Here again with the utmost uniformity on each stimulation of the second dorsal, the left pupil, and this one only, became widely dilated; whereas stimulation of the other roots was entirely negative in respect to the pupil.

I ascertained in this experiment that a strength of current which would suffice to excite the muscles of the limb or trunk to action would frequently fail to cause any dilatation of the pupil when applied to the second dorsal. Somewhat stronger, but yet barely perceptible on the tongue, the current at once caused the pupil to dilate. Occasionally also if the second root had been stimulated repeatedly the iris failed to respond, probably from mere exhaustion of the nerve.

Circumstances such as these would, I think, account for the absence of the pupil-reaction in my first experiment, and also in the experiment related by Prof. Yeo and myself, where the second dorsal root was really under stimulation.

The general result of these experiments is to show that in the monkey, and presumably also in man, the dilator fibres of the iris contained in the cervical sympathetic are derived from the anterior root of the second dorsal nerve.

Mathematical Society, June 14.—Prof. Henrici, F.R.S., president, in the chair.—Prof. W. Woolsey Johnson, of Annapolis, was admitted into the Society.—Prof. Cayley, F.R.S., spoke on the subject of seven invariants, and Mr. Hammond's recent discovery.—Prof. Sylvester, F.R.S. (who was very cordially welcomed), and Mr. Hammond spoke on the same subject.—Mr. Tucker (Hon. Sec.) read parts of papers by Prof. H. Lamb, on the mutual potential of two lines in space; by Mr. H. M. Jeffery, F.R.S., on bicircular quartics with collinear foci; and made a few remarks on the subject of inverse coordinate curves.

Physical Society, June 9.—Prof. Clifton in the chair.—Dr. Obach described an improved construction of the movable coil of galvanometer for determining currents and E.M.F. in absolute measure. This is a more sensitive, accurate, and powerful instrument than the old form. It is intended for accurate measurements and testing other instruments. The needle of the new form does not dip; and its vibrations are rendered dead beat by an air chamber. The secants of the inclination of the coil are the multipliers of the tangents of the deflections. The coil consists of a single solid rod or band of copper for measuring powerful currents; and on the same ring is a fine coil of German silver wire for measuring E.M.F. No shunt is required, owing to the movability of the coil. Dr. Obach gave figures showing the accuracy of the apparatus, which is very great.—Professors Ayrton and Perry read a paper on the electric resistance of water, being the result of some experiments made by them some time ago. A comparison of the galvanometer and electrometer methods of measuring this resistance was made during the experiments, the results being in favour of the latter, especially with currents of less than 6 volts. When the electrodes or platinum plates in the water were end-on, the resistance was less than when face to face. Mr. Boys thought this curious result might be due to the resistance between the surface of the plates and the water being reduced. In answer to Dr. Coffin, Prof. Ayrton stated that the plates were heated between every two experiments in the blow-pipe. Prof. G. Guthrie remarked that Kohlrausch had found ordinary distilled water to be much more conductive than pure distilled water, which was an insulator, and inquired if Prof. Ayrton chose pure water. The latter replied that as his experiments were to test the merits of the galvanometer and electrometer modes of testing, ordinary distilled water was used. Prof. Jones stated that he found it best to use alternating currents for measuring the liquid resistance of cells, and described a mercury commutator for rapidly reversing the testing current.—Prof. Ayrton then described a lecture apparatus for showing the laws of centrifugal force. A rapidly rotated arm carrying a movable weight springs from the centre of an aneroid chamber filled with mercury. This chamber is on the rotating axle, and as the centrifugal force of the arm pulls out the diaphragm, the mercury falls in the chamber and in a tube opening from it. Prof. Guthrie remarked that the apparatus would serve as a speed counter.—Prof. Perry then read a paper on the kinetic energy of rotating bodies, in which he pointed out the practical drawbacks to the "moment of inertia" calculations, and suggested the use of a new constant (termed for the nonce the "M"). This is the amount of kinetic energy possessed by a rotating body when making one revolution per minute. To find the energy for N revolutions per minute, multiply this by N^2. In the same way the "M" of a machine can be found and used.

