901
27/12/06
505 NAT

THURSDAY, JULY 17, 1884

PROFESSOR TAIT'S "LIGHT"

Light. By P. G. Tait, M.A., Sec.R.S.E., formerly Fellow of St. Peter's College, Cambridge, Professor of Natural Philosophy in the University of Edinburgh. (Edinburgh: Adam and Charles Black, 1884.)

THE issue of Prof. Tait's book on "Heat," recently reviewed in these pages, has been quickly followed by that of his book on "Light."

The book we are told is "not designed for those who intend to make a special study either of theoretical or of experimental optics, but for ordinary students who wish to acquire familiarity with the elements of the subject;" and its author has, as was to be expected, made it most interesting and suggestive.

The first three chapters are introductory and explanatory; we wish more space could have been found for the subject dealt with in Chapter II.—the theory of vision and colour perceptions; students' notions in general are so hazy on these points, and they are not well treated of in most of the books we are acquainted with. They fall between two stools; the physiologist considers them to belong to physics, the physicist to physiology.

In Chapter IV. the usual division of the subject into geometrical and physical optics is made. "For the explanation of the ordinary phenomena of light," says Prof. Tait, "even with accuracy sufficient for the construction of the very finest telescopes and microscopes, it suffices that geometrical optics based on laws *nearly* verified by experiment be followed out to its consequences. The residual phenomena then come in to be treated by the undulatory theory." Geometrical optics then is in the main the subject of the next 140 pages of the book, the remaining 106 pages being chiefly devoted to physical optics.

The geometrical part is excellent, and it, along with the whole book, has been rendered much more interesting by the frequent quotation, when describing some of the most important steps in the subject, of the actual words of the authors, or at all events of a close paraphrase of them. Thus Newton's celebrated discovery of the dispersion of white light is given as a quotation from his letter to Oldenburg. We in the present day gain much by reading the very words of the heroes of science, and learning with what feeble instrumental means they made their great discoveries; there is a tendency, which it is well to check, to think that nothing can be done in the way of scientific observation and discovery without the most elaborate instruments. Fresnel's apparatus in his country-house at Matthieu was the work of the village blacksmith, and Newton needed only his prisms, a measuring tape, and some screens to prove that "light is not similar or homogeneal, but consists of difform rays, some of which are more refrangible than others."

The whole chapter on refraction—Chapter IX.—and specially that part of it which deals with refraction through a prism (§ 129) and the relation between the deviation of a ray and the angle of incidence (§§ 125, 132, &c.) is particularly clear and good. The proof of the law that the deviation of a ray passing through a prism in a principal plane is a minimum when the angles of incidence and emergence are equal (§ 134) is much more elegant than any we have seen bef

But for all this we of regret when we read the sta already, as to the sufficiency o g which was greatly intensifie use was to be made of the all- e stated for reflection in § 85, in § 82, viz. "If l be the lengt[illegible] of a ray which lies within a medium whose refractive index is μ, the sum $\Sigma \mu l$ is the same for each ray of the group between any two wave surfaces;" that is, according to the undulatory theory at least, the time is the same along all rays from one wave surface to another of the same system.

BOOK NO. 1064

For the fundamental formulæ for mirrors and lenses can be deduced by a simple geometrical method from this law; this Prof. Tait points out, while the method has the great advantage that it can be extended readily to include problems in which spherical aberration is considered. Lord Rayleigh's investigations in optics, published recently in the *Philosophical Magazine*, are a distinguished example of its powers. The full treatment of spherical aberration is of course outside the limits of Prof. Tait's work, but still it would have added to its completeness had the book contained some elementary examples of the use of the method in question. Besides the law is the real link between geometrical and physical optics. That *one* ray of light can exist only when accompanied by other contiguous rays is a fact on which the teacher can scarcely too often insist, and the solution of problems in geometrical optics by the method of least time forms the best introduction to the important principle of interference required in physical optics. Prof. Tait's method is admirable for a book on "Geometrical Optics"; in a book on "Light," however, we look for something more than he gives us on the connection between geometrical and physical optics; and the development of some of the elementary consequences of this law of minimum time seems to us to afford the most suitable opening for considering that connection.

Chapter XII. on absorption and fluorescence, is made specially interesting by the quotation of an account of an experiment of Fox Talbot on anomalous dispersion, made about 1840, but not published till 1870. The method he adopted to obtain prisms of a substance showing anomalous dispersion is very beautiful and ingenious. The account is too long for quotation; we must refer the reader to Prof. Tait's book, p. 156.

The fundamental difficulty of the undulatory theory—the rectilinear propagation of light—is assailed in Chapter XIII., and in dealing with this subject we think that Prof. Tait gives too much credit to that great physicist, Huyghens. He was of course the first to give the undulatory theory definite form, and *if we allow him to make one great assumption*, he explained perfectly correctly the rectilinear propagation, the reflection, and the refraction of light. But in Huyghens' work there is an assumption the importance of which it is impossible to overlook.

"What Huyghens did not see sufficiently clearly," says Verdet ("Optique Physique," tome i. pp. 33, 34), "was why each of the elementary waves is only effective at the

point in which it touches the envelope. He contented himself with saying that the movement which exists over each of the elementary waves must be infinitely feeble compared with that which exists over the envelope," while he remarks that "this must not be examined with too much care or nicety"—"recherché avec trop de soin ni de subtilité" are his words. Nor was Huyghens in a position to give the necessary demonstration, for, to quote again from Verdet, "He never supposed that there was any general relation between the movements of these successive waves, he never combined their effects, and in particular the notion of the constant interference of two sets of vibrations bringing to one and the same point movements of opposite phase is absolutely foreign to him."

Now it is this notion of interference, which is entirely due to Thomas Young, combined with the excessive smallness of the wave-length of light that renders Huyghens' assumption correct.

"It is to Young," says Verdet, "that the honour belongs of having first applied to optical phenomena the principle of interference," and Prof. Tait recognises to the full Young's claims to this distinction; the point on which we would insist is that this principle is needed for the elementary explanation of the rectilinear propagation, the reflection, and the refraction of light, as well as of diffraction and the colours of thin plates; the principle is due to Young, and Huyghens' explanation rests on an assumption which he did not prove.

Prof. Tait regrets in his preface that his book was all in type before Prof. Stokes's "Burnett Lectures" appeared. We will quote a few lines from them bearing on the point. After referring to Huyghens' principle, he says (p. 19):—"This principle does not by itself suffice for the explanation of rays. It proves, or at least appears to prove, too much. It is as applicable to sound as, on the supposition that light consists in undulations, it is to light; and if Huyghens' explanation of rays were complete, there ought equally to be rays of sound, and sound ought to present the same sharp shadows as light."

As Young received in his own day the most unjust treatment at the hands of the leaders of scientific opinion, it is but fair that the full importance of his work should be made clear, and that he should be given all the credit he so richly deserves. In Chapter XIV. Prof. Tait brings out and illustrates with his usual force and vigour the value of Young's principle in explaining the phenomena of the colours of striated surfaces and of thin plates. Young's own attempt to account for the diffraction effects produced by a wire or straight edge was incorrect; it was left for Fresnel in his great memoir on diffraction to show that they too followed as a direct consequence of interference.

It is of course impossible to give without the aid of analysis a full explanation of the phenomena of double refraction, and so Prof. Tait contents himself with showing how Huyghens' construction, combined with the fact that light-vibrations lie in the wave front, enables us to account for many of the observed facts.

When considering the subject of polarisation by reflection (§ 268, &c.), we miss any reference to the experiments of Jamin and others, besides Brewster, on the reflection of light from transparent media. Jamin has shown that Brewster's law requires some modification, for in gener there is no angle at which light is *completely* plan polarised by reflection from a transparent surface. Fo substances in which the refractive index is about 1·4, a angle of complete polarisation exists, but only for these.

A short chapter on Radiation and Spectrum Analysi concludes the book. R. T. GLAZEBROOK

OUR BOOK SHELF

A Pocket-Book of Electrical Rules and Tables. By John Munro, C.E., and Andrew Jamieson, A.M.I.C.E. F.R.S.E. (London: Charles Griffin and Co., 1884.)

COLLECTIONS of rules and tables adapted to the wants o civil and mechanical engineers have existed for a con siderable time, and now that practical applications o electricity are becoming so many and important, a want has been felt of a useful hand-book for those engaged in this comparatively new branch of engineering. The "Pocket-Book" before us is intended to supply this want and in many respects it does so very well indeed. It is neat in appearance, handy in shape, and contains muc information in the form of tables of practical data, use rules and recipes, and specifications and directions as the performance of many different kinds of work.

But although doing good service to electrical engin by collecting together so much that is useful in the form of practical results, the compilers have, in their endeavour (a mistaken one we think) to render their manual a guide also in points of theory, fallen into many errors which render the book an unsafe one to put into the hands of any one who is capable of being misled in such matters. In the first place there are many—we cannot call them typographical—mistakes in equations given in different parts of the work. As the process by which these equations are obtained is not given, and the formulæ are in tended for reference and to be used in computation there is nothing to warn an inexperienced user of work of possible danger. The errors might, however excused in a first edition if it were not that the formulæ in question are simply inaccurate copies of results given in other works. For example, at pp. 123 and 125, a single glance at "dimensions" is enough to show that several of the formulæ for the localisation of faults in aërial telegraph lines are erroneous, and the same remark applies to the formula given at p. 174 for th calculation of the distance of a fault in a submarine cable from the testing station.

As to the more theoretical portions of the work, we have first a chapter headed "Definitions of Units." This is in great part taken *verbatim* from Prof. Blyth's new edition of Ferguson's "Electricity." An alteration on Prof. Blyth's statement is made on p. 10, and confounds the well-known and perfectly definite velocity v with the velocity which is the proper expression of any given resistance in electro-magnetic measure. Again, at p. 13, v is said to be the ratio of the *electro-static* to the *electro-magnetic unit* of quantity. The "derivation" of the practical units—volt, ohm, ampere—given in the table at p. 13 is a perfect maze of vicious circles, and in the same table the "joule" is given as alternatively "volt × coulomb" and "ampere^2 × ohm,"—the confusion, which would seem inveterate, between work and activity or rate of working. The velocity of light, we may remark, is given at p. 11 as 3×10^{10} cm. per second, and at p. 382 this is given as the "French value" of 192,000 miles per second! Here, as elsewhere in a few cases (the values of g given at p. 42 for example, where, besides, g is expressed as a *velocity*), numbers evidently culled from different sources and supposed to express the same quantity in different units are given without verification of their equivalence. In p. 43 the venerable pendulum formula is terribly misprinted

and *g*, without its being so stated, is taken in *inches* per second per second.

A chapter headed "Testing of Electric Light Dynamos, Accumulators, and Transmission of Power," given at pp. 176-86, is not at all satisfactory. The tests for the efficiency of a secondary battery are neither clearly nor fully given, and the score of lines devoted to this important subject close with a most remarkable sentence, which we quote:—"The total work done in charging and discharging may also be measured by a suitable voltameter joined up as a shunt to the secondary battery, so as to pass a known fraction of a current through it."

At p. 373 there are two or three misprinted formulas, but in the first line of p. 374 we have perhaps the most extraordinary equation ever given in a work on electrodynamics. The difference of potential at the terminals of a dynamo (a shunt-dynamo we presume is meant) is there stated to be equal alternatively to the product of the current in the field magnets multiplied into their resistance, to the current in the external circuit multiplied into the resistance of the external circuit, and *to the current in the armature multiplied into the resistance of the armature!*

The calculation (p. 345) relative to the electrolytic decomposition of copper sulphate involves also serious theoretical errors. Mr. Jamieson, multiplying together the electro-chemical equivalent of copper and the heat of combination of copper and oxygen, makes the "electromotive force required to deposit copper from a solution of sulphate of copper" to be ·836 volt. In the particular case, not however referred to, of a cell having a platinum anode and copper kathode, this would be the approximate electromotive force required on the cell to produce electrolysis. But the author actually goes on to use this result as the electromotive force required on an ordinary electro-plating bath to effect the electrolysis, and bases on it some conclusions as to the efficiency of a Siemens machine depositing copper in commercial work, or in the stereotyping of ordinary printed matter. In these cases of course both anode and kathode are copper plates, and the calculated electromotive force has no application whatever.

A single remark on another subject we would make before taking leave of this work. In many places where the compilers are under obligations to other authors due acknowledgment is wanting. For examples we may refer to several parts of the chapter on submarine telegraphy, to pp. 369-76 on dynamos and transmission of power, and [illegible] of p. 403, where, by the way, the very serious errors in the method of determining (?) the intensity of a magnetic field by counting the oscillations of a magnetic needle are not alluded to.

In conclusion we have no hesitation in saying that with a careful weeding of the tables, minute verification and correction of the algebraical work, deletion of a good deal of the "theory" given, and lastly, copious references to original sources, both as a matter of convenience to the user and of literary justice, this "Pocket-Book" will be made a very valuable *vade mecum* for electrical engineers. As it is, it will no doubt be found of service, but, as we have indicated, its statements must on several subjects be received with caution. A. GRAY

The Non-Bacillar Nature of Abrus Poison. By C. J. H. Warden, Surgeon I.M.S., and L. A. Waddell, Surgeon I.M.S. (Calcutta, 1884.)

THIS pamphlet is an exhaustive treatise on the nature, physiological and chemical properties of the seeds of *Abrus precatorius*, called Jequirity by the South Americans, and used to cure granular lids. As is now well known through de Wecker of Paris and Prof. Sattler, this popular remedy of the South Americans produces, when used as an infusion and applied to the conjunctiva, severe ophthalmia, in the course of which granular lid (trachoma) is brought to cure. In India it is used by the natives for subcutaneous injection into cattle, wherewith to produce a kind of septicæmia and death. The nature of the poison has been thought by de Wecker and Sattler, and later by MM. Cornil and Berlioz, to be due to a bacillus (the Jequirity bacillus), the spores of which are derived from the air; and, although harmless at first, assume pathogenic properties when grown in an infusion of the Abrus seeds. It has been conclusively proved, however, that this is not the case, that the active principle of the Abrus seeds is present before any contamination with the bacillus could have taken place, and further, that the Jequirity bacillus, when freed from the infusion, possesses no power of producing ophthalmia.

Messrs. Warden and Waddell have carefully examined the chemical nature of the seeds, and they find that the active principle, abrin, is a proteid, closely allied to native albumen, and obtainable not only from the seeds, but also from the root and stem. E. K.

A Text-Book of Pathological Anatomy and Pathogenesis. By Ernst Ziegler. Translated and edited for English students by Donald Macalister, M.A., M.B., &c. Part II. Special Pathological Anatomy, Sections I.-VIII. (London: Macmillan and Co., 1884.)

THE enormous success that has attended the first part of this work will, we feel sure, in no way abate with the present volume. Like its predecessor it is a masterly exposition of all that is known concerning the pathological anatomy of the parts treated. In this last volume the special pathological anatomy of the blood and lymph, the vascular mechanism, the spleen and lymphatic glands, the serous membranes, the skin, the mucous membranes, the alimentary tract, the liver and pancreas, are described with great clearness and thoroughness. The subjects are treated in a detailed and systematic way, without incumbrance with self-understood details. The illustrations are very admirable, and while not profuse, are nevertheless thoroughly representative. The bibliography, particularly of the more recent works, is, in the English edition, thanks to Dr. Macalister, a most valuable improvement on that in the German edition. While a help to the learner, it will no doubt prove also a valuable companion to the teacher. E. K.

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 Late M. Dumas

I HAVE received from M. Pasteur, President of the Committee, a letter informing me that it is proposed to erect a statue to the memory of Dumas at Alais, his native town. The name of Dumas is so prominent in the history of our science that no words of mine are needed in support of such a proposition, and I merely express the hope that many English chemists will be willing to contribute to this memorial. Subscriptions will be received by the secretaries of the Chemical Society, Burlington House, Piccadilly. W. H. PERKIN, P.C.S.

The Cholera Germ

THE latest enunciations of Prof. Koch from Toulon and Marseilles concerning the relation of his "comma-shaped" bacillus to cholera are so contradictory, that it is worth while to take notice of them.

Koch, as was mentioned in your last issue (p. 237), maintains that the "comma-shaped" bacillus is the cause of cholera; and

finding it in the alimentary canal only, but not in the blood and tissues, of persons affected with cholera, he is necessarily forced to assume that the alimentary canal is the exclusive organ into which the cholera poison enters and in which it has its breeding ground. On the other hand, Koch has ascertained that the "comma-shaped" bacillus is fatally affected by acid. This result, having been established by direct experiment, is naturally perfectly trustworthy, and is, besides, in complete harmony with what is known of other bacilli, both pathogenic and non-pathogenic, which, as is well established, succumb to the influence of acid.

Now, these three propositions, (1) that the "comma-shaped" bacillus is the cause of the cholera, (2) that the alimentary canal is the exclusive organ of entrance of the cholera virus, and (3) that the "comma-shaped" bacillus is neutralised and killed by acid, appear to me to be in hopeless contradiction.

The first two propositions are assumptions, the third is based on direct experiment, and is, as just stated, perfectly in harmony with other observations. If, then, this third proposition be true, the other two cannot be true, that is to say, if it is true—and there can be no doubt about it—that the "comma-shaped" bacillus succumbs to the action of acid, then it cannot be true that the "comma-shaped" bacillus is the cholera virus, nor that the alimentary canal is the sole entrance of the cholera virus. How, we may ask, can the "comma-shaped" bacillus pass unscathed the acid contents and the acid secretion of the stomach? To maintain, as Koch is reported to have done, that in all persons attacked by cholera the stomach must have been previously so deranged that its contents and secretions are not acid must appear to every one who has had any experience during a cholera epidemic an untenable proposition. On the one hand, it is known that such a serious disorder of the gastric mucous membrane as the total absence of acidity is of comparatively rare occurrence, while, on the other, in every cholera epidemic numbers of persons become affected with the disease in whom such a gastric condition, antecedent to the infection, can with certainty be excluded. E. K.

The Mountain System of the Malayan Peninsula

SOME new facts with regard to the mountain system of the Malayan peninsula may be of interest to many of your readers. In exploring through the native State of Perak I find that, in addition to the main range, which occupies about the centre of the territory and runs in a north and south direction, there are two other ranges belonging to quite different systems, and, as I think, of different geological age. The first is close to the coast. It is a series of ridges parallel to each other, but detached, having a north-north-east or south-south-west trend. These ridges are of granite, and rise to a considerable height, such as Gunong (Malay for mountain) Inas, over 5000 feet; Titi Wangsu, nearly 7000 feet; Gunong Hijau, 4400 feet, and Gunong Bubu, or Bubor, 5600 feet. The two latter I have ascended. Though they are detached from each other, they form a watershed between the coast and the inland drainage, and thus the River Perak has to drain an immense valley in a north and south direction until it finds an outlet to the south of the Dindings.

To the east of the Perak there is a small range about twenty-five miles long, perfectly detached from the other systems, and having generally a north and south direction, but sending off spurs a little west of south. This also is granite, but on its lower shoulders has thick deposits of stratified limestone, above and below which tin is worked. To the north this range is bounded by the valley of the River Plus, which here joins the Perak, and to the south by the mouth of the Kiuta. The latter river runs in a valley to the east of this range, and where it ceases joins the Perak. To the east of the Kiuta again comes the main range with many peaks over 7000 feet high; Gunong Riam probably reaching over 8000 feet.

The first series of ranges have their origin in the State of Keddah, just where the Malayan peninsula begins to widen out. This widening out is entirely due to this mountain system. The island of Penang is a part of it, and so are the islands called the Dinding Group. Were the coast to subside about 300 feet, we should have a narrow peninsula fronted by a series of large and very elevated granite islands having their longest diameter north-north-east and south-south-west. The second mountain chain has a different direction, and nowhere rises above 3000 feet; but both ranges are rich in tin. The first series has at its base Palæozoic schists, slates, and clays. The second has limestone. The Palæozoic rocks are rich in tin at the junction with the granite. The tin in the second range lies above and below the limestone, and has been derived from the older formation. The Palæozoic clays resemble very closely the gold-bearing slates and schists of Australia. To the south they are nearly denuded away, but in Lower Siam, from specimens I have seen, they are full of auriferous quartz reefs.

It is singular that in this mountain system we have the closest resemblance to the tin-bearing districts of north-eastern Australia. When exploring geologically the Wilde River district in 1881 and the Daintree River in 1879, I found that the sources of the tin were in detached granite mountains or groups of mountains—granite islands, so to speak, much higher than the present watershed of the country, but, being detached from each other, allowed the rivers to pass round and between them. I have referred to the same thing in Tasmania in my account of the physical geology of that country. Geologists in England can say if there is any resemblance to this state of things in the tin-bearing granites of Cornwall. I am inclined to think that we have in these rocks the remains of a former and very ancient mountain system.

I may add that it is a pity that we still find in recent books of high authority the statement reiterated that the highest mountain on the Malayan peninsula is Mount Ophir, near Malacca (4360 feet). Here are the heights of a few in Perak:—Slim Mountains, 6000 or 7000 feet; Titi Wangsu, 6900 feet; Riam, 8000 feet at least; Hijau, 4400 feet; Bubor, 5630 feet; Gunong Rampip, 7800 feet; Gunong Rajah, 6500 feet; besides many others in Reman and Pahang which have not been explored.