PARIS

Academy of Sciences, June 11.—M. E. Blanchard, president, in the chair.—On some properties of a binary form of the eighth order, by F. Brioschi.—On the homogeneity of mathematical formulas, by A. Ledieu.—Four methods of separating gallium from iridium, by M. Lecoq de Boisbaudran.—Process to be adopted in observing the first radicules of the lymphatic system, and in determining whether these radicules communicate or not with the blood capillaries, by E. Sappey. The intimate union of the radicules with the bloodvessels, which had long been assumed on general grounds, is here demonstrated by actual observation.—Researches on rabies, by Paul Gibier. The points examined are (1) the manner of inoculation; (2) transmission of rabies through the mother; (3) the presence of foreign substances in the stomach of the dog in connection with the diagnosis of rabies; (4) attenuation of the virus: (5) the parasites of rabies. The author shows that the canine, like some other kinds of virus, may be attenuated by cold. That hydrophobia is due to a special parasite, although not yet scientifically demonstrated, is rendered highly probable.—Facts and results serving to determine some new properties of sulphate of iron, by M. Robart.—On the properties of phosphoric glass (the so-called *verre de phosphate de chaux*), by M. Sidot.—M. de Quatrefages presented, on behalf of M. de Lacerda, a memoir on an organism found in the victims of yellow fever, and by him regarded as a fungus. In the accompanying plate are represented the various stages of development of this organism.—On the track of Encke's comet in the years 1871–1881, by M. Backlund.—On a mode of transformation of figures in space, by MM. J. S. and M. N. Vaneček.—On the theory of the binary form of the sixth order, by R. Perrin.—A study of continuous periodical fractions, by E. de Jonquières (continued).—On the reflection of light on the surface of disturbed fluids, by L. Lecornu.—On the variation of the capillary constant of insulating liquid surfaces, such as ether and sulphuret of carbon, in contact with water, under the action of an electromotive force, by M. Krouchkoll.—On the formation of the glycolate of biba ic soda, by M. de Forcrand.—On the hydrates of barytes, by E. J. Maumené. It is shown that barytes makes no exception to the general law of hydrates, with which the numerous results obtained by Fremy, Filhol, Deville, and others, are in harmony.—On the fermentation of bread-stuffs, by V. Marcano.—On the artificial production of barytine, celestine, and anhydrite, by A. Gorgeu.—On the origin and process of formation of bauxite and granular iron, by Stan. Meunier.—On respiration in rarefied air, by MM. Fraenkel and Geppert.