Arang Para, Perak, June 2 J. E. TENISON-WOODS

Chalk and the "Origin and Distribution of Deep-Sea Deposits"

IN consequence of Dr. Gwyn Jeffreys' letter, I feel it incumbent, in the interests of geology, to restate the position with regard to the question of the depth of the ocean in which the White Chalk of England was deposited. The cause that led to its deposition over a former land surface was indubitably a great though gradual depression of that area. The process commenced with the Neocomian age, when two seas encroached from north and south, until they were probably only separated by some relatively unimportant ridges or islands to the north of London. The depression seems to have been checked for a long [illegible] but recommenced in the Gault age in a more serious [illegible]. Now, according to Renard and Murray, the *Blue Mud*, with which I assume the Gault is to be identified, if with anything, is formed around shores and in partially inclosed seas, passing into a true deep-sea deposit at a distance from land. The limits of depth at which *Blue Mud* is formed are not stated, but the Mollusca of the Gault, if not indicating a very great depth, are quite against its being a very shallow-water formation. There are several deep-water genera, such as *Nucra*, *Leda*, *Limopsis*, *Cadulus*, *Dentalium*, *Eulima*, in it, and I believe that when the smaller Mollusca from it have been reinvestigated by the light of our present knowledge, a far greater similarity between them and deep-water forms will be apparent. The Gault also contains a very large number of Foraminifera and several Encrinites and other Echinoderms, which are not, I believe, characteristic of long-shore deposits; while there is a remarkable absence in it of the more distinctly shallow-water shells that abound in the Neocomian, and it has none of the coarser fragments of rock, 2 cm. in diameter, which are stated in Renard and Murray's paper to occur in the near-shore muds. We must assume a considerable depth of water for the Lower Gault—what depth I would be well pleased to leave to Dr. Gwyn Jeffreys to say. Now, if there is one fact more apparent than another, it is that the Upper Gault represents a deeper sea than the Lower, and therefore that the depression was maintained. The *Blue Mud* is replaced in neighbouring areas by *Green Muds and Sands* with Glauconitic grains which apparently are deposited in similar depths or situations; but the limit of depth at

which either the one or the other is dredged is not stated. A still continued depression takes us through *Green Mud* to the Chalk Marl, which apparently is a true Globigerina ooze[1]; and this passes into a true White Chalk. The White Chalk is the result of still farther depression, for it overlaps the other deposits, and as the great change in the character of the sediment cannot have been due to the shallowing of the sea, and yet must have had a cause, we must conclude it was due to deepening. Its enormous extent and thickness and great purity proclaim it in fact to be an oceanic deposit, and there does not appear to be anything with which it can be compared except Globigerina ooze.[2] The White Chalk of England could therefore only have been deposited under the conditions of depth, or remoteness from land under which the deposit of Globigerina ooze is possible. If Globigerina ooze is not a "terrigenous" deposit, Chalk is not, and it does seem singular that it should be classed as such by Renard and Murray, unless indeed they are prepared to point to an area in which a similar terrigenous formation is taking place at the present day. If genera now confined to shallow-water are present in it, it only proves that there must have been deep-water representatives of those genera in the Cretaceous ocean. This is in fact probable from at least two considerations, the one that the examination of the abyssal fauna is still relatively "extremely slight and cursory," as Dr. Gwyn Jeffreys has so amply admitted in the address he refers me to. It is probable that thousands of casts of the dredge have been made in the littoral zone for one in the abyssal zone, and we are, therefore, not in a position yet to say that any genus may not have representatives in the latter. The second consideration is far more important. Dr. Gwyn Jeffreys states that "all of them (the Cretaceous Mollusca) are evidently tropical forms." Now there is strong evidence from the present distribution, and the deposition of the Chalk, that the sea did not communicate with Arctic seas. Prof. Prestwich, in his anniversary address to the Geological Society, pointed this out in 1871. But even if it had, the Arctic climate during the Cretaceous period was a warm one, and for these two reasons, or either of them, the abyssal depths of the Chalk ocean were probably higher in temperature than they are now, while the temperature of the more littoral zones may have been almost tropical. Heat and cold seem greater factors in the distribution of Mollusca than depth of water. Relatively cold-loving genera or species of genera that could only have found the necessary temperatures then at great depths, may now find suitable habitats in shallow water. The "tropical Mollusca" of the Chalk might for this reason have been able to live at much greater depths when such were warmer, but are of necessity now restricted to those in which suitable temperatures are to be met with; and since these are now all relatively shallow, Dr. Gwyn Jeffreys may be quite right in saying that these extinct species have a shallow-water facies, without our being obliged to accept his inference that the [illegible]a was a shallow one. But if we accept the Mollusca pure inhere[illegible]le as a test of depth, their evidence as adduced is untrustworthy owing to the association together of those of the Gray Chalk and the Irish Chalk band of Kilcorrig. Eliminating these, we have no patelloid shell left but *Hipponyx*, and the Chalk species was completely different in habit to anything living. I do not know the Chalk *Chama* (if the Irish form, this is a limpet) or *Pinna*, and these must be very rare and even possibly drifted shells. The unextinct characteristic genera are in fact reduced to *Terebratula*, *Lima*, *Pecten*, *Armussium*, and *Spondylus*, and of these all but the latter are stated, in the address I am referred to, to have been met with in water 1450 fathoms deep.[3]

It would be impossible to dispose of a question of such importance in a mere letter. My object in writing is to elicit, if possible, the exact grounds on which Messrs. Murray and Renard base their statement that the Chalk was a shore deposit; and it would also be exceedingly useful if Dr. Woodward, Dr. Duncan, Mr. Davidson, and Mr. Carpenter would give their opinions, and the grounds on which they are based, on the probable depth required by each of the Cretaceous groups, respecting which they are the chief authorities. Dr. Gwyn Jeffreys is the only one who has contributed anything definite towards a solution of this most important geological problem, and for this, while believing other conclusions may be deduced than those he has arrived at, I and many other geologists heartily thank him.

J. STARKIE GARDNER

[1] Globigerina ooze is mainly composed, according to Murray, of 40 to 95 per cent. of carbonate of lime, oxides of iron and manganese, and argillaceous matter.

[2] Of reef-building corals there is not a trace either in it or in any contemporaneous formation, and nothing can be more opposed to all evidence than the supposition advocated, it will be remembered, by Wallace in "Island Life."

[3] There are few traces in the English Chalk of any Mollusca except those that possessed calcite shells, and what the rest were like as a group no one can say.

Animal Intelligence

THE following notes of facts observed in New Zealand may be thought of interest; in some way they may serve to illustrate Mr. Romanes' work on "Animal Intelligence": they are submitted without making an attempt to distinguish where they may overlap the fine line between instinct and intelligence. Cases which may show apparent intelligence or the reverse are recorded that we may arrive at a clearer view of the truth in animal life.

The dog cannot be passed over without mention; he is always to the fore where intelligence is required. Here, where sheep occupy so large a share in the employment of country people, the colly may be seen daily exhibiting its wonderful talents in controlling the movements of its simple charge. Its achievements are too numerous for recital.

Amongst birds we found the quail-hawk (*F. novæ-zelandiæ*), quickly learnt to avail itself of the property of the new settlers; it attacked both poultry and pigeons with the greatest determination directly these foreign birds appeared at the stations and outlying farms. The harrier (*Circus approximans*), more stealthy than the falcon in its depredations on the poultry, perhaps not less destructive, is careful if possible to convey its prey to a quiet spot free from interruption, where its meal can be finished at leisure in security. It found out the use of cornricks and haystacks as mouse-preserves; in some places several harriers might be seen at one time perched on the thatch carefully watching for vermin. It killed the rabbit; the swift-footed hare it found out could be hunted to best advantage in company: several of them would join in the pursuit, wheeling softly with every double of the distressed animal, till, quite exhausted, it lay stretched out in death. The harrier, the gull, the tern, all used to put in their appearance after the large grass fires of former days had swept miles of country; lizards, as they crept from under the stones laid bare by fire, seemed the attraction for all these birds. One autumn, when laid up with rheumatism, lights were brought into the room rather early. I often heard the sound of scratching on the window-glass, and found it proceeded from the efforts of an owl (*Athene, N.Z.*) to secure moths from the lighted-up window-panes; this was repeated for many evenings during parts of the months of April and May, so that I always expected my evening visitor. As a mouser this same species learnt the value of stations near barns and stacks; frequently, many scores of times, have I seen it keeping its solemn watch on a post or rail of the barnyard (see *Zoologist*, 1873, p. 3621). The kakapo or night-parrot (*Stringops*) shows intelligence in its nesting arrangements: the chamber at the end of a long tunnel is covered at the bottom with a great accumulation of excreta; each of these is an inch or more in diameter—the bird is a vegetable feeder—the warmth derived from this mass is secured by the young, reversing the proverb, "It is an ill bird that befouls its own nest."

The kea (*Nestor notabilis*) (see NATURE, vol. iv. p. 489). Its rapid development of a change of habit that led it to destroy sheep has proved very disastrous to many mountain sheep-farmers. It is remarkable that the discovery of the excellence of kidney fat should become known almost simultaneously through a long tract of country; how were beginners instructed to dig their beaks into the wool just above the sheep's kidneys? Horses have been wounded by them in the same part; all this shows a ready means of spreading information. One of the writer's sons snared a few fine specimens, but they very soon became aware of the snare and promptly avoided it. When thrown at, they learn to dodge the stone, just ducking or moving aside. One, imprisoned under an inverted bucket, after a time thrust its strong beak between the rim of the bucket and the floor, turned over the bucket and escaped.

The two cuckoos *Eudynamis* and *Chrysococcyx* offer a problem of peculiar interest as regards migration. The journeys they undertake and accomplish across wide expanses of ocean are amongst the most courageous and trying physical feats in bird history: "as bold as a hawk," "as brave as a game-cock," are proverbs that are befitting; but these birds deserve as much recognition for their adventurous daring.

When either of these species is observed flying, it will be

noticed that the wings are kept constantly in rapid motion; there is no sailing or soaring, gliding through the air on still expanded pinions, but the bird is sustained by determined work. Here in the South Island they are to be seen from the end of the first week in October (further to the north earlier) till March, or even April; the remainder of the year they are not seen in this country. Every part of the islands is known to the Maories; there is no district where they could winter without the fact becoming known. The whistler, or shining cuckoo (*Chrysococcyx*) has been observed in the month of October at Te Wakaru, Chatham Isles, on the beach and in trees exhausted, wet as though from spray; looking at the period of its arrival, and remembering that Te Wakaru is the north-east corner of the large island, it points to the probability that some birds arrive there direct from the warm and distant north, and not from New Zealand, from which the Chatham Island group lies easterly from Cook's Straits about 500 miles. From my own observation I am inclined to believe that with this species the first emigration sets in from the west coast of the South Island of New Zealand about the end of December, as I have observed adult birds in numbers on the sand dunes close to the sea, probably preparing for departure. They make use of the warmest domed nest of our native insect-eating birds, the very rare exceptions afford but two or at most three exceptions in thirty years' observation; in one of these cases an egg found in a nest of the blight-bird (*Zosterops*) approximated in colour those of the dupe; because it was dropped in an open nest? A good example of approximate coloration came under notice in the case of a wounded bittern which was secured and placed under a coop on a piece of grass; she laid an egg of a pale green colour; under ordinary conditions a buff egg would have very well matched the flags of dead sanpo (*Typha*) and faded water grasses, of which its nest is composed. The kingfisher (*Halcyon*) gives a good instance of cleanliness, most necessary in a close nest, containing from five to seven young birds, which remain at home until they can fly well; the entrance of the tunnel to the nest chamber is an upward slope, whilst the eggs are saved from rolling out by a ridge on the edge of the nesting place. In another species the flycatchers (*Rhipidura*) cleanliness is attended to thus: the young back themselves to the edge of the nest to void excrement, which is taken away by the old birds. In the slight nest of the wood-pigeon (*Carpophagus*) cleanliness is provided for by the open work of the structure, so that the dried excreta of the young pass through the spaces of the concave platform. The tui (*Prosthemadera*) enjoys the faculty possessed by the keas, gulls, terns, and many other species, of quickly making known events of interest, as, for instance, in a gorge of one of the great rivers, some cherry-trees rewarded the care of a settler with a fine crop of fruit; a wandering tui found this out, immediately the fruit was attacked by numbers of these beautiful birds, and the crop cleared off. The tuis had to travel some miles from a wood to the cherry-trees. Another instance of the possession of this quality could be witnessed here at the present moment (April 23); from the midst of the massive armed leaves of a variegated aloe has arisen a stately and erect column of blossom reaching upwards to a height of twenty-four feet; its bracts, between thirty and forty in number, laden with rich golden-coloured flowers spread out in formal array. A bell-bird (*Arthornis*) first discovered the richness of the nectaries of this foreign plant. Soon bell-birds and tuis assembled there, a most pleasing sight; their ever-varying motions and postures could be distinctly seen as they flitted about, darted between or hung suspended from the blossoms whilst probing for the honeyed sweets. It has become a floral play-place, a stage enlivened throughout the day with songs and aerial movements; even when the sun has retired behind the western hills, when bees have winged away to distant hives, a bell-bird or two will yet linger, as if to the last minute they would extract some luscious drops.

Since its arrival here in 1856 the blight-bird (*Zosterops*) has shown some notable changes in habit that are in accord with the different conditions under which it now lives in this country: for some years after its arrival it built a suspended, somewhat hammock-shaped nest, in which it laid three eggs; finding from experience that its nest was unmolested by snakes or other egg-robbers, it saved itself much pains and labour by commencing to fix its home in a spray. It, like the goldfinch (*F. carduelis*), freely availed itself of the sheep paddocks, and collected wool as an excellent fabric for nests very readily obtainable; I have seen nests of this species almost entirely constructed of it. One of its familiar names was conferred because it helped to clear fruit-trees of blight and other insect pests; it soon found out the excellent food that a variety of fruits afforded; when trees were netted to secure them from its attacks, it learnt to find out where the meshes of the nets were stretched to their full extent, and there made its ingress and egress to the fruit beneath. The robin (*P. albifrons*) visits conservatories for the sake of insects; we have known them make daily tours round a glass-house, waiting till flower-pots have been removed, when they have eagerly picked up the lurking insects that hid beneath, thus easily earning a hearty meal. The lark or pipit (*Anthus, N.Z.*) for a similar reason will leave uncultivated tussock land to follow the trench made by the gardener's spade, and thus get an abundant supply of the larvæ of the brown chaffer-beetle. I wish to say I do not think this a general habit of the pipit, but I have seen several of the species thus well employed.

The yellow-breasted robin (*P. macrocephala*) and the wren (*Acanthisitta*) will at times use man's buildings for their homes. Nesting material offered to this robin and to the flycatcher have been readily accepted; the latter species made use of some red cotton wool thus put in its way, but worked it up so that it was not seen from the outside. In some cases I have known the last-named neat architect to add a rim to the nest when the young required more room. The chaffinch (*F. cælebs*[1]) here follows the traditions of its native land, tricks out the exterior of its beautiful nest with lichens, and in many cases supplements this material with fragments of newspaper, for lichen is scarce here; singularly enough this hereditary habit outweighs its sense of concealment, as it places its nest thus adorned on trees without lichen on their bark.

The sparrow (*F. domestica*) is remarkable for the ease and readiness with which it modifies its nesting habits to suit circumstances; in the very heavily topped ti palms (*Cordyline*), where the divergence of the branches is hidden by a massive thatch of long ensiform leaves, sometimes a common roof shelters many compartments; the gregarious instincts of the species are thus carried out at breeding-time; from one of these communities we have taken thirty-one eggs and fourteen young birds at once. On the shelterless "plains" it has been known to modify its old habits by building on the ground, or in heavy road cuttings its nest may be seen in a crevice of the bank, or it builds in some fissure in the cliffs over the sea, just below man's reach; it has taken possession of intricate passages in a heap of coils of fencing-wire; in this last-named instance poultry feathers for lining had to be brought from a mile distance; but then the situation promised security.

The weka (*Ocydromus*), as curious as a magpie, knows the value of a fruit-garden, and that a poultry-yard furnishes eggs. I have seen it pecking at the skin of a dead lamb with heavy blows, and the insects being driven out, it has tugged away at the decaying skin till it has been able to pick up the insects that lay underneath. The dotterel (*C. bicinctus*), red-bill (*Hæmatopus*), paradise duck (*Casarca*), all simulate lameness or distress to lead wayfarers from their young and afford them opportunity for escape or concealment.

The Australian magpie (*Gymnorhina*) has given us some noteworthy instances of its intelligence and resource under difficulties: a pair bred here for some years; one season the young were taken, the wings cut very close. Some impatient creature who could not endure constant and sudden attacks shot the male bird; the young were given away except one poor one, which turned out to be a male. In the following season the old hen was seen building very high, as usual, in a blue gum (*Eucalyptus*); there she was observed feeding young; at length a young one flew from the nest, and, when sufficiently strong on the wing, together with the old hen left the district. Now the poor male with the wings cut was never able to rise from the ground further than by jumping; he had never flown at all, as the stumps of the quills remained in the wings. This was the only male to which the hen could have had access. Whilst the hen was intent on new family cares, the crippled male died. Another pair on the plains, where sticks were scarce, availed themselves of a supply of binding-wire from a patent reaper and binder; the wire cut in lengths furnished an ample supply of lasting material for the nest.

The big gull (*Larus dominicanus*) instantly finds out a dead beast, and makes the fact known; it attacks sickly lambs or sheep that are cast by pecking out the eyes, thus securing its prey by rendering it helpless. I have seen it ascend with a shell-

[1] See *Mittheilungen des Ornithologischen Vereines in Wien*, No. 3, Marz 1884, p. 35.

fish to a considerable height, and drop it on to a shallow in one of the bays, recover its prize, and drop it again and again to obtain the fish within. Many weeks before nesting time these birds visit the old breeding-stations, as if to estimate the repairs that will be necessary to render the old nests available; this visit is carried on with great clamour. A cormorant (*Graculus*) was shot at and wounded at a tench-pond at Rockwood; it kept in the pond; it could not fly. A dog was sent in to fetch it out; it faced the dog resolutely, which turned tail; this part of the animal was immediately seized by the cormorant, who was in this singular manner towed ashore; but its odd feat did not serve to save its life. The fantail flycatcher (*Rhipidura*) enters houses in pursuit of flies glancing from room to room; it soon clears them of these insects. Dr. Otto Finsch in his "Ornithological Letters from the Pacific" mentions this habit as witnessed by him here.

Amongst hymenopterous insects the Sphegidæ offer instances of intelligence. A species of Sphex with orange-coloured body deposits the benumbed or torpid bodies of spiders in some crevice for future use. An individual of this species had its hole in a dry corner beneath the plate of a long veranda. One day I observed it dragging a victim along a gravelled walk that was parallel to the veranda; the small stones and grit made its progress very difficult. After very trying struggles with these impediments it displayed a remarkable degree of intelligence, by which it gained its ends. It altered its course and made for the veranda, ascending the smooth, painted board that adjoined the gravelled walk. After slowly traversing seven inches of perpendicular it came to a rounded beading which projected outwards. Now came its supreme moment of physical exertion. The body of the spider apparently was too heavy to render the aid of wings available. After several pauses in its progress it slowly yet surely surmounted the difficulty presented by the projecting beading, gained the level boards of the veranda, along which it travelled rapidly with its burden, which it sometimes dragged, sometimes pushed before it. By the expenditure of great exertion in surmounting the beading it gained a smooth and level run to its home of thirty-nine feet. A species of Mantis remains so still on a leaf of its own colour that it is difficult of detection; it takes its prey by surprise, darting forward its armed fore-limbs with a sudden spring.

I have had in the shrubbery a colony of Phasmæ for the last nine or ten years. In all that time they have remained almost entirely on one tree (*Olearea Forsteri*). Yet, accustomed as I am to them, they place themselves so much in a line with the sprays of the tree that they are difficult to discern; in drizzling north-east weather some dark markings appear along their bodies, which match the wet sprays wonderfully. It should be noted that the Australian magpie, the halcyon, and many insect-eaters have for years bred and lived in the trees or banks near them; yet they still survive, notwithstanding the proximity of these enemies to insect life.

T. H. POTTS

Ohinitahi

THE following extract from a letter which I have just received from Mr. J. H. Wheelwright appears to me of sufficient interest to publish in your columns, as it serves to give, among other things, a good deal of new and first-hand information on one of the most important branches of comparative psychology, viz. that relating to feral and partly wild domesticated animals.

GEORGE J. ROMANES

Cattle very easily relapse from domestication. They become distinctly nocturnal in their habits; their sense of smell is very strong. Wild cattle degenerate rapidly in size, owing, I think, to the persecution of the young heifers by the yearling bulls. In three or four generations in Queensland wild cattle revert to one uniform colour, a dun colour or dirty brown with a yellowish stripe along the spine, and a yellow nose. Wild cattle will remain all day long concealed in the depths of thick, inaccessible jungle—"bungalow scrub" or "mallee" we call it in Australia—issuing forth at night to graze and drink, and it requires much care and very hard riding to entangle a few of them among a lot of quiet cattle and secure them. Australian cattle have many habits their domesticated progenitors have lost. For instance, in summer-time grass becomes very scarce near the rivers, and the cattle walk in from their feeding-grounds as much as ten or fifteen miles to water, marching in long strings and feeding back again. Young calves of course could not do this. I have frequently noticed two or three cows far out on the plain, who, when they saw me, would lift their heads and watch me. Presently I would come across a kind of *crèche*, a mob of perhaps thirty little calves all lying snugly in some small, sheltered dip of the ground, left there in charge of the sentinel cows by their mothers who had gone in to water. Now as soon as these calves saw me they would try to hide—do it very well too, under any little bush there might be handy, and lie close until I got off my horse and touched one; then he would jump up, and, no matter how young, make a staggering charge at my legs. He would give a peculiar cry at the same time, which would bring the guardian cows in at a full gallop and give me reason to mount at once. Cattle have extraordinary *homing* power; so have horses. Cattle recognise *individuals* in a very extraordinary way. I have had considerable experience in droving large herds, say 1000 or 1200 head, long journeys extending over many months. I have been struck with the fact that, a week after that herd has been travelling, every beast in it seems personally acquainted with every other: that is, if a strange cow or bullock were to join the herd, that cow or bullock would be immediately expelled. When a herd is travelling thus, each beast in a very few days takes up his position in the mob, and may always be found in the van, the rear, or on the right or left wing, the strongest cattle leading. That cattle and horses can *smell* water is a delusion. Cattle and horses always have their particular friends; at night when cattle are *camping* on a journey, there is always much bellowing and fuss until certain *cœteria* of friends get together and lie down comfortably. A beast blind of, say the *left* eye, always travels at the outside of the *right* wing of the drove. A beast that has been scratched sufficiently to draw blood will be hunted and pursued by all the rest. Cattle have a habit of appointing certain *camps* or *rendezvous*, where, on any alarm, they congregate. Half-wild cattle are sometimes very difficult to drive off these camps. Wild cattle are singularly clever in concealing themselves, as are all wild beasts, and will hide in half a dozen little bushes no one would suppose would hold a calf.

Wild "dingo" puppies, taken away from their mothers, are easily reared, but never lose their inborn savagery: they are not to be trusted near poultry, sheep, or cats. The chief difference between them and their civilised brethren is, if, say a collie pup misbehaves himself and is kicked, he yelps, sticks his tail between his legs, and runs away; whereas his wild brother, with his tail erect as that of a Dandie Dinmont terrier, snaps viciously at the foot which kicks him. I have owned a pure-bred dingo ("warrigal" we call them) which ran with our kangaroo dogs, and the dog would worry one of his own kind with as savage a zest as would any of the great powerful hounds with which he had associated himself. As to feigning death, I think the Australian "dingo," or "warrigal," a good case in point. We once ran a wild dog with three powerful kangaroo dogs, noted for their killing powers; they caught him, worried him, and he lay for dead; at any rate the hounds thought he was done for; they lay down quite contentedly to regain their wind. We cut off the warrigal's brush, and he gave no sign. Just as I was getting on to my horse, I saw the supposed corpse open one eye. Of course we put the thing beyond a doubt. A kangaroo dog has been known to run down a dingo bitch at heat, line her, and then kill her. The worst and most dangerous wild dogs in the Australian pastoral districts are *half-bred ones*. Kangaroo dogs should be, I think, about three-quarters greyhound—the rest either mastiff or bull-dog; such a dog should be able to catch and kill almost anything.

A doe kangaroo, when hunted and hard pressed, will throw the young one out of the pouch into any handy clump of scrub or tussock of grass. The "Joey" accepts the situation, and makes himself as small as ever he can; in fact, in looking for him, all you ever can see are his bright eyes. Young kangaroos seem to possess exactly the same instinct as the calves of wild or semi-wild cattle, that of concealing themselves. Young kangaroos soon adapt themselves to circumstances, and make themselves comfortable at the bottom of the pocket of a jacket.

I remember that once upon a time, about 1856, we caught a brood of wild ducklings, which we took home and put under a hen. These ducklings, not one of them fledged, walked a mile and a half along a very dusty road to the place whence we had taken them, and rejoined, as I hope, their progenitors. Our black boys tracked them.