June 18.—M. Blanchard, president, in the chair.—A despatch from San Francisco was read announcing M. Janssen's discovery of the Fraunhofer spectrum and of the dark lines of the solar spectrum in the corona, implying the presence of cosmic matter round the sun. Five photographs were taken of the corona and circumsolar regions to a distance of 15° for intra-Mercurial planets.—A new method of determining the right ascensions and absolute declinations of the stars (continued), by M. Lœwy.—On a drawing of the great comet of 1882, executed at M. Bischoffsheim's observatory near Nice, by M. Faye.—On the movements observed in the monolithic pillars supporting the meridian of the Neuchâtel Observatory, by M. Faye. From these observations, which have been regularly recorded since the foundation of the Observatory in 1859, it appears that even the most solid parts of the earth's crust are subject to slight movements, slow, regular, and partly oscillatory; also that the variable intensity of the movements depends on the one hand on the meteorological conditions of the year, while it is connected on the other with the periodical perturbations produced in the solar photosphere.—On a system of optical telegraphy established by M. Adam between the Islands of Mauritius and Réunion, by M. Faie.—On a carbon meteorite which fell on June 30, 1880, near Nogoga, province of Entre-rios, Argentine States, by M. Daubrée.—Experimental and clinical researches on the method of producing anæsthesia in the organic affections of the encephalon, by M. Brown-Séquard.—Numerous experiments made on dogs, rabbits, &c., seem to show that the paralysis caused by an organic affection of one of the various parts of the brain depends scarcely ever, if at all, on the cause usually assigned to it, that is, the loss of function of the part destroyed.—On the determination of the fly-wheels of tool-engines, by M. X. Kretz.—On the sulphurets of phosphorus, by M. Isambert.—On a method of transformation of figures in space, by MM. J. S. and M. N. Vanecek.—On the theory of the binary form of the sixth order, by R. Perrin (continued).—On the continuous reduction of certain quadratic forms, by E. Picard.—On the magnifying power of optical instruments, by M. Monoyer.—Evaporation of sea water in the south of France, and more particularly in the Rhone delta, by M. Dieulafait. From various observations the author concludes that throughout the deltaic region, even to a distance of twelve miles inland, the mean annual evaporation of the sea water is at least 6 mm. every twenty-four hours.—On some properties of the sulphuret, selenide, and telluride of tin, by A. Ditte.—Determination of the carbonic acid of the air in the stations selected for observing the transit of Venus, by MM. A. Muntz and E. Aubin.—Volumetric quantitative analysis of sulphuret of carbon in sulphocarbonates, by E. Falières.—On the emetics of mucic acid, by D. Klein.—On the respiratory organs in the Chelonia, by L. Charbonnet Salle.—On the cellules of the follicule in the ovum, and on the nature of sexuality, by A. Sabatier. From his protracted studies of the processes of gemmation and parthenogenesis, the author concludes that in the reproductive elements there are two principles of opposed polarities, the centripetal (blastophore) and centrifugal (spermatoblast). When the two polarities are in a reciprocal state of equilibrium the cellule is in a state of *sexual neutrality*, and capable of parthenogenesis. But should the equilibrium become disturbed by the disappearance of either element through any biological change, one of the elements becomes predominant and the cellule acquires a determined sexuality, male by the elimination of the centrifugal, female by that of the centripetal element. There may thus be various degrees of sexuality, which become completely differentiated only through successive processes of elimination.—New method of discolouration of the pigment in the eye of Arthropods, by C. E. della Torre.—Observations on the movements of the ground in the Chiloë Archipelago, by Ph. Germain.

BERLIN

Physiological Society, June 1.—Prof. Kronecker reported that in a demonstration of the action of the cooling down of nerves upon their conductibility, he observed a lesser velocity of conduction of the stimulus instead of the greater velocity that he expected, and that he had found this observation confirmed by subsequent experiments. Hence the correctness of an earlier casual observation of Herr von Helmholtz, that the cooling down of a nerve diminished its conductibility, which had been denied by subsequent observers, has been vindicated; but Prof. Kronecker admits that the contrary may also be true, because frogs may present, under different conditions and at different seasons, utterly diverse phenomena. The influence of temperature on the excitability of sensory nerves, the complement of the above observation, was investigated in frogs whose spinal cord was cut through by measuring the length of time occupied by reflex movements when their legs were dipped into dilute sulphuric acid (·5 or 1 per thousand) at different temperatures. In the case of all frogs and at all active degrees of concentration of the acid, the time required for the reflex action was shortest, *i.e.* the immersed leg was quickest drawn out, when the acid was coldest—0° or +4° up to +6°—and the time required for the reflex action was on the contrary longer at the temperature of the air of the room, and longest at the highest temperature that was employed, 30° to 35°. The influence of cooling down, not the peripheral nerves, but the spinal cord itself, will be investigated in future experiments.—Prof. du Bois Reymond communicated a short notice from a letter of Prof. Babuchin's to him, which contains a fact interesting as showing the power of adaptation to their surroundings that electric fish possess. Prof. du Bois Reymond had previously called attention to the fact that the electric eels and malapterurus that live in badly-conducting fresh water show, in as far as they have accommodated themselves to this medium, a considerable development of their electric organ in length compared with the small size of its transverse diameter, whereas in the electric rays that live in sea water, which is a good conductor, the electric organ has a greater transverse development; consequently the electromotor powers of the electric organs of the electric eel and malapterurus on one side, and of the electric ray on the other, were to one another inversely as the conductibility of the surrounding media. The measurements of Humboldt and of Sachs of growing electric eels had shown that in their growth the electric organ increased proportionately more in length than in transverse diameter, which is a teleological adaptation to the badly-conducting fresh water. Now the above-mentioned note of Prof. Babuchin contained the communication that in growing electric rays the electric organ increased proportionately much more in breadth than in height; this is likewise in conformity with the adaptation to the sea water, which is a good conductor.