Diffusion of Scientific Memoirs

IN some of the numbers of NATURE which have recently reached me I find that Prof. Tait has broached a subject of

extreme importance to societies interested in the distribution of their publications, and in the receipt of publications from kindred bodies. Although I am connected with a small society which has hitherto only enjoyed an ephemeral existence, I trust that a brief account of my experience in the distribution of publications may have a little value. Early in 1883 more than 250 copies of our publications were distributed amongst the leading societies and libraries throughout the world. On my exchange list I now have 271 names; I also send to about 100 members of the Society. A few copies of our publications have been sent to persons who have made seismology a specialty. With each volume there was inclosed a printed form to be filled up and returned, both as a receipt and as a statement of other volumes which might be required. The institutions to which volumes were sent were as far as possible selected as having an interest in scientific investigations. Especial care was taken to forward volumes to institutions established in earthquake-shaken or volcanic regions, as for instance to many parts of South America, New Zealand, Central Siberia, Iceland, &c.

In many cases our receipts were returned. In others societies returned their own special forms. A few societies sent us their publications in return. One society very kindly made a collection of earthquake literature for us. Several others made special applications for particular volumes to complete the series of our publications. *In about half the cases, however, I find that no notice whatever was taken of our gift.*

For example—

For 34 volumes sent to institutions in	England	17	receipts were	received.	
,, 49	,,	,,	,, Germany	22	,, ,,
,, 49	,,	,,	the United States	31	,, ,,
			&c., &c., &c.		

One result has been that our distribution list has been reduced. In one or two instances, where I know that earthquake literature cannot fail to be acceptable, the omission to send acknowledgment has been overlooked, and I continue to post our publications.

No doubt many societies publish lists of presents. These may be useful to the members of such societies; but they are valueless to donors who are not favoured with such publications.

The fact which is most to be regretted is that these omissions have resulted in many libraries not being *au courant* with the latest information.

Now supposing that the publications in question have any value whatever, it is natural to seek a cause for this state of affairs.

In many instances the omissions may be due to negligence, whilst in others they may be due to institutions having failed to establish a system for their correspondence.

From my own communications with various societies it is evident that many of them neither possess forms for routine correspondence nor have they the means for facilitating reference to ordinary or extraordinary correspondence. Sheets of plain notepaper, envelopes, pens, ink, and a few postcards constitute the business equipment.

Those societies which possess forms for the acknowledgement of presents, &c., often sacrifice fivepence for the postage of an elaborate document where a wrapper or a three-halfpenny postcard, although wanting in formality, would attain the same result. Although learned societies are not institutions where business is a specialty, many of them might possibly derive benefit by the adoption of more business-like methods. At present it would appear that there are many institutions which are as equally indifferent to the circulation of their own publications as they are to receive those of others.

JOHN MILNE,
Hon. Sec. of the Seismological Society of Japan

Tokio, June 7

Suicide of Snakes

THE letter of Edward F. Hardman in NATURE (vol. xxix. p. 452), with reference to the suicide of black snakes, recalls an incident which I once witnessed; I was quite small, but my memory of the strange occurrence is very clear and distinct. It was in the State of Illinois, when at that early day a short, thick variety of rattlesnake was very numerous, so much so that the State acquired an unenviable reputation in the older parts of the Union. Farmers in "breaking prairie," as the first ploughing of the prairie sod was called, would kill them by dozens in the course of a single summer. They were very venomous, but owing to their sluggish nature and their rattle, which was always sounded before an attack, but few persons were bitten by them. Moreover, there was little danger of death if proper remedies were applied at once.

I was one day following one of the large breaking ploughs common at that time. It was drawn by five or six yoke of oxen, and there were two men to manage the plough and the team. As we were going along, one of the men discovered a rattlesnake, as I remember about twelve or fourteen inches in length. They rarely exceeded eighteen or twenty inches, so that this one was probably about two-thirds grown. The man who first saw it was about to kill it, when the other proposed to see if it could be made to bite itself, which it was commonly reported the rattlesnake would do if angered and prevented from escaping. Accordingly they poked the snake over into the ploughed ground, and then began teasing it with their long whips. Escape was impossible, and the snake soon became frantic at its ineffectual attempts either to injure its assailants or to get away from them. At last it turned upon itself and struck its fangs into its own body, about the middle.

The poison seemed to take effect instantly. The fangs were not withdrawn at all, and if not perfectly dead within less than five minutes, it at least showed no signs of life. That it should die so quickly will not seem strange if it is borne in mind that the same bite would have killed a full-grown man in a few hours' time.

The men watched it long enough to be sure that it would not be likely to move away, and then went on with their work. I trudged around with them for an hour or more, and every time we came where the snake was I stopped and looked at it, but it never moved again. In this case I do not remember that the snake had been injured at all. I have often heard of rattlesnakes biting themselves under such circumstances, but this was the only case that ever came under my observation.

Ongole, India, June 17 W. R. MANLEY

Sky Glows

As we appear to be having a return of the gorgeous sunset phenomena with which we were favoured towards the end of last year, a brief mention of two of the most brilliant displays that I have recently had the good fortune to observe may be of sufficient interest to place upon record in the pages of NATURE, The "after-glow," though very brilliant, has not of course attracted the attention it would have done, on account of the twilight; if it had not been for that circumstance, I think the recent displays of the phenomena would have been quite as gorgeous as those of last year. It would certainly have been so in the case of the "after-glow" on June 22; the "glow" on that evening at nine o'clock reached an altitude of 45°, and extended from the north to the west-north-west point of the horizon. For an altitude of about 20° the glow was of a beautiful crimson tint; above that altitude it was of a pale pink fading away gradually towards the edge to a pale orange. On that evening the reddish glow was not confined to that part of the horizon where the sun had gone down, but extended over the entire sky from the west to the east, the whole celestial vault, which was quite free from clouds, appearing to be slightly tinged with red. So conspicuous was this redness of the sky that a lady friend remarked—before her attention had been called to it—"How red all the sky is."

On the 7th inst. the "glow" equalled in brilliancy, though not in extent, the display above described. At 8h. 45m. p.m. it reached an altitude of about 30°, and extended from the west-south-west to the north-north-west point of the horizon. The redness of the whole sky, which was so noticeable on the former occasion, was wanting on this. On both occasions the "glow" was not visible for more than an hour and a quarter after sunset.

Dalston, E., July 12 B. J. HOPKINS

MANY of your correspondents have referred to the "remarkable appearances of the sky" at sunrise and sunset last year, but I have not observed any reference to the following:—On the morning of November 30 I was on my way from Basle to Calais by the St. Gothard mail train, and observed the whole eastern sky become lit up as though there were a splendid sunrise; the larger print of a newspaper was easily readable at the carriage window. On referring to our watches we found it was 5 o'clock by Basle time. During the next half-hour every trace of the phenomenon gradually vanished. FRANK PETRIE

July 11

Fireball

READING W. G. Smith's remarks on lightning in last week's NATURE (p. 241), recalls to my mind a ball I saw during a storm in the autumn of 1881. The storm had lasted some time, and I sat reading a little back from an open window but facing it. Suddenly it became so dark that I could no longer see. I dropped my book and looked out. A ball of fire was passing through the window into the room. It moved very slowly onwards and downwards towards me, and became almost stationary over my book. At first I thought it rested upon it, but I soon saw it was moving slowly across. Having passed over the book, it turned in the direction of my hand, paused just beneath it, and then sank towards the carpet. At this instant a peal of thunder crashed over the house—it was the very loudest I have ever heard.

ANNIE E. COCKING

The Elms, Bedford Park, Chiswick, W., July 14

Butterflies as Botanists

THERE can be no doubt, as pointed out by Fritz Müller in your last issue (p. 240), that the habits of insects often indicate affinities in plants. There is doubtless a strong affinity between the Solanaceæ and Scrophularineæ; the small oval pollen is almost identical in both. The habits of fungus parasites sometimes disclose similar relationships, often more real than is at first apparent; we have an example of this in the fungus of the potato disease, *Peronospora infestans*. This parasite is almost peculiar to the Solanaceæ, being especially destructive to Solanum, Lycopersicum, and Petunia, but at times it invades the Scrophularineæ and grows on Anthocersis and Schizanthus. It is not common to find one parasitic fungus attacking the members of two natural orders of plants, but other examples could be given.

W. G. S.

A Cannibal Snake

ABOUT eighteen months ago, just previous to my leaving India, at Devalah in the Wynaad, the horsekeepers chased and killed a large cobra, 5 feet 4 inches; previous to death it was thrown down in front of the door of our house, when, after a good deal of twisting and wavy contortion of the body, it disgorged a small rock snake over 4 feet in length. I had heard of the same thing before in India, so that I do not think cannibalism in snakes is so uncommon as Mr. Evans thinks.

JOHN FOTHERINGHAM

96, Netherwood Road, West Kensington Park, W., July 12

FOURTH NOTE ON THE ELECTRICAL RESISTANCE OF THE HUMAN BODY

IN my communication to NATURE (vol. xxix. p. 528) I described the use of alternating currents and the telephone for the above purpose, and promised to endeavour to obtain at least an approximate measurement of the E.M.F. developed in the secondary coil of an induction apparatus. This promise I now propose to fulfil. But before proceeding to the special subject of the present note, I should wish to draw attention to a paper which appeared on the 15th of the same month in the *Asclepiad*, by that able experimentalist Dr. B. W. Richardson. He therein describes not only experiments made with the large induction coil of the Polytechnic, but also others made as early as 1868 in conjunction with the late Mr. Becker, the object of which was to obtain a measure of the resistance of animal structures.

"The results," says Dr. Richardson, "were not fully satisfactory. They were variable even when the conditions under which the experiments were made were entirely the same. This variability we found to be due to decomposition of the animal substance, a decomposition which, however feeble the battery, was sufficient to destroy the precision we desired to obtain." Putting the more recently coined word "polarisation" for decomposition, this expresses exactly the difficulty described by me in my first note. "It was, however, possible," says the doctor, "to make out that blood conducted better than any other structure of the body, and better than water." I can now fully corroborate this excellent observation, and perhaps extend its application.

Physiological and even pathological fluids, such as the serum of dropsy, conduct far better than muscle, bone, and nerve. One instance out of many may serve. In the very first case recorded in my communication to NATURE (vol. xxviii. p. 151) the lowest resistance obtained from foot to foot was 2300 ohms. The patient was then very emaciated, but quite free from dropsy. Towards the end of the case, which after death proved to be one of ulcerative endocarditis, as I had considered it to be during life, slight but distinct dropsical effusion in the lower extremities set in; the resistance sank at once to 700 ohms, and I had to discontinue my observations from the evident change of electrical conditions. I have since verified the same fact many times, and on it I partly found the belief, already several times stated, that "the human body, in spite of its large amount of liquid constituents, follows a similar thermal law of resistance to that influencing solid conductors, though in a very much higher ratio" (NATURE, vol. xxviii. p. 152).

Dr. Richardson does not seem to have attempted to determine the resistance of the living body, which Du Moncel, in 1877, did, and with fairly accurate, if unpleasant, results (NATURE, vol. xxix. p. 528). On the discovery, however, in 1879, of Prof. Hughes's electric balance, he resumed his observations, this time with an alternating induction current, though he does not himself notice the important change. His results are unfortunately taken in arbitrary units on the graduated scale of 200 parts originally applied to Prof. Hughes's instrument. If there is any way of reducing these fictitious to absolute values, my work will be both lightened and assisted by a proved observer. Blood-clot and serum, white and gray nervous substance, muscle, bone, coagulated albumen, gelatine, and pus were all tested. Some of the results were excellent. For instance, fat, which by one experimenter has been stated to increase the conductivity of the body, is found by Dr. Richardson, as I also have found it, to be an absolute non-conductor. It is almost unnecessary to say that, with so skilled a chemist and physiologist, all proper temperature corrections and other similar precautions were most strictly observed.

I can now proceed to the main topic of my present note. On receipt of the Wurzburg dynamometer it was put in adjustment, and a strenuous effort made to compare the indications given with a constant and an alternating current, to both of which it is sensitive. But the movable suspended coil made of an ivory core, with a double weight of silk-covered copper wire, hung by a platinum hook, and dipping by its other termination into a vessel of strong sulphuric acid by means of a platinised platinum plate, is very heavy; takes a long time to get to its full deflection, thus allowing the battery to run down sensibly, and, what is worst of all, has a tendency to "integrate." By this I mean to sum up, by its mechanical inertia, a large number of small, intermittent pulls as given by the reversed current, into an almost identical deflection (less, of course, losses) with that given by the one steady pull of a continuous current. In spite of its beautiful workmanship, it had to be discarded for the present research. Somewhat in despair, I fell back on a similar instrument, shown by me at the Oxford meeting of the Physical Society in June 1882, and there heavily abused. The moving coil in this is made of silk-covered aluminium wire to insure lightness, and the bifilar suspension is made of the silver-gilt wire used for military epaulettes and facings. It is the work of my own poor hands.

Herr Obach then stated, and the statement was repeated in your columns, that this material had already been used by Messrs. Siemens for their "dust-recorders," but had failed by difficulty of making contact. On testing my little toy, I found its resistance had not

altered in twenty-five months one fraction of an ohm, and that it moved briskly up to its maximum, standing there quite long enough for a good observation. Indeed, in spite of its condemnation by a jury of experts over two years ago, it was still so lively that I thought it better to check extra swing by a small platinum paddle 1 cm. square moving in sulphuric acid.

On a metre scale, at one metre distance, the reflected image in a telescope gave ·365 mm. deflection[1] with the whole induction current from Prof. Kohlrausch's metre-bridge, as described in my last note.

The object now was obviously to obtain an independent measure of the actual E.M.F. to which this deflection was due. The quadrant electrometer, or some other delicate potential measurer, of course suggested itself. A trapdoor portable, kindly lent me by Prof. McLeod, refused to take notice of my wretched little currents, limited as they are by human susceptibility. I do not possess a quadrant, nor will the Royal Society, though twice asked, lend me one. Here again my friends at Cooper's Hill came to my rescue, and I have to express my thanks, not only to Prof. McLeod, but also to Prof. Stocker and his excellent demonstrator Mr. Gregory, for their assistance. With my Kohlrausch induction bridge in a big bag I journeyed to Egham, and thence on foot to Cooper's Hill.

The formula to be made use of was obvious. It is given in Prof. Adams's Cantor lectures, and has been kindly verified for me by Prof. Hopkinson. In it the needle is connected with one pair of quadrants, so that $V_3 = V_4$. In this case—

$$\text{Deflexion} = \frac{k}{2}(V_1 - V_2)^2.$$

Prof. Adams has since shown me a different, and perhaps better, way of working, which I intend to make use of in the future. It was found that the two fine quadrant electrometers at Cooper's Hill College were unavailable; the one given by Lord Salisbury not admitting of the needle being placed in connection with either pair of quadrants, the other being disabled by some casual contact. We therefore with heavy hearts made a last struggle with the old Elliott pattern and single quadrants. This succeeded admirably, and on a mean of the four best out of six observations, we obtained a deflection of 107 with the intermittent current. "In order to be quite sure," Mr. Gregory wrote to me next day, "of the true value of the mean deflection we obtained, I have executed measurements with different numbers of cells. In these, the negative pole was to earth, the positive being connected at will to either pair of quadrants, and the needle also at will to either pair, giving four readings for each observation. I give only means, which agree well.

E.M.F.		Defl.		k
21 volts	...	32·75	...	·149
29 ,,	...	63·75	...	·151
47 ,,	...	161·75	...	·146
	Mean ...		...	·1486

k was calculated from the formula

$$\delta = \frac{k}{2}(V_1 - V_2)^2.$$

By calculation, using the mean value of k, the E.M.F. to give a deflection of 107 came out 38. By observation, using an E.M.F. of 38 volts, the deflection was 107·25. This agrees so well with the calculated value that it will be easy to evaluate the E.M.F. corresponding to any deflection by the above formula."

The effect of rapid alternations seems to be to lessen the deflection, though Mr. Glazebrook stated, in a paper read before the Physical Society, that with between 10 and 120 contacts per second the result, in charging a condenser, was not perceptible.

[1] The bridge arrangement being entirely disconnected.

On the whole therefore, though I agree with Mr. Gregory that we have not obtained a measure of the maximum E.M.F., but only an integration, disregarding sign, the approximation is, I hope, superior to any made before, and affords a good general basis for farther work.

W. H. STONE

GAS-BURNERS[1]

THE economist who wished to point the moral of a healthy competition in industrial commerce could scarcely find a better instance to his hand than the progress made by gas illumination under the impetus given in the last few years by the rise of electric lighting. It is not overstating the case to say that greater improvement in the use of gas has been made since Jablochkoff introduced his electric candle than in the previous sixty years' history of gas lighting. Compared with the recent development of invention, the long period of non-competition appears almost stagnant. With the introduction of electricity arose a popular demand for "more light." With a new illuminant competing for favour, consumers growled more openly at "bad gas" and high gas bills. Each advance of the electric light was greeted with acclamations by the popular voice, shareholders began to tremble, and gas shares came down with a rush. It was time for gas managers and manufacturers to bestir themselves. The happy days of a monopoly in light seemed over. The consumers have reaped the benefit. Under the stimulus of competition the price of gas has been lowered, impurities have been cut down. Some half a dozen years ago the great London Companies were endeavouring to prove before a Parliamentary Committee that coal-gas could not be purified from bisulphide of carbon without creating such a nuisance as to be intolerable. Their object was to do away with the lime purifiers, made necessary by the regulations of the Gas Referees, and to use only oxide of iron. Since the advent of the electric light not a word has been heard about the impossibility of purifying coal-gas by lime. On the contrary, every effort is now made to supply gas as free from sulphur as possible. But while the gas has thus been improved in quality and lowered in price, a still greater improvement has been effected in the methods of burning it. By the application of the regenerative principle to gas-burners, the illuminative value of coal-gas has been doubled.

But in spite of the great advances made in gas-burners, the public have by no means yet reaped the full benefit. Owing to the carelessness of gas-fitters and the ignorance of consumers, the great majority of those who light their houses by gas waste at least 20 per cent. of their gas as an illuminating agent. If the flame smokes, or flickers, or gives a poor light, most people put it down to "bad gas," when in reality the burner is unsuitable, or worn out, or the supply pipes (nearly always too small) are choked. To all who burn coal-gas in their houses, and are troubled with "bad gas," we can heartily recommend "Gas-Burners, Old and New," by Owen Merriman.

This little book, published at a price which places it within the reach of a large public, describes very plainly in popular language the evolution of the best modern burners of Sugg, of Bray, and of Siemens, from the original "cock-spur burner" of Murdock, and Accum's "tube with a simple orifice, at which the gas issues in a stream, and if once lighted will continue to burn with the most steady and regular light imaginable, as long as the gas is supplied." The illustrations are all that can be desired.

Owen Merriman has taken pains to insist on the two great *desiderata* of gas-burners—high temperature and low temperature, but we think he has gone too far in attempting to give a popular "theory of luminous combus-

[1] "Gas-Burners, Old and New." By Owen Merriman. (London: Walter King, 1884.)

tion." We are told that "the various gases which constitute ordinary coal-gas do not all burn together in the flame; . . . thus hydrogen is the first to burn, taking fire readily as soon as it issues from the burner, while the combustion of heavy hydrocarbons does not commence until they enter the hotter portions of the flame." Again Owen Merriman says: "the amount of light developed by any coal-gas flame is *directly proportional* to the degree of intensity to which the temperature of the carbon particles is raised." The italics are ours. In a note on page 23 there is some confusion as to the effect of the admission of air into a Bunsen burner. "A continuous wind blowing upon the flame destroys its luminosity altogether, because the heat intensity of the flame is *lowered below the temperature necessary to decompose the hydrocarbons*; consequently these latter burn without the preliminary separation of carbon, and a non-luminous flame is produced—exactly as in the Bunsen burner." The reader would gather from this that the flame of a Bunsen was colder than an ordinary flame, and by the same argument the blast of a blow-pipe would render a gas-flame colder instead of hotter. And again on page 43 a similar mistake is made when we are told that a too long flame is bad because the gas is "brought too early into intimate contact with air, and so oxidised, or fully consumed, *before its carbon has been raised to the temperature necessary to enable it to give out light*." We point out these few blemishes in the hope that the author may correct them in a future edition of the work, to which we wish a hearty success.

BIRDS'-NEST SOUP

IT is scarcely probable that the famous birds'-nest soup which Chinese cooks at the Health Exhibition offer to favoured visitors will ever become a popular dish in England. The tasteless, gelatinous compound is not suited to our palates. Perhaps this is not to be regretted, as the supply of material for this mysterious compound is far from being inexhaustible. There appears to be only one place in the world where it can be obtained in any quantity, and this has recently been visited by Mr. Pryer, a naturalist of Yokohama, who communicates his observations to the *Japan Gazette*, an English journal published in that settlement. Leaving Elopura, the infant capital of the infant colony of British North Borneo, in March last, Mr. Pryer ascended for some thirty miles the Sapugaya River, which flows into Sandakan Bay, on which the town is built. Passing through the mangrove and nipa swamps which line the banks, he arrived at noon on the second day at his destination—the celebrated birds'-nest caves of Gomanton. These caves, which are two in number, called by the natives the Black and the White Caves, are situated in a limestone cliff 900 feet in height, which the traveller came on quite suddenly in the centre of the forest. The porch, Mr. Pryer writes, is rather over 100 feet wide by 250 high, and the roof slopes up for 110 feet more, so that the height of this magnificent natural cathedral is 360 feet. The interior of the Black Cave is well lighted, as there is a large circular hole in the roof on the right, and a smaller one on the left, forming two aisles. The walls and roof are rugged, and beautifully coloured, shading from black to brown, gray, dark yellow, red, and green. The nests of the bats and swifts were seen hanging in clusters from the sides and roof, and here and there in seemingly the most inaccessible places were the rattan stages, ladders, and ropes of the nest-gatherers. These latter reached their perilous heights by means of many smaller caves in the cliff above. The White Cave is 400 feet higher up than the Black Cave, and at the entrance to this the nest-gatherers live under a guard of the North Borneo Company's soldiers. After some examination Mr. Pryer was able to discover the material which forms these mysterious nests, and from which they derive the qualities which render them so highly prized in China. They are made from a soft fungoid growth that incrusts the limestone in all damp situations; it grows about an inch thick, outside dark brown, but inside white. The birds make the black nests from the outside layer, and the best quality of white nests are, of course, from the inside. It is taken by the bird in its mouth, and drawn out in a filament backwards and forwards like a caterpillar weaving its cocoon. At nightfall takes place what the natives style with much justice the most wonderful sight in all Borneo, and it might be added, one of the most wonderful sights in the world—viz. the return of the swifts to their nests, and the departure of the bats for the night. About that time a rushing sound was heard, and peering over the abyss into the Black Cave Mr. Pryer saw columns of bats wheeling round and round the sides in regular order; soon they began to circle up, rising into the air in a corkscrew flight. Having reached a certain height, a detachment would break off and fly away rapidly. He counted nineteen flocks go off like this, each flock consisting of many thousands, and then they commenced to pour away in a continuous stream until it was too dark to see them any longer. Soon after the bats emerged from their cave, the swifts began to return to theirs, first in tens, then in hundreds, and at last they too streamed in continuously, and when the traveller went to sleep at midnight they were still flying in in undiminished numbers. Rising before daylight the following morning, Mr. Pryer witnessed a reversal of the proceedings of the previous night, the swifts going out and the bats coming home. The latter, he says, literally rained into their chasm for two hours after sunrise; looking up to the bright sky, numbers of small specks appear, flash down perpendicularly with great rapidity, and disappear into the darkness. From specimens of the bat which were secured, they were found to be all of one species, the caudal membrane extending only half down the tail, which is free for an inch and a half, giving the animal, when the wings are folded up, very much the appearance of a mouse. The wings are very long and narrow, and it flies with great speed. Two species of birds of prey—one a kite, the other a hawk—the *Haliaster indus* and the *Machæramphus alcinus*, prey on the bats and swifts when swarming into and out of the caves. A detailed examination of the latter was rendered disagreeable by enormous quantities of guano, the deposit of centuries. Its depth is not known, but a long spear does not touch the bottom when thrust in to the hilt. All the roof of the dark parts of the cave was occupied by birds who keep up an intermittent twittering, sounding, from the immense number of them, like the surf beating on a rocky shore. Near the centre of the largest cave the explorer was shown a small beam of light from a funnel at the top of the rock, exactly 696 feet above his head. The nests are gathered from these enormous elevations by means of flexible rattan ladders and stages. On these two men take their station; one carries a light four-pronged spear about 15 feet long, and just below the prongs a lighted candle is fixed. Holding on to the ladder with one hand, the spear is managed with the other, and the nest transfixed, a slight push detaching it from the rock. The spear is then withdrawn until the head is within reach of the second man, who takes the nest off the prongs and puts it in a pouch carried at the waist. According to statements made by the headman of the place, the annual value of the nests taken varies from five to six thousand pounds sterling. This, it is to be presumed, means the value on the spot; their value on reaching China must be far higher. The caves have been worked for seven generations without any apparent diminution, although three crops are gathered in the year. Notwithstanding the dangerous nature of their occupation—for even samphire-gatherers work in the open—accidents are very rare amongst the natives employed in

collecting the nests. There is an almost inexhaustible supply of guano in the caves, and the number of bats and swifts in them is so enormous that if they are undisturbed a regular quantity may be taken out yearly. Should the visitor to the Health Exhibition who obtains some of this far-famed and mysterious soup have little relish for it, as is not unlikely, he will at any rate have the satisfaction of knowing that he has before him a dish the principal ingredient of which was formed by the little swifts and bats which inhabit the Gomanton Caves in the centre of the magnificent tropical forests of North Borneo. There is probably no other article of food in the Health Exhibition, or in all Europe, more extraordinary in the mode of production, or in the method and circumstances under which it is obtained.