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ASTRONOMICAL PHENOMENA FOR THE WEEK 1886 JANUARY 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 January 3

Sun rises, 8h. 8m.; souths, 12h. 4m. 48·8s.; sets, 16h. 2m.; decl. on meridian, 22° 48′ S.: Sidereal Time at Sunset, 22h. 55m.

Moon (New on January 5) rises, 6h. 7m.; souths, 10h. 36m.; sets, 15h. 3m.; decl. on meridian, 18° 12′ S.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	6 17	10 28	14 39	20 41 S.
Venus	10 6	15 6	20 6	12 23 S.
Mars	22 13*	4 46	11 19	5 45 N.
Jupiter	23 32*	5 31	11 30	0 59 S.
Saturn	15 14	23 24	7 34*	22 33 N.

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

Phenomena of Jupiter's Satellites

Jan.	h. m.		Jan.	h. m.	
4	1 13	IV. ecl. reap.	6	6 58	I. occ. reap.
4	1 29	II. ecl. disap.	7	1 51	I. tr. ing.
4	6 44	II. occ. reap.	7	4 6	I. tr. egr.
5	6 29	III. ecl. disap.	8	1 26	I. occ. reap.
5	7 23	I. tr. ing.	9	1 11	III. tr. ing.
6	1 46	II. tr. egr.	9	4 0	III. tr. egr.
6	3 31	I. ecl. disap.			

The Phenomena of Jupiter's Satellites are such as are visible at Greenwich.

Saturn, January 3.—Outer major axis of outer ring 46″·6; outer minor axis of outer ring 20″·5; southern surface visible.

Jan. h.
9 ... 2 ... Mercury at greatest elongation from the Sun, 23° west.

Variable Stars

Star	R.A. h. m.	Decl. ° ′		h. m.	
U Cephei	0 52·2	81 16 N.	Jan. 3,	1 5	*m*
V Virginis	13 20·2	2 47 S.	,, 4,	9 30	*M*
S Libræ	14 54·9	8 4 S.	,, 5,	18 13	*m*
U Coronæ	15 13·6	32 4 N.	,, 6,	3 41	*m*
R Serpentis ...	15 45·4	15 29 N.	,, 5,		*M*
U Ophiuchi ...	17 10·8	1 20 N.	,, 5,	4 45	*m*
			,, 6,	0 53	*m*
			,, 6,	21 1	*m*
δ Cephei	22 24·9	57 50 N.	,, 6,	17 0	*m*
S Aquarii	22 51·0	20 57 S.	,, 6,		*M*

M signifies maximum; *m* minimum.

Meteor Showers

Meteors have been observed during this week in former years from the following radiants:—Near β Aurigæ, R.A. 93°, Decl. 43° N.; R.A. 145°, Decl. 5° N.; R.A. 150°, Decl. 67° N.; and R.A. 181°, Decl. 35° N.

GEOGRAPHICAL NOTES

The current number of *Petermann's Mittheilungen* contains an account of Herr Menge's second journey in the Somali Peninsula, accompanied by an excellent map showing the courses of both journeys. The traveller's meteorological observations and measurements, worked out by Dr. Schmidt of Gotha, are appended to the paper. Dr. Paulitschke's account of his journeys to Harar and amongst the Northern Gallas is concluded in this number. It contains a mass of interesting information of all descriptions with regard to this region. In an appendix a sketch is given of the scientific results of the journey, arranged under the heads—astronomical and magnetic observations, topography, anthropology and ethnography, and natural history.

The *Bulletin* of the Paris Society of Geography just published (3e trimestre, 1885) contains the full text, with maps, of Dr. Heis's journeys amongst the Laos. M. Errington de la Croix, under the title of "Seven Months in the Tin Country," describes the method of working the tin-mines of Perak, in the Malay Peninsula. The only other paper in the number is one of great interest by M. Pinast on certain explorations of his in the State of Panama, especially in the regions around the Chiriqui lagoon, and the districts inhabited by the Guaymi Indians.

The last Ergänzungsheft, or supplementary number of *Petermann's Mittheilungen*, is a lengthy account by Dr Boas of his journeys during 1883 and 1884 in Baffin Land. It is divided into four main parts: an account of the journey from day to day, worked into a narrative; the history of past discoveries in the same region; geography; and, lastly, anthropo-geography. One appendix contains a long list of Eskimo place-names in Baffin Land, with their meanings; another gives a number of astronomical observations at various stations. The work is accompanied by two maps, one of Cumberland Sound and Cumberland Peninsula; the other represents the distribution of Eskimo tribes in Baffin Land.

The current number of the *Proceedings* of the Vienna Geographical Society (Bd. xxviii. No. 11) contains a paper entitled "Shamanism in Upper Austria," by Dr. Zeberg. The district specially referred to is the wide granite plateau which forms the watershed between Bohemia and Upper Austria, and the paper describes the old superstitions and practices still surviving amongst the comparatively primitive people who inhabit the district. The application of the term "Shamanism" to these in the bulk is curious, and somewhat questionable. Shamanism is the form of Buddhism ("Northern Buddhism") prevailing amongst the Mongols and Thibetans, the *Shaman*, or priest, being one who has overcome all his passions. It is said to be a word of Hindu origin. The Pope of this sect, which differs from the Buddhism of India and Ceylon more in state and power than in doctrine, is the Dalai Lama at Lhassa. It has an enormous literature, which is described as the dreariest in existence. Like every other form of religion, and perhaps more than most religions of civilised peoples, it has its superstitious practices and beliefs; but there appears no more excuse for transferring this name from Thibet and Mongolia to Austria, and applying it to superstitions there, than for calling the latter Babylonian, Chaldean, or something else that has no connection whatever with them. The number also contains further letters from Dr. Lenz, in charge of the Austrian expedition to the Congo.

A telegram was received in Berlin on the 27th inst., announcing the death of Dr. Büttner, a German explorer travelling in Bonnyland, in Africa. The deceased, like Livingstone, was formerly engaged in missionary work in South Africa.

TEMPERATURE OF THE SURFACE OF THE MOON

In a memoir on this subject presented to the U.S. National Academy of Sciences by Prof. S. P. Langley, the author concludes by reviewing as follows our sources of information, and weighing the imperfect and contradictory results each has brought us:—

(1) *Direct Measurement of Lunar Heat as compared with Solar.*—Our direct comparison indicates that we receive nearly the whole proportion of solar energy from the full moon that we should expect to get from a diffusive disk of the same angular aperture. This heat must in reality be partly diffused and partly radiated, and we do not know (from the present observations) in what proportions these two kinds enter. So far as the observation itself is reliable, we may, however, infer that our atmosphere is permeable to most of the lunar heat of either kind, but the method is unfortunately subject to such large sources of constant error, that we cannot derive great confidence from the apparent agreement of different observations or even of different observers. It may be said, however, to create a certain presumption that the earth's atmosphere is diathermanous to heat of lower wave-length than has been heretofore supposed, *and of lower wave-length than appears to reach us from the sun.*

(2) *Comparison of Moon's Heat with that of Leslie Cube.*—If we may draw any inference from this class of observations it is that the sunlit surface of the moon is not far from the freezing temperature, but not so far below as we might expect to find that of an absolutely airless planet.