ON THE EVOLUTION OF FORMS OF ORNAMENT[1]

II.

THE leaf in Dracunculus has a very peculiar shape: it consists of a number of lobes which are disposed upon a stalk which is more or less forked (tends more or less to dichotomise). If you call to your minds some of the Pompeian wall decorations, you will perceive that similar forms occur there in all possible variations. Stems

FIG. 12.

are regularly seen in decorations that run perpendicularly, surrounded by leaves of this description. Before this, these suggested the idea of a misunderstood (or very conventional) perspective representation of a circular flower. Now the form also occurs in this fashion, and thus negatives the idea of a perspective representation of a closed flower. It is out of this form in combination with the flower-form that the series of patterns was developed which we have become acquainted with in Roman art, especially in the ornament of Titus's Thermæ and in the Renaissance period in Raphael's work. [The lecturer here explained a series of illustrations of the ornaments referred to (Figs. 12, 13, 14).]

[1] From a paper by Prof. Jacobsthal in the *Transactions* of the Archæological Society of Berlin. Continued from p. 251.

The attempt to determine the course of the first group of forms has been to a certain extent successful, but we meet greater difficulties in the study of the second.

It is difficult to obtain a firm basis on which to conduct our investigations from the historical or geographical point of view into this form of art, which was introduced into the West by Arabico-Moorish culture, and which has since been further developed here. There is only one method open to us in the determination of the form, which is to pass gradually from the richly developed and strongly differentiated forms to the smaller and simpler

FIG. 13.

ones, even if these latter should have appeared contemporaneously or even later than the former. Here we have again to refer to the fact that has already been mentioned, to wit, that Oriental art remained stationary throughout long periods of time. In point of fact, the simpler forms are invariably characterised by a nearer and nearer approach to the more ancient patterns and also to the natural flower-forms of the Araceæ. We find the spathe, again, sometimes drawn like an Acanthus leaf, more often, however, bulged out, coming to be more and more of a mere outline figure, and becoming converted into a sort of background; then the spadix, generally conical in

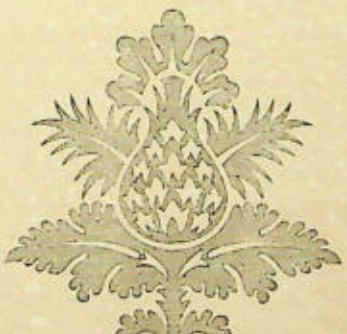


FIG. 14.

shape, sometimes, however, altogether replaced by a perfect thistle, at other times again by a pomegranate. Anberville in his magnificent work "L'Ornement des Tissus," is astonished to find the term pomegranate-pattern almost confined to these forms, since their central part is generally formed of a thistle-form. As far as I can discover in the literature that is at my disposal, this question has not had any particular attention devoted to it except in the large work upon Ottoman architecture, published in Constantinople under the patronage of Edhem Pasha. The pomegranate that has served as the original of the pattern in question is in this work surrounded with leaves

till it gives some sort of an approach to the pattern. (There are important suggestions in the book as to the employment of melon-forms.) Whoever has picked the fruit from the tender twigs of the pomegranate-tree, which are close set with small altered leaves, will never dream of attributing the derivation of the thorny leaves that

Fig. 15.

appear in the pattern to pomegranate-leaves at any stage of their development.

It does not require much penetration to see that the outline of the whole form corresponds to the spathe of the Araceæ, even although in later times the jagged contour is all that has remained of it, and it appears to have been provided with ornamental forms quite independently of

Fig. 16.

the rest of the pattern. The inner thistle-form cannot be derived from the common thistle, because the surrounding leaves negative any such idea. The artichoke theory also has not enough in its favour, although the artichoke, as well as the thistle, was probably at a later time directly pressed into service. Prof. Ascherson first called my attention to the extremely anciently cultivated plant, the

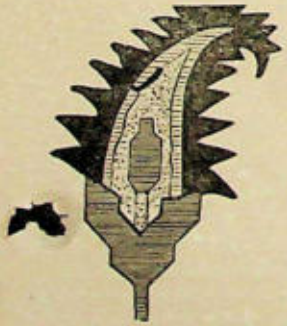


Fig. 17.

Fig. 18.

Fig. 19.

Safflor (*Carthamus tinctorius*, Fig. 15), a thistle plant whose flowers were employed by the ancients as a dye. Some drawings and dried specimens, as well as the literature of the subject, first gave me a hope to find that this plant was the archetype of this ornament, a hope that was borne out by the study of the actual plant, although I was unable to grow it to any great perfection.

In the days of the Egyptian King Sargo (according to Ascherson and Schweinfurth) this plant was already well known as a plant of cultivation; in a wild state it is not known (De Candolle, "Originel des Plantes cultivées"). In Asia its cultivation stretches to Japan. Semper cites a passage from an Indian drama to the effect that over the doorway there was stretched an arch of ivory, and about it were bannerets on which wild safran (*Saflor*) was painted.

The importance of the plant as a dye began steadily to decrease, and it has now ceased to have any value as such in the face of the introduction of newer colouring matters (a question that was treated of in a paper read a short time ago by Dr. Reimann before this Society). Perhaps its only use nowadays is in the preparation of rouge (*rouge végétale*).

But at a time when dyeing, spinning, and weaving

Fig. 20.

were, if not in the one hand, yet at any rate intimately connected with one another in the narrow circle of a home industry, the appearance of this beautiful gold-yellow plant, heaped up in large masses, would be very likely to suggest its immortalisation in textile art, because the drawing is very faithful to nature in regard to the thorny involucre. Drawings from nature of the plant in the old botanical works of the sixteenth and seventeenth centuries look very like ornamental patterns. Now after the general form had been introduced, pomegranates or other fruits—for instance, pine-apples—were introduced within the nest of leaves.

Into the detailed study of the intricacies of this subject I cannot here enter: the East-Asian influences are not to be neglected, which had probably even in early times an effect upon the form that was assumed, and have fused the correct style of compound flowers for flat ornament with the above-mentioned forms, so as to produce peculiar

patterns; we meet them often in the so-called Persian textures and flat ornaments (Fig. 16).

We now come to the third group of forms—the so-called Cashmere pattern, or Indian palmetta. The developed forms which, when they have attained their highest development, often show us outlines that are merely fanciful, and represent quite a bouquet of flowers leaning over to one side, and springing from a vessel (the whole corresponding to the Roman form with the vessel), must be thrown to one side, while we follow up the simpler forms, because in this case also we have no information as to either the where or the when the forms originated. (Figs. 17, 18, 19.)

Here again we are struck by resemblances to the forms that were the subjects of our previous study, we even come across direct transitional forms, which differ from the others only by the lateral curve of the apex of the leaf; sometimes it is the central part, the spadix, that is bent outwards, and the very details show a striking agreement with the structure of the Aroid inflorescence, so much so that one might regard them as actually copied from them.

This form of ornament has been introduced into Europe since the French expedition to Egypt, owing to the importation of genuine Cashmere shawls. (When it cropped up in isolated forms, as in Venice in the fifteenth century, it appears not to have exerted any influence; its introduction is perhaps rather to be attributed to calico-printing.) Soon afterwards the European shawl-manufacture, which is still in a flourishing state, was introduced. Falcot informs us that designs of a celebrated French artist, Couder, for shawl-patterns, a subject that he studied in India itself, were exported back to that country and used there (Fig. 20).

In these shawl-patterns the original simple form meets us in a highly developed, magnificent, and splendidly coloured differentiation and elaboration. This we can have no scruples in ranking along with the mediæval plane-patterns, which we have referred to above, among the highest achievements of decorative art.

It is evident that it, at any rate in this high stage of development, resisted fusion with Western forms of art. It is all the more incumbent upon us to investigate the laws of its existence, in order to make it less alien to us, or perhaps to assimilate it to ourselves by attaining to an understanding of those laws. A great step has been made when criticism has, by a more painstaking study, put itself into a position to characterise as worthless, ignorantly imitated, or even original, miscreations such as are eternally cropping up. If we look at our modern manufactures immediately after studying patterns which enchant us with their classical repose, or after it such others as captivate the eye by their beautiful colouring, or the elaborative working out of their details, we recognise that the beautifully-balanced form is often cut up, choked over with others, or mangled (the flower springing upside down from the leaves), the whole being traversed at random by spirals, which are utterly foreign to the spirit of such a style, and all this at the caprice of uncultured boorish designers. Once we see that the original of the form was a plant, we shall ever in the developed artistic form cling, in a general way at least, to the laws of its organisation, and we shall at any rate be in a position to avoid violent incongruities.

I had resort, a few years ago, to the young botanist Ruhmer, assistant at the Botanical Museum at Schöneberg, who has unfortunately since died of some chest-disease, in order to get some sort of a groundwork for direct investigations. I asked him to look up the literature of the subject, with respect to the employment of the Indian Araceæ for domestic uses or in medicine. A detailed work on the subject was produced, and establishes that, quite irrespective of species of Alocasia and Colocasia that have been referred to, a large number of Araceæ were employed for all sorts of domestic purposes. Scindapsus, which was used as a medicine, has actually retained a Sanscrit name, "vustiva." I cannot here go further into the details of this investigation, but must remark that even the incomplete and imperfect drawings of these plants, which, owing to the difficulty of preserving them, are so difficult to collect through travellers, exhibit such a wealth of shape, that it is quite natural that Indian and Persian flower-loving artists should be quite taken with them and employ them enthusiastically in decorative art. Let me also mention that Haeckel, in his "Letters of an Indian Traveller," very often bears witness to the effect of the Araceæ upon the general appearance of the vegetation, both in the full and enormous development of species of Caladia and in the species of Pothos which form such impenetrable mazes of interlooping stems.

In conclusion, allow me to remark that the results of my investigation, of which but a succinct account has been given here, negative certain derivations, which have been believed in, though they have never been proved; such as that of the form I have last discussed from the Assyrian palmetta, or from a cypress bent down by the wind. To say the least the laws of formation here laid down have a more intimate connection with the forms, as they have come down to us, and give us a better handle for future use and development. The object of the investigation was, in general words, to prepare for an explanation of the questions raised, and even if the results had turned out other than they have, it would have sufficed me to have given an impulse to labours which will testify to the truth of the dead master's words:—

"Was Du ererbt von deinen Vätern hast,
Erwirb es, um es zu besitzen."

NOTES

THE death is announced, at the age of seventy-four years, of Prof. Lepsius, the celebrated Egyptologist.

THE conference and jury work at the Health Exhibition is now in full swing, and we are glad to note that, with regard to the Conference, all the societies and organisations that have to deal with subjects akin to health or education are taking up the matter very warmly, so that the executive of the Exhibition has the advice and opinion of many experts. The recent opening of the Educational Section by the Prince of Wales, to which we have already referred, has recently drawn more attention to the *mens sana*, the *corpus sanum* having up to the present moment been alone regarded. From the first we consider that the matter of education has been placed altogether in far too secondary a position, and if a little more trouble had been taken by those who are responsible for the Exhibition, the educational exhibits might have been as extensive and as important as those regarding health. That is the more to be regretted, because so much is being said about education nowadays, especially technical education, by those who know very often very little of what is really wanted, and of what true technical education really means. The members of the various juries are working with a will, and from what we learn we do not think it probable that the objections made to some of the awards last year will be renewed this. The opportunity which has been afforded to the exhibitors of practically nominating a considerable number of jurymen is a measure well adapted to allow the thing to work smoothly. One of the great difficulties encountered by the jurymen has been the hurried way in which the Exhibition itself has been put together and catalogued. We have for too great an extent a succession of shops containing various articles, instead of a complete separation of the various articles among their several classes. This of course gives great trouble to all concerned, and is an administrative blunder which should not be allowed to be repeated.

WE are glad to be able to announce that H.R.H. the Prince of Wales has become Patron of the Marine Biological Association, and has contributed a handsome donation to its funds. The following is now the full list of Officers and Council as definitely elected by the Association, at its meeting on June 17:—Patron, H.R.H. the Prince of Wales, K.G. President, Prof. Huxley (President of the Royal Society). Vice-Presidents: The Duke of Argyll, K.G., the Duke of Sutherland, K.G., the Marquis of Hamilton, the Earl of Dalhousie, K.T., Lord Walsingham (Trustee of the British Museum of Natural History), Edward Birkbeck, M.P. (Chairman of the Executive Committee of the International Fisheries Exhibition), George Busk, F.R.S., W. B. Carpenter, C.B., M.D., F.R.S., W. H. Flower (Director of the British Museum of Natural History), J. Gwyn Jeffreys, F.R.S., Sir John Lubbock, Bart., M.P. (President of the Linnean Society). Council: Prof. Moseley, F.R.S. (Oxford), Chairman, Prof. Jeffrey Bell, F.Z.S. (British Museum), W. S. Caine, M.P., W. T. Thiselton Dyer, C.M.G. F.R.S. (Royal Gardens, Kew), John Evans, D.C.L. (Treasurer Royal Society), A. C. L. G. Günther, F.R.S. (British Museum), Prof. Herdman (Liverpool), E. W. H. Holdsworth, Prof. McIntosh (St. Andrew's), Prof. Milnes Marshall (Manchester), Sir Philip Cunliffe Owen, K.C.M.G., C.B., G. J. Romanes, F.R.S. (Sec. Linn. Soc.), P. L. Sclater, F.R.S. (Sec. Zool. Soc.), Adam Sedgwick (Cambridge). Hon. Treasurer, Frank Crisp, (V.P. and Treas. Linn. Soc.), 6, Old Jewry, E.C. Hon. Secretary, Prof. E. Ray Lankester, F.R.S., 11, Wellington Mansions, North Bank, N.W.

WE regret to learn of the death of the venerable Abbé Moigno at the age of eighty-one years. The name of the Abbé has been long known in connection with French science, and more especially as the founder, and till quite recently the editor, of *Les Mondes*.

IT is proposed to hold a special American Exhibition in London in May 1886, at which the products, manufactures, and varied phases of life in the United States will be represented.

BY a decree dated Ems, July 4, the Emperor conveys his thanks to Dr. Auwers, the celebrated astronomer who so successfully superintended the German preparations for observing the transits of Venus in 1874 and 1882. The Emperor further expresses his thanks for the assistance so hospitably rendered to the German scientific expeditions, not only by Germans living abroad, but also by many persons belonging to other nationalities.

BIOLOGISTS attending the Montreal meeting of the British Association will be pleased to hear that Prof. Asa Gray has promised to be present and to read a paper in Section D "On some characteristic features of the Botany of North America," with the special view of aiding botanists and members of the Section generally in their appreciation of the flora.

IT is announced from Montreal that a large number of the members of the British Association visiting Canada next month have already been "placed" in private houses in the city. The matter continues to be very heartily taken up in the towns of the Dominion, and there is every probability of a warm welcome being extended to the members. Considerable amusement has been caused in Montreal by some of the letters received by the Montreal Committee of the British Association from those members on this side of the Atlantic desiring information regarding Canada. The climate of the country is evidently a subject upon which there is much misconception among members. The queries on this point are most exacting, while a quite unwarranted dread of mosquitoes is held by not a few members. It is satisfactory to learn that a circular is now in course of preparation that will answer most of the queries received by letter, and that on the completion of the labours of the Private Hospitality Committee a directory of the visitors will be published.

PROF. R. S. BALL has accepted an invitation from the Lowell Institute, Boston, United States, to give a course of six lectures on "Chapters in Modern Astronomy" next October.

THE Society of Chemical Industry held their annual meeting in Newcastle last week. Dr. Perkin, F.R.S., was elected President for the next year.

UNDER the auspices of the Royal Geographical Society, Mr. E. C. Rye has done a most useful service to students by compiling a New Guinea Bibliography. It will be appended to Mr. C. R. Markham's paper on New Guinea, to be issued in No. 2, vol. i. of the Society's Supplementary Papers. Mr. Rye's Bibliography covers over fifty pages, and contains considerably over a thousand entries. It is evidently the result of immense labour and research, and is practically exhaustive. It includes not merely geography proper, but every aspect of the country; the references to natural history are specially copious, and include not only books but papers and notes in periodical publications of all kinds. The references are of the most precise character, and the whole is worthy of the editor of the *Zoological Record*.

IT may interest many of our readers—especially those who would like to add to the pleasure of a tour by a little photography—to know that the London Stereoscopic Company give gratuitous private lessons to amateurs who purchase their apparatus from the Company. We have no doubt this will solve a prime difficulty in the case of many who are ambitious to be able to photograph on their own account, but who do not know how to take the first step.

NOTWITHSTANDING the troubles that have surrounded Madagascar for the last year or two, the scientific activity of the missionaries of the London Missionary Society has not abated, and the native printing press has not been idle. We have just received from Antananarivo two numbers of the *Antananarivo Annual and Madagascar Magazine*, edited by the Rev. R. Baron, containing numerous papers of varied scientific interest. The following are those of most importance:—The Sakalava (No. 2), by the Rev. A. Walin; Notes on four species of Lemur and on the Aye-Aye, by Mr. G. A. Shaw; Customs connected with death and burial in Malagasy, by the Rev. S. E. Jorgensen; Resemblance between Malagasy words and customs and those of Western Polynesia, by the Rev. R. S. Codrington. In No. 7 for 1883 we have—The race elements of the Malagasy, by the Rev. L. Dahle; the Sakalava (No. 3), by the Rev. A. Walin; Volcanoes in Eastern Imerina, by the Editor; Malagasy "Fady" (Tabu), by Mr. H. E. Standing; Genera of Malagasy plants, by the Editor; Relics of sign and gesture language among the Malagasy, by the Rev. J. Sibree; and various natural history and meteorological notes.

DR. REGEL, the Russian traveller, who recently arrived in Merv, intends proceeding along the northern mountain slopes of Afghanistan and the Amu Daria to Pamir. This journey will conclude the doctor's explorations in Central Asia.

THE Milan Society for the Commercial Exploration of Africa has organised a circumnavigation of Africa, with a view of affording the pupils of the High School of Commerce, and others, an opportunity of becoming acquainted with likely markets for Italian products. The steamer will leave Genoa on September 1, and the whole voyage will occupy four months. A professor is to lecture during the voyage on the commercial geography of Africa.

THE first mail from Kadiak Island received this season, *Science* states, has arrived at San Francisco, bringing dates to May 2. According to the correspondent of the *Bulletin*, the account of the eruption of the volcano on Augustine Island, Cook's Inlet, sent by the last advices of 1883, was much exaggerated. The island "was not split in two, and no new island was formed

but the west side of the summit has fallen in, forming a new crater, while the whole island has risen to such an extent as to fill up the only bay or boat harbour, and to extend the reefs, or sea-otter rocks, running out from the island in various directions." The hunting-party feared to be lost has arrived safely in Kadiak. No tidal waves were observed on the west shore of Cook's Inlet or on Kadiak Island. The winter had been very mild, the mercury not having fallen below 10° F.; and spring began in March, wild flowers being in bloom in the latter part of April.

THE educational statistics of Japan for the past year show that the number of common schools throughout the country is 29,081, being an increase of 339 as compared with the preceding year, while the number of scholars is 3,004,137, an increase of 396,960, and the number of teachers is 84,765, being an increase of 8147.

THE Swedish Government have granted a sum of 850*l.* for the establishment of five additional so-called "chemical" stations, in order to benefit the agriculturist with scientific advice as to the crops, their diseases, &c.

THE sixth Davis Lecture of the Zoological Society of London was given in the Lecture-Room in their Gardens in Regent's Park, on Thursday, the 10th inst., by Mr. Henry Seebohm. The subject was that of "Birds' Nests," and consisted of an account of the breeding of birds on the Fern Islands off the coast of Northumberland, on the Derbyshire Moors, and in the valley of the Lower Danube. The lecturer pointed out that, so far as regards the means which birds take for the protection of their eggs, they may be classified in five groups—(1) those which rely upon the concealed position of the nest, such as the king-fishers, bee-eaters, pigeons, &c.; (2) those which rely upon the inaccessible position of the nest, such as guillemots, herons, &c.; (3) those which rely upon the protective colour of the eggs, such as sandpipers, terns, &c.; (4) those which rely upon the protective colour of the sitting hen, such as the blackbird, game birds, &c.; (5) those which rely upon their own ability, either singly, in pairs, or in colonies, to defend their eggs, such as cormorants, birds of prey, &c. Mr. Seebohm laid great stress upon the much greater interest to be found in the study of the life and habits of birds than in the investigation of the form and colour of their feathers or the peculiarities of their anatomy.

UNDER the auspices of the East India Association, a meeting of naturalists, planters, sportsmen, and others interested in the affairs of India, was held on Friday, July 11, at the rooms of the Zoological Society, under the presidency of Prof. Flower, LL.D., F.R.S. (Director of the British Museum Natural History Department, and President of the Zoological Society), for the purpose of urging the necessity of Government measures for the preservation of wild birds in India. The principal address was delivered by Mr. Robt. H. Elliot, sometime planter of Mysore, and a well-known writer upon Indian topics. He pointed out that every civilised Government with the exception of that of India has recognised the value of birds as insect-eaters, and has adopted measures for their preservation; and that the absence of legislation forebodes, where it has not yet presented, serious results to planters and agriculturists. As the most convenient season for the destruction of birds is during the fine weather that succeeds the heavy rains of the monsoons, and as this season is also the breeding time, the destruction of insect-eating birds proceeds at such a rate as must soon lead to almost absolute extermination unless preservative measures are speedily adopted. There was a general agreement at the meeting that legislation on the subject is imperatively required; and it was resolved that a representation to that effect should be addressed to the Government of India.

MR. J. H. ANGAS, who has already founded an engineering scholarship of the annual value of 200*l.* in the Adelaide University, has signified his intention of endowing a Chair of Chemistry. For this purpose Mr. Angas is prepared to give the sum of 6000*l.*, and to pay an annual sum of 350*l.* until he pays over the capital sum. A letter to this effect from Mr. J. H. Angas was recently read by the Chancellor at a special meeting of the Council. The Council resolved to accept the gift, and authorised the Chancellor to write and thank Mr. Angas for his continued munificence to the University.

PROF. MILNE of Tokio, Japan, writes to us:—"A short time ago I described a pair of conical pendulum seismographs. Each seismograph consisted of a heavy mass suspended by a string, &c. A local paper describing this innocently gave to the world an account of a pair of 'comical pendulums.' Each 'comical' pendulum consisted of a heavy 'man' suspended at the end of a string, &c. These errors, which were repeated throughout the article, did so much to popularise the instrument that their correction was neglected."

A RECENT number of *L'Exploration* contains an article by the Chancelier of the French Consulate at Hanoi, M. Aumoitte, which possesses special interest at the present time. It is the record of a journey from Hanoi through Bacninh to Langson on the Chinese frontier, thus following the same route as the French troops have done in their recent operations in Tonquin. From Hanoi to the meeting of the provinces of Bacninh and Langson, the country is described as populous and fertile, but on entering the latter district it becomes mountainous, with bad roads, and almost depopulated by the brigand hordes which have infested this borderland. Almost everywhere the water is bad, and fever rife even amongst the natives. Nowhere is this the case more than at Bacle, where the French forces are now hurrying up to retrieve the recent reverse at Langson. The country around Langson is described as healthy, it is rich in rice and cotton, but the trade here, as all along the valley of the Red River, is in the hands of the Chinese. When the French occupy this region, and when the recent treaty is carried out, we may expect a vast addition to our scanty knowledge of the geography of this little visited region.

FROM a paper contributed by the veteran scholar, Dr. Edkins, to a recent number of the *Chinese Recorder*, it appears that about B.C. 2200 the Chinese possessed a knowledge of the art of writing, a year of 366 days with an intercalary month, the astrolabe, the zodiac, the cycle of sixty, of twelve musical reeds forming a gamut, which also constituted the basis of a denary metrology for measures of length, weight, and capacity, divination, and a feudal system. In B.C. 1130 they were acquainted with the clepsydra and with the gamut of five musical notes. "Human knowledge was systematised in a scheme of numerical categories in which the five elements played a special part." About B.C. 550 the silk trade sprang into existence, the stars were classified, foreign names of unknown origin were introduced for the purpose of applying the cycle of sixty-two years. About B.C. 140 Chinese travellers visited Afghanistan, India, Bactria, &c. The cycle of Calippus was introduced into Chinese astronomy, and geographical knowledge concerning western nations was acquired. In the first two centuries of our era trade became more extended by sea; paper-making and the manufacture of ink were introduced from Europe, the Babylonian cosmogony became the main element of the Taoist cosmogony, and the gamut of five was increased to seven notes.

THE last volume (ii.) of the *Revue d'Ethnographie* contains, among others, articles by M. Bertrand on the Troglodytes, the introduction of metals into the West, and the great routes of migration and commerce in the earliest historical period; by M. Charnay, on the ruins in Yucatan; by M. Deniker, on the Giliaks; by Dr. Martin, on the cranial malformation of the

Chinese; by M. Ujfalvy, on the Aryans north and south of the Hindoo Koosh; and by Baron Vaux, on the Kanakas of New Caledonia.

THE additions to the Zoological Society's Gardens during the past week include two Quebec Marmots (*Arctomys monax* ♂ ♀) from North America, presented by Mr. N. Stainfield; a Prairie Wolf (*Canis latrans* ♂) from North America, presented by Mr. R. Payze; three Suricates (*Suricata tetradactyla*) from South Africa, presented by Mr. W. R. Dobbin; two Red-beaked Weaver Birds (*Quelea sanguinirostris* ♂ ♀) from West Africa, presented by Mrs. Nettleship; two Swift Parrakeets (*Lathamus discolor* ♂ ♀) from Tasmania, presented by Mr. J. Abrahams; four Common Vipers (*Vipera berus*), British, presented by Mr. Walter E. Blaker; two Smooth Snakes (*Coronella lævis*), British, presented by the Rev. Charles Harris; two Red Kangaroos (*Macropus rufus* ♂ ♀), a Greater Sulphur-crested Cockatoo (*Cacatua galerita*) from Australia, deposited; four Beautiful Finches (*Estrelda bella* ♂ ♂ ♀ ♀) from Australia, a Lanner Falcon (*Falco lanarius*), captured at sea, purchased; a Hybrid Luhdorf's Deer (between *Cervus luehdorfi* ♂ and *C. canadensis* ♀), a Hybrid Mesopotamian Deer (between *Dama mesopotamica* ♂ and *D. vulgaris* ♀), a Red Deer (*Cervus elaphus* ♀), four Australian Wild Ducks (*Anas superciliosa*), a Mandarin Duck (*Aix galericulata*), bred in the Gardens.

ZOOLOGICAL NOMENCLATURE[1]

II.

DR. COUES said that he was much gratified at the interest shown in the subject of zoological nomenclature, and indorsed the words of the Chairman that names were of the greatest possible consequence. Nomenclature was a necessary evil, and the point was always to employ that method of naming objects which should most clearly reflect not only the characters of the objects themselves, but our ideas respecting those characters and the view we take of them. As to what constitutes a species, there had been an absolute revolution in the definition of a species since the time of Linnæus, the opinion having been long held that every species was a distinct and individual creation. But that idea had passed out of existence in the minds of most natural historians of the present day, who accepted a general theory of the evolution of species by a gradual modification. That being the case, it was idle to inquire "What is a species?" no such thing existing any more than a genus; and so intimately related were all forms of animal and vegetable life that, if they were all before us, no naming would be possible, for each would be found to be connected completely with another; therefore the possibility of naming any species was, as it were, the gauge and test of our ignorance. Having thus touched very briefly upon the subject of missing links, which alone enable us to name objects which still exist, Dr. Coues proceeded to inquire, "What of so-called species the connecting links between which are still before our eyes?" In illustration of this he would cite some instances of connecting links which exist between certain forms. He then referred to the case of one of the best-known Woodpeckers in North America (*Picus villosus*), and discussed its climatal and geographical variation. He was of opinion that all these geographical races were indistinctly separable forms, and he would indicate them by trinomial names, proceeding upon the definite principle of geographical variation according to conditions of environment, meaning by this all the external influences which modify the plastic organism. Moisture, the humidity of the atmosphere, appeared to have the greatest effect, particularly in regard to colour. Latitude, with its varying degrees of heat, determined size more than any other influence. As a matter of fact this condition of things was found to occur, and the question was, How should we recognise it in our language? Specification had ceased to be of use, and the question was whether the system in favour in America was sufficient or insufficient to meet the case. On these points he would be glad to hear opinions; and in concluding he would read a paragraph from the new edition of the "Key to North American Birds," giving formally the rule for the employment of trinomials as now in use by American ornithologists and many other zoologists of the United States. This rule is as follows:—

"No infallible rule can be laid down for determining what shall be held to be a species, what a con-species, sub-species, or variety. It is a matter of tact and experience, like the appreciation of the value of any other group in zoology. There is, however, a convention upon the subject, which the present workers in ornithology in this country (America) find available—at any rate, we have no better rule to go by. We treat as 'specific' any form, however little different from the next, that we do not know or believe to intergrade with that next one;—between which and the next one no intermediate equivocal specimens are forthcoming, and none, consequently, are supposed to exist. This is to imply that the differentiation is accomplished, the links are lost, and the characters actually become 'specific.' We treat as varietal of each other any forms, however different in their extreme manifestation, which we know to intergrade, having the intermediate specimens before us, or which we believe with any good reason do intergrade. If the links still exist, the differentiation is still incomplete, and the characters are not specific, but only varietal, in the literal sense of these terms. In the latter case, the oldest name is retained as the specific one, and to it is appended the varietal designation."[1]

Dr. Günther, F.R.S., said that during the whole of this discussion it appeared to him that this new movement was in fact a reaction. It had always appeared to him that ornithologists went too far in attaching to the slightest modification of colour the rank of a species; and when he looked over the list of species of a genus well known to him, he found there a number of different forms distinguished for very different reasons, and could not help being struck by the great diversity of value which was attached to the distinctive characters of these various forms. There was nothing to show that there was any system in distinguishing and naming the species of birds. He looked with favour on the method proposed by Dr. Coues and his compatriots. It was a system he had himself employed occasionally in his systematic writings since 1866, and Dr. Coues would find that in some cases he had adopted it pure and simple. He (Dr. Günther) had been disappointed in looking over the new edition of Dr. Coues' "Key to North American Birds," for he found there that Dr. Coues adopted trinomials in some cases and binomials in others. He maintained that logically one ought to adopt the trinomial nomenclature for all other forms, and keep the binomial only for that category in which these varieties may be contained. If Dr. Coues and those who were with him adopted that system, he for one would gladly employ it in all those cases in which the geographical range of certain forms is clearly ascertained.

Dr. Sclater, F.R.S., would remind Dr. Coues that this mode of designating the forms of animal life was by no means a new one, as might be seen on reference to Schlegel's "Revue Critique," published in 1844. He thought the only difficulty lay in the extent to which it was likely to be carried out. Dr. Coues, in his preface to the new "Key to the Birds of America" had hinted at this difficulty. If too much stress were laid upon the value of trinomialism we should open the flood-gates to an avalanche of new names by naturalists who have not taken enough trouble to investigate the matter under consideration. The time had now come when it would be advisable to a certain extent to use trinomials. He could not at all agree with Dr. Coues when he said that no such thing as species exists, for forms were known which had all the characters of well-marked species. It was only in cases where faunæ had been fully worked out that trinomial names would come into use, and for such forms he was quite prepared to adopt the system.

Mr. Blanford, F.R.S., said that he would add one word to the discussion, as nobody else had taken up the one or two points which might be advanced in opposition to the proposed system. He thought the movement an unfortunate one, for the reason that it would certainly have the effect of rendering nomenclature in general less certain than it was before. An equation containing three variables was much more complicated than one in which there were only two, and when one had three names any one of which was liable to be changed to suit personal views the fixture of nomenclature would be even further off than it is now. Then the case of ornithology was not nearly, in point of fact, so complicated as some other classes, as, for instance, in the Mollusca. Trinomial nomenclature had been proposed to,

[1] Continued from p. 259.

[1] A more formal and elaborate presentation of Dr. Coues' views may be found in the *Zoologist* for July, 1884, p. 241, being the verbatim report of the address delivered before the National Academy of Sciences at Washington U.S.A., in April last.—ED.

but almost universally rejected by, a meeting of geologists. He did not consider that the time had arrived for any innovation, and thought it desirable first to agree upon strict rules of zoological nomenclature.

Prof. Bell agreed with Mr. Blanford that the method would not be universally applicable. How could it be applied for instance to cases where varieties were found living with one another, as was often the case with littoral forms with free-swimming embryos?

Mr. W. F. Kirby said that it was necessary to distinguish sub-species and varieties at times, and there seemed to be only two courses open to us, either to retain the binomial nomenclature, and to treat sub species, so far as nomenclature was concerned, as equivalent to species, or to retain varietal names. Still it was difficult to lay down hard and fast rules, applicable to all cases; and he feared that the system of naming varieties was liable to great abuse, especially in entomology, where the number of species is already so great. Thus we have 100,000 species of *Coleoptera* on our lists; and one of the most variable families is that of the *Coccinellidæ*, in which some entomologists have lately begun to name mere colour varieties of single species by twenty and thirty at a time. Mr. Kirby thought, too, that, whenever a named form previously regarded as a variety was held by a later author to be worthy of specific rank, the varietal name should, wherever practicable, always be retained for the species, instead of a new one being imposed. He knew that this was not always adhered to, but in his own work he made it an invariable rule.

Lord Walsingham said that, as Dr. Coues suggested that the trinomial system should be used only in distinguishing gradations, he would instance two species very common in England, small species of the genus *Teras* (*Teras hastiana* and *Teras cristana*). These exhibited a very extensive series of individual variations, but some varieties, although perhaps reared from the same brood of larvæ, showed marked differences not distinctly connected by intermediate gradations with other forms of colouring. He asked how the method was to be applied to these if indeed it was intended to be applied at all to such cases. He himself knew several cases in North America in which variation, according to latitude, is very marked. You get a form in Vancouver Island gradually merging into the form in California, and in Mexico something apparently distinct if taken by itself, and probably only an extreme variety in colour and markings, but you have no form for the South of California. Would it be proposed to treat this Mexican form as a proper subject for the trinomial system or to give it only two names as at present? The principle appears to be right provided it facilitates the recognition of the forms we are naming. He hoped there was no danger of drifting into the inconvenient multiplication of names too commonly known in the catalogues of professional horticulturists.

Dr. Sharp said that whatever names we gave to morphological forms of less than specific value, whether we called them varieties, or sub-species, or morphological forms, we could not define or limit them; and if we attempted to name them, as no line could be drawn, we must go on till we gave a separate name to every individual that had passed through the hands of zoologists. He considered Dr. Coues' system of a third name unnecessary, because all the purposes it sought to attain could be accomplished without it by the old-fashioned system of "var. *a*, var. *b*," and so on. The adoption of a system of names for forms lower than species he thought would lead to complete chaos.

Dr. Woodward, F.R.S., said he might mention two cases which occurred to him in which perhaps the system would be convenient. It was considered desirable by many palæontologists that the group of Ammonites should be broken up into a number of genera, and he thought the present plan of erecting specific names into generic ones was inconvenient. The student was already hampered with too many names, and we ought to remember that students were harder worked now than they were twenty-five years ago. The system of cramming he considered deteriorating to the stamina of the future naturalist. Every time a group was broken up into genera, sub-genera, species, and sub-species, the labour of the student was increased. Therefore it appeared to him that the use of a third term following the generic and specific one, as proposed, was very convenient if not insisted on as a matter of instruction.

Mr. H. T. Wharton would prefer not to see other names troduced unless they were absolutely necessary. But when ell-marked intermediate forms had to be dealt with he admitted the value of the trinomial system, but of course Dr. Coues knew that the method advocated by him was not new to naturalists, for trinomial names were to be found in botanical catalogues. He should be glad to know how it was proposed to deal with such a form as *Corvus cornix*, for example, which in the new edition of Yarrell's "British Birds" had been united with *Corvus corone*.

Mr. H. Saunders said he would like to direct attention to a practical point of the question. Most of those present were aware that there was an unpretending annual called the *Zoological Record*, which consisted now of about 800 pages, and that if trinomialism were adopted, it would make the volume of too great a size. He would also remind those present that Mr. Sharpe was the recorder of Aves, and he did not know how that gentleman would relish the additional labour which would be thrown upon him if this system were generally adopted.

Dr. Traquair said:—I think I quite understand the scope and limits of the system so ably advocated by Dr. Coues, but I feel convinced that were any such system to receive the authoritative sanction of naturalists, these limits would not be observed by the ordinary crowd of name manufacturers. My own studies in recent zoology have been more especially of an anatomical and morphological character, but in the subject of fossil ichthyology I have been brought face to face with the question of the definition and naming of species. Here I conceive that the "species" must include all those forms which can be indubitably shown to graduate into each other. For such species, the only idea of a species which seems to me practicable, one generic and one specific name are quite enough, and I would leave each author to deal with "sub-species" and varieties as he pleased, but without permitting him to apply any *authoritative* name to such. So great, in many cases, is the amount of variation observed in fossil fishes and fish remains, and so difficult is it also to arrive at safe conclusions as to specific identity or distinction with the material before us, that, were the proposed system of trinomial nomenclature to receive the authoritative sanction of naturalists, I am convinced that in this department the flood-gates would simply be opened for a deluge of new names, from people whose sole function in life seems to be to invent such on the most trifling pretext. If the binomial system is at present often abused by such people for the creation of "species" which have no existence, save in their own imaginations, what might we not expect them to do if the adoption of a trinomial system afforded them further scope for their faculties!

Mr. J. E. Harting said if he could be satisfied that the introduction of a system of trinomial nomenclature, as proposed, would be of any real benefit to science, he should have no hesitation in adopting it. But, so far from any advantage resulting from it, he feared that a positive disadvantage would accrue from its adoption in a way which had not been sufficiently considered. The tendency to describe as new species mere individual variations had already (with certain specialists at least) become very p evalent, and had led to an expression of regret and dissatisfaction amongst those who were content to take a broader view of things, and who regarded such a process of refining as tending to perplex, while in no way advancing science. All workers in zoology found themselves sooner or later in one of two classes, which had been named, expressively, if not elegantly, "lumpers" and "splitters." Now, if the proposed system of trinomial nomenclature were to be adopted, the former class would have either to surrender at discretion to the latter, or a wider gap than ever would be created between them, a result which would surely lead to great inconvenience; while the latter, who had already gone to great lengths in what he had termed the process of refining, would receive fresh encouragement to go to still greater lengths in that direction, to the disadvantage, as he conceived, of those who were to come after them. We had been told by the advocates of the trinomial system that it was impossible not to recognise climatic variations in any given species when they were found to be constant and well marked. In this he agreed: he only dissented from them in regard to the mode by which such recognition was to be effected. To say that the only mode of recognising such variations was to add a third name to the generic and specific names was begging the question. If any such variation as that alluded to was sufficiently well marked to distinguish it at once from the species of which it was said to be a variety, he would prefer to regard it as an allied species, and bestow on it a specific name, retaining a binomial nomenclature. The binomial system had been found to work well enough in practice, from its simplicity; and it was

surely simpler to write *Turdus propinquus* than *Turdus migratorius propinquus*. After all, nomenclature was not science, and even if we had the most perfect system of nomenclature which could be devised, he did not see how science would be thereby advanced. It is true we could not get on without nomenclature, but the simpler it was the better; and the less time we spent in discussing it the more we should have to devote to real study.

Dr. Coues, replying to previous speakers, said that the system of trinomial nomenclature had nothing whatever to do with individual variations of specimens from one locality. It was not a question of naming varieties or hybrids, but there was a definite principle to proceed upon, namely, that of geographical and climatal variation. He was well aware that the use of three names to designate objects in zoology was no new thing; but he believed that the restricted application of trinomialism to the particular class of cases he had discussed was virtually novel, and that his system would prove to be one of great practical utility. He thought that the application of the principle was a question which, after this discussion, and after further private discussions, might well be left to the discretion of authors.

The Chairman concluded the meeting by saying:—I hope that Dr. Elliott Coues is satisfied with the manner with which his views have been received. Although there are some uncompromising binomialists present, many have pronounced themselves as what may be termed limited trinomialists, and some appear to go as far as Dr. Coues himself. Distinctly defined species undoubtedly exist in great numbers, owing to extinction of intermediate forms; for these the binomial system offers all that is needed in defining them. But on the other hand there are numbers of cases in the actual state of the earth, and far more are being constantly revealed by the discoveries of palæontology, and nowhere so rapidly as in Dr. Coues' own country, where the infinite gradations defy the discrimination either of a binomial or a trinomial system. Zoologists engaged in the question of nomenclature are being gradually brought face to face with an enormous difficulty in consequence of the discovery of these intermediate forms, and some far more radical change than that now proposed will have to be considered. In conclusion I must express the thanks of the meeting to Dr. Coues for having brought his views and those of his countrymen, of whom he is such a worthy representative, before us, and also to Mr. Bowdler Sharpe, to whose zeal and energy the organisation of the meeting is entirely due.

A unanimous vote of thanks was given to Prof. Flower for presiding.

KRAKATOA

AT the meeting of the Meteorological Society of Mauritius on May 22 some interesting communications were made relating to the Krakatoa eruption. Among others was a letter from M. Lecomte regarding detonations heard at Diego Garcia on August 27. In his letter, which was written at Diego Garcia on April 24, M. Lecomte says:—"Le lundi 27 août entre 10 et 11 heures du matin, pendant le déjeûner, nous avons entendu des détonations sourdes mais violentes. Nous avons cru tellement à l'appel d'un navire en détresse que nous avons couru et que j'ai envoyé plusieurs hommes vers le rivage extérieur de l'île sur plusieurs points différents, en observation. Le Capitaine Florentin de l'*Eva Joshua* et son second, M. Daniel Sauv. ge, venaient de quitter Pointe de l'Est pour aller mouiller à Pointe Marianne, lorsqu'ils ont entendu les mêmes détonations. Ils ont aussitôt envoyé des hommes en observation à l'extrémité des mâts. Mais comme les miens ils n'ont rien vu.

"Ce jour là et les jours suivants le soleil était comme obscurci, probablement par la formidable quantité de vapeurs et de cendres qui ont du s'élever dans l'atmosphère."

The information obligingly furnished by M. Lecomte was valuable, inasmuch as, taken in conjunction with the reports which had been received from Rodrigues, it confirmed verbal information which had been previously obtained. There could now be no doubt that the explosions which took place at Krakatoa were distinctly heard both at Diego Garcia and Rodrigues, and there was probably no other recorded instance of sound having travelled over so great a distance. The fact, also, that at Diego Garcia the sun was partially obscured on August 27 and on several subsequent days, as well as at the Seychelles and Rodrigues, was an additional proof of the great quantity of matter which must have been ejected from Krakatoa, and of the rapidity with which it was conveyed from its source. There could be no reasonable doubt that the presence of that matter in the atmosphere was the cause of at least the lurid sunsets and sunrises which were observed over the Indian Ocean on the last days of August and in the first week of September.

The Secretary, Dr. Meldrum, stated that the Royal Society of London had appointed a Committee to collect information regarding the phenomena which had been observed during and after the volcanic eruptions that took place at Krakatoa in August, and requests had been received from that and other quarters for information from Mauritius. To these requests the Secretary had replied that he was preparing for his Excellency the Governor a detailed account of what had been observed at Mauritius and several of its dependencies, but that owing to the almost daily reception of additional details his report was not yet ready. All he did, therefore, was to give the general results as far as they had been determined.

Several remarkable phenomena had to be described. In the first place, there were disturbances of the sea water, or, as they had been called by some, tidal disturbances, and these had been observed all over the Indian Ocean.