(3) *Transmission of Lunar Heat by the Earth's Atmosphere.*—Our observations indicate a not materially greater co-efficient of transmission for lunar heat than for solar; and though their

limited number and the uncertainty of the correction for change fr of heat with phase render more certainty as to the fact desirable, o we may (accepting them as probable) reason thus.

Previous observations both at Allegheny and Mount Whitney have shown that the solar rays are transmitted with greater and greater facility (except for cold bands) as the wave-length increases up to the point (near $\lambda = 3^{\mu}$) where they suddenly disappear altogether. This shows either that (1) the solar heat, which, according to the customary assumption, exists to an unlimited wave-length before absorption, has here been cut off by a suddenly absorbent action, like that of a cold band extending indefinitely below 3^{μ}, or (2) that, either through a precedent th absorption of such rays in the sun's own atmosphere or their f non-existence, no solar rays below 3^{μ} present themselves to our atmosphere for admission.

The first view is that which I have treated as most in accordance with received opinion. It is not, however, the only one, since the second is not to be absolutely rejected, considering our experimental ignorance of the laws of radiation from gaseous bodies for great wave-lengths. Of these two hypotheses we see that, according to the first, our atmosphere is quite opaque to all heat below 3^{μ}, and the writer's (unpublished) experiments show that heat above this point must come almost wholly from a source much above 100° C. In this view, then (unless we agree that the radiations from the lunar soil correspond to a source much above 100° C.), we conclude that sensibly none of them pass our atmosphere, but that what we receive is diffused and reflected heat coming within the range of the known solar energy spectrum, and transmitted with nearly the same facility as solar heat, or if with a little greater, because lowered in wave-length by selective reflection at the lunar surface, not by absorption and re-radiation from the lunar soil.

In the second view, for anything we have absolutely known to the contrary, our atmosphere may be permeable to radiations of any wave-length below 3^{μ}, and we could draw no certain inference, even if the lunar radiation were more distinctly different in transmissibility than it is.

As a matter of fact, with the actually limited difference in the character of its transmissibility, a difference which, as so far determined, is of the same order as that of the error of observation, we have no ground then from this present class of observation (*i.e.* Class 3) for any absolute conclusion one way or the other. But, we repeat, it seems to be a probable inference from our whole work that the earth's atmosphere is more diathercarbonious to heat of extremely low refrangibility than has heretotransit been supposed.

quanti(4) *Comparative Transmission of Glass for Lunar and Solar* by E. *lat.*—The evidence here, which at first seems to so directly the report the view of a sensible radiation from the surface of the On soon, proves, on examination, to be subject to other interpretasion, for the observed effect is almost certainly due in part to a degradation of wave-length by selective reflection from the lunar soil.

We can draw no absolute conclusion, then, from this evidence, at first in appearance so promising, though we may say that it certainly indicates an increased probability for the view that radiations from the lunar soil may be transmissible by our atmosphere.

(5) *Observations during a Lunar Eclipse.*—If our own observations in this respect are imperfect, those of Lord Rosse, before cited, are, on the other hand, clear. They appear to bear but one interpretation—that all heat from the moon disappears immediately that it passes into the earth's shadow, and there is no evidence of any being retained, for any sensible time, more than if it were reflected.

It is so difficult to conceive that while the moon has been storing heat during many days of sunshine, it can part with it instantly, so that the temperature of the whole earthward surface of the planet disappears in an inappreciable interval, that most will see in this observation an argument against the existence of any such heat sensible to us at any time whatever.

(6) *Formation of a Lunar Heat Spectrum.*—The observations made here with the lunar heat spectrum are as yet incomplete. With improving experience and apparatus, we hope to make others which shall give information of a character no other means can furnish (see note, *infra*).