There were also barometric disturbances, to which attention had first of all been called in Mauritius early in September, and which at the time were ascribed to the explosions at Krakatoa. Some time afterwards it was ascertained in England that these disturbances had extended over the whole globe and that they were recorded by all self-registering barometers in both hemispheres. At Mauritius there were at least seven well-marked disturbances of which the epochs of *maximum intensity* were as follows:—

		h. m.		
(1)	August 27,	0.6	p.m.	local time.
(2)	,, 28,	2.20	p.m.	,,
(3)	,, 28,	10.40	p.m.	,,
(4)	,, 30,	1.35	a.m.	,,
(5)	,, 30,	9.17	a.m.	,,
(6)	,, 31,	1.48	p.m.	,,
(7)	,, 31,	8.00	p.m.	,,

At first these disturbances were supposed in Mauritius to have been due to successive eruptions, but General Strachey, who examined a number of barographs received from different parts of the world, had recently adduced evidence to show that they were produced by an air-wave proceeding outwards from Krakatoa in all directions round the earth, expanding till it was half round, then contracting till it reached the antipodes of its origin, and afterwards returning, the wave thus travelling round the globe two or three times. Assuming that view, the first disturbance at Mauritius (which was at its maximum at 0h. 6m. p.m. on the 27th) would be caused by the passage over the Observatory of the wave travelling from east to west; and the third, fifth, and seventh disturbances would be returns of the wave to Mauritius after having gone round the earth. Similarly the second disturbance would be the first passage of the wave travelling from Krakatoa eastward, and the fourth and sixth would be its returns to Mauritius. Now, the mean interval in time between the returns of the wave to Mauritius, in its passage from east to west, was 24h. 38m., and in its passage from west to east 35h. 44m. It would thus appear that the rate of progression had been greater from east to west than from west to east, which may have been partly or wholly due to the great circle passing through Krakatoa and Mauritius being within the tropics, where the prevailing wind was from the eastward. The rate of progression from east to west was very nearly 709 miles an hour, and from west to east 697 miles. By taking as nearly as possible the times half way between the commencements and endings of the disturbances similar results were obtained. There was also an *eighth* (but small) disturbance between 7 and 9 a.m. on September 2, which may have been the fourth return of the wave from east to west, the interval in time between that disturbance and the seventh having been nearly thirty six hours. The sixth disturbance was the last indication of the wave in its passage from west to east.

Another effect of the Krakatoa eruptions was the spread of ashes and pumice over considerable portions of the Indian Ocean, and a good deal of information on that point also had been collected in Mauritius. The first intimation of the probability of volcanic action in the direction of the Straits of Sunda was contained in a letter published by Capt. Walker, of the *Actæa* in the *Mercantile Record* of June 16, 1883. At noon on

May 20 the *Actæa* was in 6° 50′ S. and 104° 2′ E., and on the morning of that day a "peculiar light green colour" was observed in the sky to the east-south-east, while "from east to east-north-east there was a dark blue cloud, which reached from the horizon to the zenith." "About 2 p.m. it was quite dark. What appeared to be a rain squall rose up from the east, but, instead of rain, a kind of very fine dust commenced to fall, and very soon everything was covered; ships, sails, rigging and men were all dust colour; nothing could be seen 100 yards off. The fall continued steadily all night, and stopped about 9 a.m. on Monday the 21st. When we saw the sun it looked like dull silver. At noon we were in lat. 8° 15′ S. and long. 102° 28′ E., distant from Java Heads about 170 miles. The sky all round remained a dusty hue, and small quantities of dust again fell during the night. The sky did not assume a natural appearance till the 23rd." At a meeting of this Society held on July 12, the Secretary called attention to Capt. Walker's letter, and said there was little doubt that the dust in question had come from Krakatoa, as, according to a note in NATURE of June 7, a volcano in that island was in full eruption. From that time accounts of pumice and ashes observed in the Indian Ocean had been extracted from log-books, and they showed that on several occasions vessels had passed through fields of pumice long before the great eruptions of August 26 and 27. After that month the reports became more frequent, and they still continued, the latest being from the vicinity and shores of Mauritius, where, since the middle of February, large quantities of pumice had been seen. It would appear, however, that fields of pumice had passed Mauritius long before February, for "a large quantity of pumice-stone and lava was washed up on the beach at Durban (Natal) on October 23." According to the reports received, fields or lanes of pumice had been observed in different parts of the Ocean from 105° to 48° E. and 6° to 12° S. Farther south the extent in longitude had been apparently less.

That the remarkable sunrises and sunsets which had been observed over a great part of the world after August 27 were due to matter ejected from Krakatoa seemed to be generally admitted. The few who objected to the volcanic dust theory had not proposed any other theory that so completely accounted for the facts. The presence of vapours and finely-divided dust at certain elevations would, as a consequence of known physical laws, produce all the chromatic effects that had been seen and described, and it was known that immense quantities of matter had been shot up from Krakatoa. Similar phenomena had been witnessed by observers between whom and the sun volcanic dust passed, as on the occasion of an eruption of Cotopaxi a few years ago. But it was not necessary to go so far back. From May 20 to 22 last, after an eruption of Krakatoa, Captain Walker, as already stated, observed that to the east-south-east the sky was of a light green colour, that on the 21st the sun looked like dull silver, that the sky all round was of a dusty hue, and that it did not assume its natural appearance till the 23rd. That was perhaps the earliest instance of the chromatic effects of the Krakatoa dust and vapours. Immediately after the eruptions of August 27 they were more intense and on a greater scale. At the Seychelles on the 27th the sky, according to Mr. Estridge, was hazy all day. The sunset on that day was gorgeous; the sky was lurid all over, and beams of red light stretched from over St. Anne's to nearly the horizon. At sunset on the 28th the sun looked as it did through a fog on a frosty day in England. On the morning of the 29th the sun at 7 a.m. was more like a full moon than anything else. According to other letters from the Seychelles the sun for a whole week appeared dim. At Rodrigues, according to Mr. Wallis, whose report was written on August 31, the sky at north-west on every evening since the 27th had a very threatening and strange appearance of a deep purplish red colour, which lasted till 7.15 p.m., and which, with the disturbances of the sea water, caused much fear and excitement. Similar phenomena were observed on the same evenings at Diego Garcia and St. Brandon, and for several days the sun looked as if partially obscured. At Mauritius the sky was overcast throughout the whole of the 27th, and it was observed and noted at the time that there was an unusual dimness. On the evening of the 28th there was a gorgeous sunset, the first of a long series of remarkable colorations and glows, which had already been described. Observations of these optical phenomena had been taken daily during nearly the last nine months whenever the weather permitted. Knowing what had been observed on board of the *Actæa*, and that Krakatoa had been in eruption, these extraordinary sunsets and sunrises were attributed to the presence in the upper strata of the air of finely-divided matter, and probably gases and vapours, from Krakatoa, and subsequent events confirmed that opinion. It was difficult to explain phenomena which had been identical under all conditions of weather, and in many distant places, by any purely meteorological causes. To the meteoric dust theory it might be objected that it was purely an hypothesis almost, if not wholly, unsupported by facts. No unusual number of meteors had been seen. No extraordinary glows had been observed at or near the times of the great meteoric showers of November 1866, and November 1872. Moreover one would suppose that if the earth had for months been passing through volumes of meteoric dust the chromatic effects would have appeared simultaneously wherever the sun rose and set. But such had not been the case. Upon the whole there seemed to be a preponderance of evidence in favour of the volcanic dust theory. The objection that the quantity of matter was insufficient was not a formidable one, for the effects did not depend merely upon the quantity of matter that had reached the higher regions, but also upon its form and degree of tenuity. A few pounds of matter might be spread over thousands of square miles. As to the objection that it was difficult to conceive how even finely-divided matter could remain so long in suspension, it might be remarked that, independently of the possibility of the particles being electrified, the lower strata of the atmosphere might be denser than the foreign matter in the upper strata. The extraordinary sunsets and sunrises which were observed in 1783-84, and which Arago and others ascribed to volcanic dust, were said to have lasted eleven months. Those of 1883-84 would probably last fully as long. Within the last few weeks there had been at Mauritius a considerable increase in the intensity and duration of the glows.

EVIDENCES OF THE EXISTENCE OF LIGHT AT GREAT DEPTHS IN THE SEA[1]

THE evidences of the presence of light and its quality and source at great depths are of much interest. At present very little experimental knowledge in regard to these questions is available. That light of some kind, and in considerable amount, actually exists at depths below 2000 fathoms, may be regarded as certain. This is shown by the presence of well-developed eyes in most of the fishes, all of the cephalopods, most of the decapod Crustacea, and in some species of other groups. In many of these animals, living in 2000 to 3000 fathoms, and even deeper than that, the eyes are relatively larger than in the allied shallow-water species; in others the eyes differ little, if any, in size and appearance, from the eyes of corresponding shallow-water forms; in certain other cases, especially among the lower tribes, the eyes are either rudimentary or wanting in groups of which the shallow-water representatives have eyes of some sort. This last condition is notable among the deep-water gastropods, which are mostly blind; but many of these are probably burrowing species; and it may be that the prevalent extreme softness of the ooze of the bottom, and the general burrowing habits, are connected directly with the habits or rudimentary condition of the eyes in many species belonging to different classes, including Crustacea and fishes. Such blind species usually have highly developed tactile organs to compensate for lack of vision.

Other important facts bearing directly, not only on the *existence*, but on the *quality*, of the light, are those connected with the coloration of the deep-sea species. In general, it may be said that a large proportion of the deep-sea animals are highly *coloured*, and that their colours are certainly *protective*. Certain species, belonging to different groups, have pale colours, or are translucent, while many agree in colour with the mud and ooze of the bottom; but some, especially among the fishes, are very dark, or even almost black; most of these are probably instances of adaptations for protection from enemies, or concealment from prey. But more striking instances are to be found among the numerous brightly-coloured species belonging to the echinoderms, decapod Crustacea, cephalopods, annelids, and Anthozoa. In all these groups, species occur which are as highly coloured as their shallow-water allies, or even more so. But it is remarkable that in the deep-sea animals the bright colours are almost always shades of orange and orange-red, occasionally brownish red,

[1] From a paper in *Science*, July 4, on "Results of Dredgings in the Gulf Stream Region by the U. S. Fish Commission."

purple, and purplish red. Clear yellow, and all shades of green and blue colours, are rarely, if ever, met with. These facts indicate that the deep sea is illuminated only by the sea-green sunlight that has passed through a vast stratum of water, and therefore lost all the red and orange rays by absorption. The transmitted rays of light could not be reflected by the animals referred to, and therefore they would be rendered invisible. Their bright colours can only become visible when they are brought up into the white sunlight. These bright colours are therefore just as much protective as the dull and black colours of other species.

The deep-sea star-fishes are nearly all orange, orange-red, or scarlet, even down to three thousand fathoms. The larger ophiurans are generally orange, orange-yellow, or yellowish white, the burrowing forms being usually whitish or mud-coloured, while the numerous species that live clinging to the branches of gorgonians and to the stems of Pennatulacea are generally orange, scarlet, or red, like the corals to which they cling. Among such species are *Astrochele lymani*, abundant on the bushy orange gorgonian coral, *Acanella normani*, often in company with several other orange ophiurans belonging to Ophiacantha, &c. *Astronyx loveni* and other species are common on Pennatulacea, and agree very perfectly in colour with them. These, and numerous others that might be named, are instances of the special adaptations of colours and habits of commensals for the benefit of one or both. Many of the large and very abundant Actiniæ, or sea-anemones, are bright orange, red, scarlet, or rosy in their colours, and are often elegantly varied and striped, quite as brilliantly as the shallow-water forms; and the same is true of the large and elegant cup-corals, *Flabellum goodei*, *F. angulare*, and *Caryophyllia communis*,—all of which are strictly deep-sea species, and have bright orange and red animals when living. The gorgonian corals of many species, and the numerous sea-pens and sea-feathers (Pennatulacea), which are large and abundant in the deep sea, are nearly all bright coloured when living, and either orange or red. All these Anthozoa are furnished with powerful stinging organs for offence and defence; so that their colours cannot well be for mere protection against enemies, for even the most ravenous fishes seldom disturb them. It is probable, therefore, that their invisible colours may be of use by concealing them from their prey, which must actually come in contact with these nearly stationary animals in order to be caught. But there is a large species of scale-covered annelid (*Polynoë aurantiaca*, Verr.) which lives habitually as a commensal on *Bolocera tuediæ*, a very large orange or red actinian, with unusually powerful stinging organs. Doubtless the worm finds, on this account, perfect protection against fishes and other enemies. This annelid is of the same intense orange colour as its actinian host. Such a colour is very unusual among annelids of this group, and in this case we must regard it as evidently protective and adaptive in a very complex manner.

It has been urged by several writers, that the light in the deep sea is derived from the phosphorescence of the animals themselves. It is true that many of the deep-sea Anthozoa, hydroids, ophiurans, and fishes are phosphorescent; and very likely this property is possessed by members of other groups in which it has not been observed. But, so far as known, phosphorescence is chiefly developed in consequence of nervous excitement or irritation, and is evidently chiefly of use as a means of defence against enemies. It is possessed by so many Anthozoa and acalephs which have, at the same time, stinging organs, that it would seem as if fishes had learned to instinctively avoid all phosphorescent animals. Consequently it has become possible for animals otherwise defenceless to obtain protection by acquiring this property. It is well known to fishermen that fishes avoid nets, and cannot be caught in them, if phosphorescent jelly-fishes become entangled in the meshes; therefore it can hardly be possible that there can be an amount of phosphorescent light, regularly and constantly evolved by the few deep-sea animals having this power, sufficient to cause any general illumination, or powerful enough to have influenced, over the whole ocean, the evolution of complex eyes, brilliant and complex protective colours, and complex commensal adaptations.

It seems to me probable that more or less sunlight does actually penetrate to the greatest depths of the ocean in the form of a soft sea-green light, perhaps at two thousand to three thousand fathoms equal in intensity to our partially moonlight nights, and possibly at the greatest depths equal only to starlight. It must be remembered that in the deep sea, far from land, the water is far more transparent than near the coast. A. E. VERRILL

ARTIFICIAL LIGHTING[1]

IN early times but a small fraction of our forefathers' lives was spent under artificial light. They rose with the sun and lay down to rest shortly after sunset. During the long winter evenings they sat round the fire telling stories and singing songs of love and war; the fire-light was sufficient for them, except occasionally during grand feasts and carousals, when their halls were lighted by pine-wood torches or blazing cressets. But, as a rule, after sunset they lived in semi-darkness.

From that early period, as man has advanced in civilisation, in the thirst for knowledge derived from books, and in following the gentler pursuits which demand an indoor life, there has been a steady increase in that fraction of our lives which is spent under light other than that of the sun. But the improvement in the quality of the artificial light has been very slow. The ruddy lights and picturesque shadows so faithfully handed on to us by Rembrandt's pictures show us very graphically what our poets have called "the dim glimmer of the taper" of those days. A few years before the introduction of gas, Argand, by his improvements in the burners of oil lamps, enabled our fathers to see for the first time a comparatively white light, but as far as the matter we to-day propose to discuss is concerned, viz. the effect of artificial lighting, and more particularly electric lighting, on our health, we need only consider the reign of artificial light as it commenced with the general use of gas and petroleum, for then and only then could it be said to affect our health.

Prior to the introduction of the electric light we have been accustomed to consider every hour spent under artificial light as an hour during which all conditions are less favourable to perfect health than they would be during daylight. Can we now hope to ameliorate this condition of things through the agency of electricity? Before we can discuss this question I must point out to you the chief differences which exist between hours of work or recreation spent in daylight and under artificial light. In the former case we live in abundance of light. The sunlight itself exercises a subtle influence on our bodies; that mixture of heating and chemical rays which when analysed form the solar spectrum, and combined form the pure white light of daylight, is needed to enable all animal and vegetable organisms to flourish in the fullest conditions of healthful life.

In nearly all cases when the sun is up, the functions of life are in the state of fullest activity, and when it sets they sink into comparative repose. In daylight life wakes, in darkness life sleeps. In addition to the abundance of pure white light, the heat attending is only that necessary for health. The air remains unvitiated, except by our own breathing. On the other hand, when working under artificial light, we have these conditions all altered in degree:

1. We have an insufficient light; a scale of lighting by gas or by electricity which would be pronounced excessive at night-time is still far inferior to average daylight.

2. All artificial lights, whether produced by combustion, as in the case of candles, oil, gas, and petroleum, or by the incandescence of a conductor by the means of electricity, produce heat; this heat, in proportion with the light afforded, is enormously in excess of the heat given by sunlight. Electricity, as you will see hereafter, is far the best in this respect, but even it is inferior to sunlight.

3. All these same illuminants, excepting electricity, contaminate the air and load it with carbonic acid, sulphur, and other compounds—all injurious to the health and to the general comfort of the body. It will be convenient to consider the effects—first, on our health generally; second, on our eyesight in particular. I have already called your attention to the fact that that proportion of coloured rays which, when combined, form white sunlight, is that best suited to healthy life. It is necessary too to that sufficient and proper stimulus to the organic changes which go on in our bodies, and which we call a state of good health. The various artificial lights differ very widely from sunlight in this respect, that they are all more or less deficient in the rays at the violet end of the spectrum, commonly called the actinic rays, and which most probably exercise a very powerful effect on the system. It is the want of a due portion of these violet rays which makes all artificial light so yellow. Even the light of the electric arc, which is richer in these rays than any other, is still on the yellow side of sunlight. The incandescent electric light is next best in this respect; next in order come gas, petroleum, and the various oil lamps. No doubt some of you will

[1] Lecture delivered at the Health Exhibition by Mr. R. E. B. Crompton

challenge my statement that the electric arc is yellow. It has always been called a cold blue light. It is not so; it is only by comparison with the yellower light of gas or with the incandescent lamps that it appears blue; when compared with the sunlight reflected from a white cloud it will be seen to be distinctly yellow in tinge; but still both classes of electric light are far superior to all others in nearest approaching the white light of daylight, and thus satisfying the actinic action which our bodies demand.

Turning now to the comparative heating and air-vitiating properties of artificial lights which we shall find it convenient to take together, I have here a table (Table A) prepared by Dr.

TABLE A.—*Showing the Oxygen consumed, the Carbonic Acid produced, and the Air vitiated, by the Combustion of certain Bodies burnt so as to give the Light of* 12 *Standard Sperm Candles, each Candle burning at the rate of* 120 *grains per hour*

Burnt to give light of 12 candles, equal to 120 grains per hour	Cubic feet of oxygen consumed	Cubic feet of air consumed	Cubic feet of carbonic acid produced	Cubic feet of air vitiated	Heat produced in lbs. of water raised to° F.
Cannel Gas	3·30	16·50	2·01	217·50	195·0
Common Gas..	5·45	17·25	3·21	348·25	278·6
Sperm Oil.....	4·75	23·75	3·33	356·75	233·5
Benzole	4·46	22·30	3·54	376·30	232·6
Paraffin.....	6·81	34·05	4·50	484·05	361·9
Camphine	6·65	33·25	4·77	510·25	325·1
Sperm Candles	7·57	37·85	5·77	614·85	351·7
Wax.....	8·41	42·05	5·90	632·25	383·1
Stearic....	8·82	44·10	6·25	669·10	374·7
Tallow.....	12·00	60·00	8·73	933·00	505·4
Electric Light.	none	none	none	none	13·8

Meymott Tidy, which shows the oxygen consumed, the carbonic acid produced, the air vitiated, and the heat produced by the combustion of certain bodies burned so as to give the light of twelve standard candles, to which Mr. R. Hammond has added the heat produced by a 12-candle incandescent electric lamp. From these figures you will see that the air of a room lighted by gas is heated twenty times as much as if it were lighted to an equal extent by incandescent electric lamps. When arc lamps are used, the comparison is still more in favour of electricity. You will be surprised to see from the table that our old friend the tallow candle, and even the wax candle, is far worse than gas in the proportion of air vitiated and heat produced, and you will be disposed to disbelieve it; but the fact is, that so long as candles were used light was so expensive that we were obliged to be content with little of it; in fact we lived in a state of semi-darkness, and in this way we evaded the trouble. It is only since the general introduction of gas and petroleum that we have found what an evil it is.

It is not unusual, in fact it is almost invariable, for us to find the upper stratum of air of the rooms in which we live heated to 120° after the gas has been lighted for a few hours. We have grown accustomed to this state of things, and are not surprised that when we take the library ladder to get a book from the upper shelf we find our head and shoulders plunged into a temperature like that of a furnace, producing giddiness and general malaise. If you look again at the table you will see that each gas burner that we use consumes more oxygen and gives off more carbonic acid, and otherwise unfits more air for breathing, than one human being, and it is this excessive heating and air vitiation combined which are the main causes of the injury to the health from working long hours in artificial light. I could go on for a long time giving instances of the fearful state of the atmosphere of our large public buildings as well as of our private homes after the gas has been lighted for a few hours, but this paper is not intended as an onslaught on gas; moreover these ills are so well known to nearly all of you that I need not bring them more prominently before you. I will only take one instance, viz. that of the Birmingham Town Hall, which has been lighted alternately by gas and electricity.

During the grand Birmingham Musical Festival, which was held in that hall two years ago, some careful experiments were made to show how the orchestra and audience in the hall were affected by the two kinds of lighting. The gas lighting was in the form of several huge pendants suspended down the centre of the hall. The electric lighting was in the form of clusters of lights placed on large brackets projecting from the side walls with two central pendants placed between the gas pendants. The candle-power given by the electric light was about 50 per cent. in excess of that given by the gas light; the degree of illumination by electricity was consequently very brilliant.

It was found that when the gas was used the temperature near the ceiling rose from 60° to 100° after three hours' lighting. The heating effect of the gas was, therefore, the same as if 4230 persons had been added to the full audience and orchestra of 3100. Similarly the vitiation of the air by carbonic acid was equal to that given off by the breathing of 3600 additional persons added to the above audience of 3100. But on evenings when the electric light was used the temperature only rose 1½° during a seven hours' trial, and the air, of course, was only vitiated by the breathing of the audience. The further experiment was tried of giving to every member composing the large orchestra a printed paper of questions asking how the new mode of lighting affected him or her personally, and I have here 265 replies to those questions. They are very interesting. I will read a very few of them out to you. From this you will learn that without exception the comfort and general well-being of this large orchestra was increased enormously by the use of the new illuminant, yet it is reasonable to suppose that the comfort of the audience was increased in an equal degree. Now we all of us know that the times when we suffer most from the effect of artificial light is in crowded places of public amusement, which are at the same time brilliantly lighted. Many of us are unable to go to the theatre or to attend evening performances of any kind, as the intense headache which invariably attends through staying a single hour in such places entirely prevents them. This headache we commonly say is inseparable from the heat and glare of the gas. Now this phrase is not strictly correct. It is no doubt due to the heat of the gas and its air-vitiating properties, but when we use the word glare I believe we refer to the effect the gaslight has upon our heads, and which effect is not due to excess of light. On the contrary, I believe if a far greater amount of light be given by the electric light without the heating and air vitiation being present such headache is never produced, although some of the more tender-headed amongst us will at first complain of the glare because they are habituated to associate plenty of light with great heat, great air vitiation, and other evils.

Indeed, so long have we been accustomed to closely associate brilliant artificial light with headache and glare, that we who are introducing electric light are most cautious not to give the full quantity of light which we could afford to give, and which would afford the greatest rest to the eye and greatest bodily comfort. I now come to the effect that light has upon the temperament. If we try the experiment in an assemblage of people of gently decreasing the lighting of the room, it will be found that the spirits of every one will be depressed just as the light is depressed, and, *vice versâ*, their spirits will be raised just as the light is raised. I have many times, when conducting experiments of electric lighting on a large scale, noticed this fact, and I have been led to the conclusion *that during hours of waking every person is benefited by increase of light up to the extent of full sunlight*, providing that this high degree of lighting is not attended by heat and by air vitiation; and I must add that the source of light must not be from one or two brilliant points only, but it must be well regulated and not such as to cause dark, deep shadows.