Conclusion.—While we have found abundant evidence of heat from the moon, every method we have tried, or that has been tried by others, for determining the character of this heat appears to us inconclusive; and, without questioning that the moon radiates heat earthward from its soil, we have not yet found an experimental means of discriminating with such certainty between this and reflected heat that it is not open to misinterpreation. Whether we do so or not in the future will probably depend on our ability to measure by some process which will inform us directly of the wave-lengths of the heat observed.

Note added February, 1885.—Since the above paragraph was written, we have succeeded in obtaining measures with rock-salt prisms and lenses in a lunar *heat spectrum*. These difficult measures must be repeated at many lunations before complete results can be obtained; but, considering their importance to the present subject, we think it best to state now in general terms, and with the reserve due to the necessity of future experiment, that they indicate two maxima in the heat curve—one corresponding within the limits of errors of observation to the solar curve maximum, the second indefinitely lower down in the spectrum, corresponding to a greater amount of heat at a lower temperature. Exactly what temperature this latter corresponds to we have no present means of knowing. We have succeeded, however, in forming a measurable heat spectrum from the surface of a Leslie cube containing boiling water, and the maximum ordinate in the lunar heat curve appears to be below the maximum ordinate in the hot water curve. The inference from this is, of course, that the temperature of the lunar soil is, at any rate, below that of boiling water and in an indefinite degree.

We cannot close this note without calling attention to the remarkable fact that we here seem to have radiations from the moon of lower wave-length than from the sun, which implies an apparent contradiction to the almost universally accepted belief that the sun's emanations, like those from any heated solid body include all low wave-lengths representing temperatures inferior to those certainly emitted.

SYMBIOSIS BETWEEN FUNGI AND THE ROOTS OF FLOWERING PLANTS

A VERY remarkable phenomenon has for some time past attracted the attention of a few physiological botanists in France and Germany, and was the subject of an interesting discussion at the annual meeting of the Association of German Naturalists and Physicians at Strassburg in September last. This is no less than the discovery of the fact, which may now be considered fairly established, that a considerable number of phanerogams, especially forest trees, do not draw their nourishment directly from the soil, but through the medium of an investing layer of fungus-mycelium, to which B. Frank gives the name of Mycorhiza.

The observations which first called the attention of botanists to this interesting subject were those of F. Kamienski, on *Monotropa hypopitys*, published in the *Mém. de la Soc. National des Sci. Nat. de Cherbourg*. He came to the conclusion that this plant is not, as is usually believed, a parasite, the most careful observation failing to detect any haustoria or other parasitic union with the root of any host. On the other hand, he found the root of the *Monotropa* to be completely covered by the mycelium of a fungus, which branches abundantly, and forms a pseudo-parenchymatous envelope, often two or three times the thickness of the epidermis, and especially well developed at the apex of the root. This fungus, the species of which M. Kamienski is unable to determine, is entirely superficial, not penetrating into the living cells, though occasionally forcing its way between those of the epidermis. He contends that the *Monotropa* derives its nourishment from the soil entirely through the medium of this fungus-mycelium; the only parts of the root which are in actual contact with the soil are composed of lifeless cells with no power of deriving nutriment from them. The connection of the fungus with the roots of the *Monotropa* is not one of parasitism, but of true symbiosis, each of the two organisms deriving support and nutriment from the other.

More recently similar observations on the mode of nutrition of trees belonging to the natural order Cupuliferæ have been made by Dr. B. Frank and confirmed by M. Woronin (both recorded in the *Berichte der Deutsch. Bot. Gesellschaft*). Dr. Frank finds the roots of our native oaks, beeches, hornbeams, chestnuts and hazels, to be covered by a dense cortex of Mycorhiza organically associated in growth with the root, and composed entirely of fungus-hyphæ, completely enveloping the whole of the root, even the growing point. The structure of this cortex is that of a sclerotium; it is composed of a dense mass of hypha