This leads me on to the subject of the effects on the eyesight of the electric light as compared with other lights. *Healthy eyesight demands a plentiful supply of light. It is the greatest mistake to suppose that a state of semi-darkness is good* for our eyes, unless they are defective, or recovering from the effects of past injury or disease. Whoever saw a painter, engraver, printer, watchmaker, or indeed any one the quality of whose work depends on the excellence of his eyesight, who did not desire a flood of pure white light thrown on to his work. I think I have the authority of oculists when I say that 19-20ths of the diseases of the eyes arise from working the eyesight long hours with insufficient light. Again, another great cause of injury to eyesight is the unsteadiness of most artificial lights. Much improvement has been made in the light of gas during the

last few years by the introduction of argand burners, and globes for the flat gas burners having much larger lower openings, so that the dancing and flickering batswing burner of five years ago is not so common in a good house. Even the steadiest of the modern gas burners is extremely unsteady as compared with the light of the incandescent electric lamp. Those of you who have been to the Savoy Theatre will have noticed the effects of the lights behind the scenes on the scenery itself. The light is so absolutely steady that it is comparable to sunlight. Hitherto I have said nothing as to the comparative excellence of the two forms of electric light, viz. the electric arc and the incandescent lamp. Both have their proper places. The arc light, which is the whitest in colour and most economical to produce, is not so steady as the incandescent lamp. It is therefore unsuitable for indoor use or for reading by, or for such occupations as require the maximum of steadiness. But it is well suited for the lighting of large buildings and public places. I am unaware if any experiments have been made as to the effects of brilliant arc lighting on the eyesight of men who have to work night shifts, as although the opinion of the workmen who have to work under it is unanimous in its favour, yet that opinion is more based on their personal comfort, due to their being able to carry on their work with facility almost equal to that given by daylight. The large sorting rooms at the General Post Office at Glasgow have been for a long time lighted by the arc light, and with a most beneficial result to the health and eyesight of the letter-sorters and telegraph clerks. The former occupation is one which tries the eyesight very severely. The public generally does not know how the habit of writing the addresses on envelopes with pale ink and blotting it off rapidly before it has time to darken tries the eyesight of the Post Office letter-sorters. So long as gas is used, a powerful burner has to be brought very close to the head of the sorter, and under such conditions the eyesight fails at an early age. At Glasgow Post Office I am able to boast that by the introduction of the electric light I enabled many of the more aged sorters who were commencing to use spectacles to do without them—and even I put back the clock of time in enabling several who had used them for some years to disclaim them. I am aware that it has been alleged by the opponents of the electric light, whether interested or otherwise, that in many cases the intensity of the light has injured eyesight. I do not think any such cases can be substantiated. Many of us who are in the habit of experimenting with powerful arc lamps have had our eyelids temporarily affected by incautious exposure at too short a distance. Again, over and over I meet with the complaint that if I stare at an arc lamp for a long time it will make my eyes ache; the obvious retort being, Why should you stare at the light? If you do the same with the sun, you will be equally inconvenienced. Before such an audience as this, which is of course familiar with the beautiful electric lighting in the Health Exhibition itself, it is useless for me to enlarge on the many conditions of the electric light as it indirectly affects health. I may only name the many additional pleasures of the eye we get from its use. Our flowers in our rooms do not fade away, and are seen in their true colours. Our pictures or all coloured objects are seen to better advantage. I may mention one thing which would not generally occur to you, that in London certainly an electric-lighted house can be cleaned properly in winter. You may smile at this, but I assure you that the advantage of being able to turn a flood of light into your drawing-rooms and dining-rooms at six o'clock on a winter's morning, so that the whole of the cleaning can be finished as thoroughly as if done by daylight, before the family comes down to breakfast, is one that must be experienced before it can be thoroughly appreciated. Again, the advantage to the health of our children is simply inestimable. No night-lights, matches left about, or gas turned down low are required. A child of years old can be trusted to press a button and so turn the light off or on; the lamps being high and out of reach are not easily broken or over-turned, and the air of the children's nursery, even if the light be kept burning the night through, remains pure throughout. Another indirect advantage due to the absence of heat is that it is comparatively easy to thoroughly ventilate and cool during the hot weather a room lighted by the electric light. The heat of gas placed high in the room causes such intense draughts when the windows are open that the discomforts and dangers of the draughts are almost worse than the discomfiture from the heat and vitiated air, whereas in an electric-lighted room there is no difficulty in opening wide all the windows, the draughts produced being so gentle as to be hardly felt.

SOCIETIES AND ACADEMIES

LONDON

Physical Society, June 28.—Prof. Guthrie, President, in the chair.—New Member, Mr. W. H. Hensley.—Lord Rayleigh made a communication on the practical use of the silver voltameter for the measurement of an electric current. On a former meeting of the Society the method was explained by the author, but on the present occasion the apparatus was exhibited. The author considers this the best method of determining the strength of current in absolute measure. One ampere deposits 4 grammes of silver in an hour; therefore a quarter to half an hour is sufficient to give 1 or 2 grammes, quantities which can be measured with accuracy. Any current from 1/10 to 4 or 5 amperes can be measured successfully in this way. With very weak currents there is a difficulty in weighing the deposits; with very dense currents the deposit is apt to be irregular. The author deprecates the use of acetate of silver, pure nitrate or pure chlorate of silver giving the best results. The cathode of his apparatus is a platinum bowl, the anode a silver sheet wrapped with clean filter paper sealed over it to keep any loose silver from dropping on the cathode. The anode is immersed in the solution of silver salt; and at the end of several hours (if great accuracy is required) a measurement of the weight of silver deposited is made by weighing the bowl cathode in a chemical balance. Dr. Fleming inquired whether it was not better to weigh the loss of weight suffered by the anode, as is sometimes done. Lord Rayleigh had not found this plan so good, the anode being apt to disintegrate and lose weight, not by true electrolytic action. Prof. Guthrie remarked that with small electrodes peroxide of silver is formed, and that the inferiority of acetate of silver might be due to formation of subacetate.—Lord Rayleigh then made a communication on a colour-mixing apparatus founded on refraction. This apparatus had been described at a former meeting of the British Association, and consists of a double-refracting prism, a lens, dispersing prism, and screen, by which an overlapping of spectra can be obtained, and thus a mixture of colours. In comparing different eyesights with it Lord Rayleigh finds that the majority of persons are more sensitive to red than he himself. In answer to Mr. W. Baily he had not observed any difference between the two eyes of the same person, except what might be due to fatigue and freshness. Dr. Guthrie inquired if the author had discovered any racial characteristics of colour-blindness. Lord Rayleigh had not observed any so far. Dr. Guthrie stated that, though colour-blind to red, he believed he was more than usually sensitive to blue. Dr. Stone and Mr. Stanley referred to known cases of blindness to green, as well as red. Dr. Lodge asked if persons abnormally sensitive to red could see further down the spectrum. Lord Rayleigh believed they could see the spectrum brighter near its limits at all events. Mr. Glazebrook briefly described a modification of Lord Rayleigh's apparatus by which the distance on the spectrum which any one can see could be measured.—Mr. C. V. Boys read a paper on a phenomenon of electro-magnetic induction. Between the poles of an electro-magnet a small disk of copper is hung by a bifilar suspension. If the magnetic field is uniform, and the disk at an angle to the lines of force, then on making the magnet it is jerked parallel with the lines of force. If it is a changing field, and the disk perpendicular to the lines of force, it is repelled on making the magnet and attracted on breaking by the nearest pole. This phenomenon, which was observed by Faraday, was shown by Mr. Boys to be useful for determing the intensity of a magnetic field by measuring the throw of the disk on magnetising and demagnetising. It might also be employed to measure the resistance of bodies in the form of plates, from their diameter, moment of inertia, and observed throw. Any structural difference of resistance in different directions in the body might be determined by its means. Mr. Boys illustrated his remarks with curves of results obtained by experiment. Lord Rayleigh considered that the effect of self-induction on the results was not likely to be serious.—Mr. J. Hopps read a paper on the alteration of electrical resistance in metal wires produced by coiling and uncoiling. His experiments were made with an inclined plane, the angle of which could be varied, and a car, carrying bobbins, which was drawn up or let down the plane by the wires experimented on. It appeared that coiling and uncoiling tends to produce hardness in a wire. Coiling produces an increase of resistance, and uncoiling a decrease in the resistance of a wire.—Mr. R. T. Glazebrook, M.A., F.R.S., read a paper on the determination

in absolute measure of the electrical capacity of a condenser, and on a method of finding by electrical observations the period of a tuning-fork. The paper described experiments conducted according to a method given in "Maxwell," vol. ii. §776, for measuring the capacity of a condenser. Mr. J. J. Thomson showed (*Philosophical Transactions*, 1883, part iii.) that Maxwell's formula is only approximate, and gave the correct formula, which was used in the author's experiments. In these tuning-forks were used of frequencies approximately 16, 32, 64, and 128 to a second, the frequencies being determined by careful comparison with the clock by Lord Rayleigh's method, and the corresponding values found for the capacity were '3336 m.f., '3340 m.f., '3335 m.f., '3337 m.f. The mean is '3337 m.f., and the experiments do not show any variation in the capacity, as the time of changing varies from 1/16 to 1/128 of a second. The condenser was furnished by Messrs. Latimer Clark, Muirhead, and Co. The method also gives a ready and accurate means of determining the pitch of a tuning-fork, for if the capacity of the condenser used is known the frequency (n) can be determined. The author has used the method successfully for this purpose. Lord Rayleigh objected to mercury contacts in such experiments; and Dr. Stone said he had found iron and mercury contacts good.—Prof. Herbert Macleod exhibited a sunshine recorder made by placing a water lens in front of a camera box and lens. Sensitised paper is placed in the bottom of the box so that the focused ray strikes on it, and as the sun moves traces a curved line or band on the paper. Several of these records were shown to the meeting.

Royal Microscopical Society, June 11.—Rev. W. H. Dallinger, F.R.S., President, in the chair.—Prof. Zenger's method of constructing endomersion objectives by using a mixture of ethereal and fatty oils for correcting chromatic aberration was explained and an objective exhibited.—Dr. Wallich exhibited a new condenser which he had devised.—Mr. J. Mayall, jun., exhibited and described his method of applying amplifiers to a microscope, by which a considerable range of magnifying power and working distance was obtained.—Mr. C. Beck exhibited and described a new form of microscope lamp for use in various pathological and physiological investigations.—Notes were read on human spermatozoa with two tails (Mr. Hazlewood), on the potato-blight insect (Mr. Brennan), and on a *Spirochæte* of unusual form (Mr. Cheshire).—Dr. Anthony read a paper on drawing prisms, on which a long and interesting discussion took place.—Mr. Dowdeswell read a paper on some appearances in the blood of vertebrate animals with reference to the occurrence of bacteria therein; Mr. Oxley, on *Protospongia pedicellata*, a new compound infusorian; and Mr. C. D. Ahrens on some new polarising prisms which he had devised.

PARIS

Academy of Sciences, July 7.—M. Rolland, President, in the chair.—Remarks in connection with a note of M. Berthot on the mutual attraction and repulsion of the molecules of bodies, by M. de Saint-Venant.—Note on the absorption of chlorine by carbon, and on its combination with hydrogen, by MM. Berthelot and Guntz.—Remarks on the projected inland sea in North Africa, by M. de Lesseps. The author, who supports the scheme, replies to the objections raised by M. Cosson, and denies that its execution would involve the ruin of the Belad-al-Jerid and Sûf districts.—On the cholera epidemic, by M. E. Cosson. While admitting that the present epidemic in the south of France is of the Asiatic type, the author points out that it is of a much less virulent character than previous visitations. The germs of the malady seem to lose their intensity and power of transmission in proportion to the distance of the places whence they have been imported. They may thus be compared to the attenuated virus artificially cultivated by M. Pasteur. The efficacy of military cordons and measures of isolation and disinfection is insisted upon, and illustrated by reference to the results obtained by these precautions during the prevalence of cholera in Algeria in the year 1867.—On the so-called algebraic monothetic equations, in which all the coefficients are functions of a single matrix m, by Prof. Sylvester.—Memoir on the chemical composition and alimentary value of the various constituents of wheat, by M. Aimé. Contrary to the generally received opinion, the author concludes, from experiments made on himself, that whole meal or household bread, containing all the ingredients of the grain, is less wholesome and more indigestible than pure white bread made of the flour alone.—New researches on the structure of the brain and on the functions of the white fibres of the cerebral substance, by M. J. Luys.—On the developments bearing on the distance of two points, and on some properties of the spherical functions, by M. O. Callandreau.—Note on the holomorphous functions of any genus (mathematical analysis), by M. E. Cesaro.—On the determination of longitudes in the region of the Caucasus, letter addressed to M. Faye by General Stebnitski.—Note on the electric conductivity of highly diluted aqueous solutions of organic substances, such as ethylic alcohol, glycerine, phenol, glucose, urea, acetone, albumen, ordinary ether, and ethylic aldehyde, by M. E. Bouty.—Researches on anhydrous phosphoric acid, by MM. P. Hautefeuille and A. Perrey.—On some new borotungstates, by M. D. Klein.—On the dishydrating action of salts, by M. D. Tommasi. According to the researches of M. Grimaux, salts would appear to favour the coagulation of colloidal substances by acting as dishydratants. But the author shows that in some cases certain salts produce the opposite result.—On perseite, a saccharine substance extracted from the berry of *Laurus persea*, and analogous to mannite, by MM. A. Muntz and V. Marcano.—On the bibromide of metaxylene, metaxylenic glycol, and other derivatives of metaxylene, by M. A. Colson.—Polarimetric researches on the regenerated cellulose of pyroxylenes and on the cellulose subjected to the action of sulphuric acid, by M. A. Levallois.—Experiments on the artificial fabrication of farmyard manure, by M. P. P. Dehérain.—Contribution to the comparative anatomy of the races of mankind: dissection of a Bosjesman, by M. L. Testut. These studies, made on a subject from twelve to fourteen years old, have revealed a muscular system in a more or less rudimentary state, which exists in a normal condition in various anthropoid and other apes, and in some instances even in mammals of other orders. In his remarks on the paper M. de Quatrefages points out that it supplies no fresh argument in favour of man's descent from a simian prototype.—On the submaxillary of *Oligotoma saundersii*, *Œdipoda cinerascens*, *Gryllus domesticus*, and some other members of the locust family, by M. J. Chatin.—Researches on the transpiration of vegetables under the tropics, by M. V. Marcano.—On a new genus of fossil grain (*Guetopsis eliptica*, *G. trigona*, and *G. hexagona*) from the Upper Carboniferous Measures, by MM. B. Renault and R. Zeiller.

CONTENTS

	PAGE
Professor Tait's "Light." By R. T. Glazebrook	261
Our Book Shelf:—	
Munro and Jamieson's "Pocket-Book of Electrical Rules and Tables."—A. Gray	262
Warden and Waddell's "Non-Bacillar Nature of Abrus Poison"	263
Zeigler's "Text-Book of Pathological Anatomy and Pathogenesis"	263
Letters to the Editor:—	
The Late M. Dumas.—Dr. W. H. Perkin, P.C.S.	263
The Cholera Germ.—E. K.	263
The Mountain System of the Malayan Peninsula.—Rev. J. E. Tenison-Woods	264
Chalk and the "Origin and Distribution of Deep-Sea Deposits."—J. Starkie Gardner	264
Animal Intelligence.—T. H. Potts; Dr. George J. Romanes, F.R.S.	265
Diffusion of Scientific Memoirs.—Prof. John Milne	267
Suicide of Snakes.—Rev. W. R. Manley	268
Sky-Glows.—B. J. Hopkins; Capt. Frank Petrie	268
Fireball.—Annie E. Cocking	269
Butterflies as Botanists.—W. G. S.	269
A Cannibal Snake.—John Fotheringham	269
Fourth Note on the Electrical Resistance of the Human Body. By Dr. W. H. Stone	269
Gas-Burners	270
Birds'-Nest Soup	271
On the Evolution of Forms of Ornament, II. By Prof. Jacobsthal. (*Illustrated*)	272
Notes	274
Zoological Nomenclature, II.	277
Krakatoa	279
Evidences of the Existence of Light at Great Depths in the Sea. By A. E. Verrill	280
Artificial Lighting. By R. E. B. Crompton	281
Societies and Academies	283

THURSDAY, JULY 31, 1884

FORESTRY

Introduction to the Study of Modern Forest Economy, and *Forestry in Norway, with Notices of the Physical Geography of the Country*. By John Croumbie Brown, LL.D. (Edinburgh: Oliver and Boyd, 1884.)

EVERYTHING connected with forestry is especially attractive just now when so much attention is being drawn to the subject in its very varied aspects by the Exhibition at Edinburgh. Dr. J. C. Brown is one of the most voluminous writers we have on forest matters; his pen indeed is scarcely ever at rest, for he has told us about forests and forest management in various parts of the world, both in ancient and modern times, and now he publishes just at an opportune moment two little books the titles of which are given above. The first of these he tells us is issued in accordance with, and in discharge of, obligations imposed by a resolution passed on March 28 last year by a "scientific, practical, and professional" assemblage presided over by the Marquess of Lothian for the purpose of furthering "the establishment of a national School of Forestry in Scotland," and the promotion of "an International Forestry Exhibition in Edinburgh in 1884," the last of which is now being realised, but the former has yet to be accomplished, we hope, however, at no distant date.

Dr. Brown's first book commences by defining what a forest is, and he then goes on to point out that "in the conservation, culture, and exploitation, or profitable disposal, of forest products considerable differences of practice exists," as, for instance, the preservation of game in this country, while on the Continent the wood is the primary object. "In Britain," he says, "we hear much of arboriculture; on the Continent we hear much of sylviculture; the former refers to woods and plantations, the other term speaks of woods and forests; in the one case the unit is the tree, and the wood is considered as the collection of trees; in the other the wood is the unit, and the trees are considered only as the constituent parts. In the former attention is given primarily to the sowing and planting, and pruning it may be, and general culture of the tree; nowhere perhaps has this arboriculture been carried nearer to perfection than it has been in Britain, and the effects produced by the resulting woods are wonderful. In the latter, attention is given primarily to the wood or forest as a whole, capable of yielding products which can be profitably utilised; and the result generally is to produce a much greater proportion of fine trees than does even the arboriculture which has been referred to. And not less different is the exploitation of woods in Britain and on the Continent. In Britain the pecuniary return obtained from woods is considered a secondary matter in comparison with the amenity and shelter which they afford; but on the Continent the materials or pecuniary product, or other economic good, is made the object of primary importance."

This opens the subject of forestry in its widest aspect, and Dr. Brown naturally draws from it a moral on the necessity of forming the much talked of British School of Forestry. The book is divided into three parts, in the first of which the successive chapters treat of the following subjects: Ancient Forests of Europe, the disappearance of European Forests, the evils which have followed their destruction, scarcity of timber and firewood, droughts, floods, landslips, and sand drifts. The second part is devoted to the consideration of "Elements of Modern Forest Economy," under which head we find chapters on Forest Conservation, Replanting or Reboisement, as Dr. Brown prefers to call it after the French usage; Exploitation or Management, Sartage and Jardinage, or Clearance and Selection, &c., concluding this part with a chapter on the study of Pathology. The third part is simply a short notice of modern forest conservancy in general. All these points are of extreme importance in a well-organised system of forest teaching, and under each head Dr. Brown brings together a quantity of matter which, besides being of a practical character, and consequently valuable, is also interesting reading. He possesses the power in an eminent degree of weaving into one uniform fabric what has been said by various writers on the subject that he has so much at heart, for Dr. Brown's books contain long and numerous quotations, through which it will not be necessary to follow him. On the study of pathology, however, as one of the branches in the curriculum of a forest officer's education, we entirely agree with him as to its great importance. It should indeed be equally imperative that a young forester should know something of the nature of the diseases with which the trees under his care are liable to be attacked, as that he should be acquainted with the structure, constitution, and habits of those trees, so that he may be enabled, if occasion requires, to cope with their diseases, and if possible save the victims from premature decay. For this reason a pathological museum should be attached to every forest school, and specimens might be continually added to it by preserving those that might be brought into the school for determination. Such a museum indeed is referred to by Dr. Brown in the following paragraph:—"In the Museum of the Prussian Forest Institute at Eberwalde the impression produced upon the mind of the visitor is that there are there specimens representative of every disease to which trees are heir; specimens exhibiting the progress of the disease from the attack to the consummation; and, hard by, the bark, the wood, the insect, or the parasitic herb or fungus by which it has been induced, the insect and the fungus being exhibited under all the transformations through which they pass; while specimens of the effects of lightning and other physical causes of the decay or destruction of trees are not lacking. And similar collections sufficient to afford facilities for the study of the diseases of trees and of means of preventing or of remedying the evils done are to be found in many other similar institutions." Dr. Brown concludes his first book with a sketch of the curriculum of the Spanish School of Forestry, which includes a wide range of subjects in mechanics, physics, acoustics, heat, optics, electricity, meteorology, chemistry, natural history, including botany and zoology. "The instruction is given (1) by oral lectures and lessons in drawing by the professors; (2) by written exercises, calculations, and analyses on the subjects embraced by these lectures; (3) by the detailed study of the animals, rocks, plants, and forest products which constitute the collections and adjuncts of the establishment; (4) by the practice of topography, land-surveying, the

study of natural history, and of mountains in the field; (5) by excursions to the plantations and mountains."

With regard to the status of forest officers in different parts of Europe they are described as taking rank with military men and other Government officers of recognised social position, and having in many instances an official uniform and a higher salary than is accorded to military officers, by way of compensation for the monotonous life they are called upon to lead in the forests, which often has a depressing influence—"day after day, month after month—trees, trees, trees everywhere, trees and shade, trees and shade—shade that reminds one of the expression '*the valley of the shadow of death.*'"

"Forestry in Norway" is a book of a different character from the preceding. It treats of the general features of the country in its various aspects, with especial regard of course to its arboreal vegetation, and the effects of temperature, rainfall, rivers, lakes, mountains, valleys, &c. The book is for the most part very pleasant reading.

In Chapter IV., under the head of Geographical Distribution of Trees in Norway, Dr. Brown shows that he has made himself acquainted with the modern literature of the subject, especially with the well-known report and maps prepared by Dr. F. C. Schubeler, Professor of Botany in the University of Christiania. From this and from the numerous other works cited the conclusion is drawn that the true forests of Norway are composed almost entirely of the Norway spruce fir (*Picea excelsa*, Link.) and the Scotch fir (*Pinus sylvestris*, L.), though some other trees, as the elder, beech, and oak, are found forming little woods. We must here point out that nearly the whole of this chapter requires careful editing. There is no excuse for the retention of old and exploded names, still less perhaps for absolute mistakes. On p. 39, for instance, it is stated that the Norway spruce is generally known as *Abies communis*, a name under which very few indeed would know it except those well versed in the synonymy of the plant. On the same page *Millaw* is printed for Miller, *Lank* for Link; and a page or two further on, the Norwegian birch is referred to *Betula odorata*, Bechet, when it should be *B. alba*, L. Again on p. 45 we are told that two species of oak "are found growing wild in Norway, the sessile-fruited oak, *Quercus robur*, W., and the common oak, *Q. pedunculata*, W." The fact is that the sessile-fruited oak is *Q. sessiliflora*, Sm., and the pedunculated oak, *Q. pedunculata*, Ehr., both of which are now placed by most modern authorities under the one name of *Quercus robur*, L. Similar instances occur further on, as well as misspellings, all of which could be easily rectified, and the book made more trustworthy.

The general readable nature of the bulk of the book will no doubt cause it to be read by those into whose hands it may fall, whether they are specially interested in forestry or not, and will thus form one means of promoting the extended use of the volume.

LENSES

Lenses and Systems of Lenses. By Chas. Pendlebury, M.A., F.R.A.S., Senior Mathematical Master of St. Paul's. (Cambridge: Deighton, Bell, and Co., 1884.)

WE are glad to welcome at last an English book on this subject, on which up to the present but little has been written in our language. An abstract of Gauss's paper in Taylor's *Scientific Memoirs*, and a paper by Maxwell in the second volume of the *Quarterly Journal of Mathematics* form, so far as we are aware, the main English literature of the subject. Of course since the time of Gauss foreign writers have used it freely: Listing, Helmholtz, and Carl Neumann in Germany, Verdet and others in France, have introduced it with more or less modification into their works. We would suggest that a list of books and memoirs on the subject would form a valuable addition to Mr. Pendlebury's book. The author gives frequent references in footnotes to books or papers from which he has drawn information, but a complete list would be a great help to others studying the subject. The method itself is very elegant and attractive, though somewhat barren of results; perhaps this is the reason why it has been neglected in England. It enables us to obtain a beautiful solution of the problem to a first approximation when all the rays make but small angles with the axis, but refuses to help us further.

The book before us is clear and well written, though perhaps unnecessarily long. Mr. Pendlebury has three chapters successively on refraction at a single surface, at two surfaces, and at any number of surfaces. This would be very well for a student who was supposed to begin the study of optics with this book, but such a student is hardly likely to exist; and one who has read the ordinary text-books on the subject could easily follow at once the reasoning of the most complicated case, and might be left to deduce the others so far as they differ from it as corollaries.

Referring, however, to some points in the book, we think that in Fig. 4 it would have been better to take as the standard case one in which the points X and X' both lie to the same side of A, the case usually considered in text-books on optics. This would have obviated the necessity of having to put a negative sign to the symbol u in the algebraical work. Attention also might with advantage be called to the point that one of the two focal distances is negative.

Again, a difficulty occurs when we compare the results of Sections 67 and 74; in the one we have

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f},$$

while, using the same notation, the results of the other may be written

$$\frac{1}{v} + \frac{1}{u} = \frac{1}{f}.$$

The explanation, of course, is that Fig. 18, from which the last result is deduced, is not drawn for the standard case of a lens forming a virtual image of an object. There is another small point of arrangement which it seems to us might be slightly modified with advantage; we would draw a rather more definite line between the analytical and geometrical methods of treating the subject.

If we assume that a pencil of rays diverging from a point will, after refraction, pass through a point, we can prove geometrically the existence of the principal points, the focal points, and the nodal points. We cannot, however, without analysis, find the position of these points in terms of the curvatures and distances between the various refracting surfaces.

Again, if we assume the position of the focal and

principal points, we can find geometrically the position of the image of any point after refraction through the surface. This we may describe as the geometrical treatment of the subject.

By the aid of analysis we can show that there is, to the degree of approximation to which we go, a point image of any point, and we can find in terms of known quantities the positions of the cardinal points of the system and the relation between a point and its conjugate focus. Mr. Pendlebury adopts both methods indiscriminately; it seems to us that it would have been better to have kept the two somewhat more distinct.

A short account of the paper of Maxwell to which reference has been made, "On the General Laws of Optical Instruments," would form a valuable addition to the book, and may, perhaps, be included when the author extends it, as he hopes to do, so as to cover a wider area in the field of geometrical optics. At present the field is open to him, and a book on the whole subject as good and interesting as "Lenses and Systems of Lenses" is greatly needed. R. T. G.

OUR BOOK SHELF

Fuel and Water. Translated from the German of Franz Schwackhöfer, by Walter R. Browne, M.A. (London: Charles Griffin and Co., 1884.)

MR. WALTER R. BROWNE has made a very good translation of a book written for the German students of agriculture in Vienna. He has added a clever sketch of the mechanical theory of heat as an introduction. The English of the translation is remarkably good and clear, and the original treatise has been written by a competent man. The translator in his preface appeals to manufacturers and users of steam on a large scale; but the work is much too scientific for them, dealing not with the various forms of boiler now in the market, but rather with the general principles on which boilers should be constructed. On the other hand I fear that the information given is in many parts not full enough for the engineer, and we frequently find data given such as will be of more value to the German than to the English reader. The chief physical formulæ relating to heat and applicable to practical questions connected with engineering are clearly stated, but the comparison of results deduced from these formulæ with the results derived from actual experience is rather sparingly made. The third chapter, which is headed "Heating Apparatus," treats of the furnace and its management. The author gives the results of some actual experiments as to the loss of heat in the chimney, in the ash-pits, in priming water, and by conduction and radiation. He also gives an experiment with what is called an economiser. This chapter seems to me one of the best in the book. Altogether, I think the work is one which may in many parts be profitably consulted by those engineers who desire to compare theory with practice.

FLEEMING JENKIN

The Elements of Euclid. Books I. to VI. With Deductions, Appendices, and Historical Notes. By J. S. Mackay, M.A. (London: W. and R. Chambers, 1884.)

THIS text-book has been compiled at the request of the publishers, and the event shows that it was by a "happy thought" their choice of an editor fell upon Mr. Mackay, the Mathematical Master of the Edinburgh Academy. Of it we have nothing to say but what is good. This praise is not so much for the text, for others have done well in this direction. Still even here Mr. Mackay has shown great judgment and skill in his selection of proofs. The text is in the main that of R. Simson's well-known editions, and no change has been made in Euclid's sequence of propositions, and no violent change in his modes of proof.

But what we particularly like are the carefully prepared historical notes, which take the form of footnotes or of fuller paragraphs in the six appendices. Mr. Mackay remarks, "It would perhaps be well if such notes were more frequently to be found in mathematical text-books: the names of those who have extended the boundaries, or successfully cultivated any part of the domain, of science, should not be unknown to those who inherit the results of their labour."

We regret that though authors have before expressed themselves to similar effect, yet few have had the inclination or leisure to act as our present author. He has had to curtail his material, but what he gives us shows that he is well qualified by the extent of his reading to satisfy this want.

We note here that recent French mathematicians are in the habit of attributing the first use of the word "orthocentre" (which Mr. Mackay ascribes to Dr. W. H. Besant) to Dr. Booth; in so doing they are certainly in error, as Dr. Booth himself, in the second volume of his "New Geometrical Methods" (p. 261), says "the point has been called by some geometers the *orthocentre*." What he may lay claim to is his calling what is now often called the *pedal* triangle the *orthocentric* triangle.

The figures are admirably drawn and are quite a feature of the book; they deserve the editor's commendation when he thanks Mr. Pairman for the "excellence of the diagrams."

This edition is well suited for the geometrical student, and, at the same time, its cheapness puts it within the reach of all who wish to study "Euclid."

Traité Pratique d'Analyses chimiques et d'Essais industriels. Par Raoul Jagnaux. (Paris: Octave Doin, 1884.)

THE purpose and character of this little book is best indicated by the saying of Berzelius which heads the author's preface: "Le meilleur mode d'analyse est celui qui exige le moins d'habitude chez l'opérateur." The book is mainly intended for the use of the chemical engineer and the metallurgist, and the methods of analysis described are essentially "works-methods," in which rapidity of execution is a very important consideration. Many of these methods are new, and have been devised partly by M. Hautefeuille, and partly by the author. We would especially note those depending upon the precipitation of such metals as zinc, copper, nickel, and bismuth as oxalates, whereby the formation of gelatinous precipitates, difficult to wash, is avoided. The book contains a large number of analytical results as evidence of the validity of the methods employed; many of these analyses, such as those of aventurine glass, garnierite, sylverine, are valuable as illustrating the composition of substances which are not frequently examined. T.

LETTERS TO THE EDITOR

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

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

The Relation between the B.A. Unit and the Legal Ohm of the Paris Congress

AT a meeting of the Electrical Standards Committee of the British Association held on Saturday, June 28, the following resolution was carried:—

"That for the purpose of issuing practical standards of elec-

trical resistance, the number of B.A. units adopted as representing the resistance of a column of mercury 100 centimetres in length, one square millimetre in section, at a temperature of 0° C. be ·9540."

It follows from this that the legal ohm of the Paris Congress, which is defined as the resistance of such a column 106 cm. in length, contains 1·0112 B.A.U., while the B.A.U. contains ·9889 legal ohm. Thus resistances which are expressed in terms of B.A. units may be reduced to legal ohms by multiplying by ·9889, while makers and others who have a standard B.A. unit can construct a legal ohm by making a coil equal to 1·0112 times that unit.

A resolution of the nature of the above was rendered necessary by the fact that the legal ohm is defined in terms of the resistance of a column of mercury, while the resistances in use in England are B.A. units. The relation between the two has been determined by different observers with slightly different results. The Committee hope to secure uniformity in the resistances sold to the public as legal ohms, by stating the number they intend to adopt for the purpose of issuing standards.

R. T. GLAZEBROOK,
Secretary Electrical Standards Committee
of the British Association

The Yard, the Metre, and the Old French Foot

THE ratio of the metre to the yard can scarcely be said to be known with certainty at the present day. The latest and most exhaustive investigation of this question is due to Prof. W. A. Rogers of Cambridge, Mass. The value which he assigns to it (pending a final and authoritative comparison of the "Mètre des Archives" with its chief representative, by the International Commission of Weights and Measures) is—

39·37027 : 36.

This ratio is very nearly identical with the much simpler one—

35 : 32,

the error of which is less than 1 in 5000. If we disregard this error, the conversion of yards into metres can be effected with the greatest ease by the following arithmetical process. Thus—

Given	35 yards or	39·37027 yards
Subtract 1/10th	− 3·5	− 3·937027
Add 1/7th	+ ·5	+ ·5624324
Results	32·0 metres	35·9956754 metres
		Error − ·0043246

By a singular piece of good luck, this error, small as it is, may be entirely removed by one more easy approximation: for dividing the last quotient by 130 gives + ·0043263—where the outstanding disagreement is less than a unit in the last given figure. Hence, if we wish for a closer conversion than will be given by the terms 1, $-\frac{1}{10}$, $+\frac{1}{7}$ (of the last), we have only to add further, $+\frac{1}{130}$ (of the last) to obtain the utmost accuracy at present possible.

The converse operation—to convert metres into yards—is not quite so short and easy in the closer approximation. The following shows the approximate and the more exact conversion:—

	Ex. 1	Ex. 2
Given	32 metres	36 metres
Add 1/10th	+ 3·2	+ 3·6
Subtract 1/16th	− 0·2	− 0·225
,, 2/100ths ...	—	− ·0045
,, 1/20th	—	− ·000225
Results	35·0 yards	39·370275 yards

The fact is, almost any conversion may be performed in some such way, in three or four operations; and it was not for the sake of the rigorous ones that this note was written, so much as to bring into notice the very close and useful approximation represented by the ratio 32 : 35.

By way of applying the rules usefully, we may take as examples:—To find the equivalent of a kilometre in yards, and of a mile in metres. Thus—

	1000 metres		1760 yards
+	100	−	176
−	6·25	+	25·14286
−	·125	+	·19341
−	·00625		—
Answers	1093·61875 yards ...		1609·3363 metres

Here we see that the approximate ratio 32 : 35 entails an error of only 0·131 yard (or less than 5 inches) in one kilometre; or of 0·103 (or less than 2) decim. in one mile, so converted.

The old French foot, the sixth part of the toise—the famous "Toise of Peru"—survives now practically only in the Prussian toise, so far as that is not superseded by the metre. Whatever may be its present range, the ratio of the old French foot to the present English foot is curious. I believe it may be expressed, within the limits of error of the relation so far as can now be known, by the fraction 389/365. That is to say, the excess of the former is 24/365 × the latter, the two components of which fraction are such as may easily be remembered when once the coincidence has been noted.

J. HERSCHEL

Collingwood, July 25

Fireballs

IN reference to the phenomena of fireballs the following notes may be of interest. Last year, in July, I was residing on Naphill Common, Buckinghamshire. About midday, during my absence at Oxford, a violent thunderstorm broke over the district, and appeared to extend from Oxford to London. On returning I found that the house had been struck by lightning, apparently in two places. One chimney was knocked in through the roof, the debris partly filling up my room. The kitchen chimney had also been visited, the lightning breaking some of the brickwork of the hearth, and passing a person cooking at the fire; two or three others were in the house at the time, but no one was hurt. On carefully examining the marks left, I found that a door in a room adjoining the one above-mentioned had been split, and some iron knobs knocked off and broken, the screw nails being removed out of the wood, and a large hole several feet square made in the side of the house. From examination of the outside of the wall at the foot of the kitchen chimney, the bricks showed displacement opposite the marks inside at the hearth. I believe a tree was struck, and a water-trap or cesspool shifted out of position. Some men using a reaping machine in a neighbouring field stated that they knew the storm was coming by the fire playing about the blades of the machine. A boy who had been near at the time said that he saw a large ball of fire fall on the house, which it seemed to enter; it then reappeared, and passed into the meadow. I therefore think it likely that the damage done to the rooms and side of house was due to the electric development called a fireball.

Glasgow W. J. MILLAR

The Swallowing of one Snake by another

As the author of the article "A Cannibal Snake" (NATURE, July 3, p. 216) wishes to know whether an instance similar to that recorded by him has ever before been brought to notice, I feel bound to publish an occurrence which I witnessed many years ago, and of which I have often told, without ever putting it into writing. During the summer of 1857 I lived in the environs of Washington; as an amusement, snakes were kept in cages. Sometimes, in the evening twilight, when toads and frogs appeared on the garden paths we used to feed the snakes with them. The usual habit of the snakes was to seize the toad wherever the jaws happened to strike, and to move them afterwards along the body of the victim, so as to begin the process of swallowing from the head. Once I threw a toad into a cage containing two of the common water-snakes of that region (*Nerodia sipedon*, if I recollect right, is the scientific name of the species). Both seized the toad at the same time; the one near the head began at once to swallow; the other put its jaws in motion as usual, in order to get at the head, but in doing this it reached the head of its comrade, and *began to swallow that, as well as the toad*. This went on for some time, until about three-quarters of the one snake were ingulfed within the other. Then the snakes separated again, the swallowed one coming out covered with slime, but apparently unhurt and as lively as ever. It lived a long time afterwards. The snakes were of about equal size, and, as far as I remember, from 2½ to 3 feet long. I suppose that it was the swallowing snake, and not the swallowed one, that kept the frog, but I do not think I ascertained the fact at the time. The whole performance lasted a few minutes only.

Heidelberg, Germany, July 27 C. R. OSTEN SACKEN

The Red Sunsets

I NOTE in NATURE of July 3 (p. 229) an abstract of a communication of M. Gay to the Paris Academy of Sciences, made

on June 23, in which he suggests a connection between the red sunsets and the frequent rains. During the latter half of the past winter the rains were incessant in the Atlantic States of America, and the writer suggested that they were due to the volcanic dust in the atmosphere, in a letter published in the *Philadelphia Public Ledger* of February 23. In a subsequent issue, March 8, he called attention to Dr. Aitken's researches. Subsequently Prof. Heilprin, of the Philadelphia Academy of Natural Sciences, offered a similar suggestion.

Philadelphia, July 16 CHAS. MORRIS

THE SALTNESS AND THE TEMPERATURE OF THE SEA[1]

PROFESSOR DITTMAR'S researches, an account of which forms Part I. of this volume, have finally proved that, so far as the most refined analysis can go, the mixture of salts dissolved in ocean water has attained a state of chemical equilibrium. But, although there is constancy of proportion between the various salts, the ratio of the total salts to the water varies considerably in different parts of the ocean.

The great evaporation in the dry tropical areas and the removal of water by freezing in the Polar seas tends to increase the salinity in these places, while in the tropical zones of continual rain and in the Polar fringes where the icebergs melt, there is constant dilution going on. The determination of the salinity at different places and depths is of great oceanographic importance, and the problem of finding the salinity has been attacked in various ways. The most simple and straightforward is to evaporate a weighed portion of the water to dryness and weigh the residue, but this cannot be done without chemical change taking place. The magnesium chloride present decomposes with the water into magnesia and hydrochloric acid, and all the carbonic acid of the carbonates is driven off. Gay-Lussac showed long ago how to avoid the error due to the dissociation of magnesium chloride, but no means have yet been suggested for taking account of the carbonates in a total salt determination. Direct weighing being thus found inexpedient, the next best method would appear to be to find the exact amount of any one element present, and by means of a table of complete analysis, taking advantage of the constancy of composition of ocean salts, to convert that into the salinity by multiplication with a constant factor. This is the method which Prof. Dittmar prefers, and for the purpose he estimates the chlorine or rather the total halogen by means of his refinement of Volhard's process. When the salinity of water has to be determined at sea, this delicate method cannot be conveniently employed, and it has been customary hitherto to measure the specific gravity of the water very carefully and afterwards to reduce the results to salinities. An attempt has been made with considerable success in the United States to substitute the determination of the refractive index of water for that of the density, and thence to deduce the salinity by a formula. This method is pre-eminently adapted for use at sea, but it appears not to possess the necessary delicacy.

The only method by which the specific gravity of a fluid can be ascertained on board ship is by means of hydrometers, and as the extreme values for sea-water are, according to Mr. Buchanan, 1·02780 and 1·02400, apparatus of great delicacy must be employed. A very delicate glass hydrometer was used on the *Challenger*, yet in spite of its fragility and the thousands of observations that Mr. Buchanan made with it in all weathers, he succeeded in carrying the one instrument which he had used during the entire voyage back to this country unbroken. His description of the hydrometer is as follows :—

"Preliminary calculations showed that convenient dimensions would be about 3 mm. for the diameter of the stem and about 150 c.c. for the volume of the body, and from 10 to 12 cm. for the length of the stem. The tube for the stem was selected with great care from a large assortment, and no want of uniformity in its outward shape could be detected with the callipers. The tube for the body of the instrument was also selected from a number, in order to secure such a diameter as would give the instrument a suitable length. In order to provide against accidents, I had four instruments made from the two lengths of tubing. The glass work of the instrument being finished—except that the top of the stem, instead of being sealed up, was slightly widened out into a funnel—the instrument was loaded with mercury, until the lower end of the stem was just immersed in distilled water of 16° C. A millimetre scale on paper was then fixed in the stem, and the calibration carried on by placing decigramme weights on the funnel-shaped top, and noting the consequent depression on the scale. The whole length of the scale was 10 cm., and this portion of the stem proved to be of perfectly uniform calibre. Several series of observations were made in order to determine accurately the volume of any length of the stem. . . . When this operation of calibration was finished, the end of the stem was carefully closed before the blowpipe."

The constants necessary for making a specific gravity observation were all determined with the utmost care. They included the exact weight *in vacuo* of the instrument, the volume of the body, the volume of each division of the stem, and the expansion of the whole instrument for a degree Centigrade. These data were fully tabulated, and in addition tables were made of the total weight when each of a set of brass weights was placed on a small table that could be slipped over the top of the stem. These weights were necessary, as, without them, the stem would require to be of great length in order to serve for waters of different density.

In making an observation Mr. Buchanan always kept the water sample in the laboratory for a night in order that it might have time to attain the temperature of the surrounding air. He then placed about 800 c.c. in a glass jar supported on a swinging table, and immersed the hydrometer in it after ascertaining its temperature exactly. To insure the greatest possible accuracy two readings were frequently made with different weights on the table, the results separately reduced, and the mean taken as the density. The density was calculated in every case by ascertaining the weight of the loaded hydrometer and dividing it by the immersed volume, which is calculated from the temperature and stem-reading.

Prof. Dittmar examined very particularly into the probable error in reading Buchanan's hydrometer, and after a long series of experiments, described in the chapter on Salinity in Part I., he came to the conclusion that the difference between the salinity as calculated by it and by his direct chlorine determinations (*i.e.* $\chi_1 - \chi$ where χ stands for the permilleage of chlorine) amounted to $-\cdot042 \pm \delta$, δ being a variable the chances of which being greater or less than ·06 are equal, and are 4 to 1 in favour of its being less than ·12. The value of χ is usually between 19 and 20.

At first Mr. Buchanan reduced his specific gravities to the temperature of 15°·56 C. by Hubbard's tables, but Prof. Dittmar, in the course of his investigation of "The specific gravity of water as a function of salinity, temperature, and pressure," succeeded in constructing a much better table in which the variation of the coefficient of expansion with the salinity of the water is taken account of, and all Mr. Buchanan's results published in this volume have been calculated by it. A very ingenious graphic method of comparing Hubbard's results with Dittmar's and converting one into the other is given in Plate I. of Part II.

[1] "The Physics and Chemistry of the Voyage of H.M.S. *Challenger*." Vol. i. Part ii. "Report on the Specific Gravity of Ocean Water" By J. Y. Buchanan, M.A., F.R.S.E. Part iii. "Report on the Deep-Sea Temperature Observations obtained by the Officers of H.M.S. *Challenger* during the Years 1873-76." (London: Longmans and Co., 1884.) See NATURE, July 24, p. 292.

In the course of his work Prof. Dittmar hit upon an elegant method of determining densities, which was found to be very satisfactory. He filled a water-bath with a particular sea-water that had been selected as a standard, and kept it at a constant temperature. A specific-gravity bottle was filled with the same water, stoppered, hung in the bath to the balance-pan, and weighed accurately. To compare any number of samples of water it was sufficient to fill up the bottle with the water in question, and again weigh it immersed in the standard. Prof. Dittmar confined himself to making out the relation between salinity, specific gravity, and temperature, leaving the relation of specific gravity and pressure for subsequent treatment by Prof. Tait, whose great chain of experiments on the compressibility of sea-water is now drawing to a close, and the results of which will shortly be published in the *Challenger* Reports. The conclusion Prof. Dittmar comes to is summed up in the formula—

$$\chi = \frac{{}_4S_t - {}_4W_t}{a + bt + ct^2},$$

where χ is the "salinity" or permilleage of halogen; ${}_4S_t$ the specific gravity of sea-water at $t°$ relatively to pure water at 4° C.; ${}_4W_t$ is the specific gravity of pure water in the same way; a, b, and c are constants which have been determined once for all.

In the chapter on Salinity in Part I. Prof. Dittmar gives a table dealing with 300 samples, collected in all parts of the ocean and from all depths. These tables show the position, the depth of the ocean at the station, the depth from which the sample was drawn, the permilleage of chlorine (χ), the mean deviation of the mean χ from the individual results, and the difference between the amount of chlorine as calculated from Buchanan's observations of specific gravity, and as found directly by Dittmar.

Mr. Buchanan gives in his report all his observations classified according to geographical position and depth, and arranged in eighteen large tables. These record the specific gravity of water from all depths in the North and South Atlantic, the Southern Indian Ocean, the North and South Pacific, and the interesting inclosed seas of the Malayan Archipelago. The numbers are simply given as they were observed, only corrected for temperature by Dittmar's table, and all discussion of their oceanographic significance has been deferred until a subsequent occasion.

A series of coloured charts illustrating the bathymetrical and geographical distribution of specific gravity over the whole world and in the individual oceans accompanies the memoir. These are extremely interesting, and in many cases they tell their own story without explanation, though when the full descriptions are published, the value and interest of the plates will be greatly increased. The track-chart of the *Challenger* coloured to show the surface salinity of the ocean, is especially worthy of notice; its details have been filled in, and the whole rendered more complete, by the incorporation of the results of other exploring expeditions.

The great importance of Mr. Buchanan's specific gravity observations will be more readily recognised by the general reader when they are elucidated by the work of Prof. Tait and Mr. Buchan, and treated more generally than is possible in a mere statement of observed figures.

The third part of the volume is devoted to the temperature observations made during the cruise. The nature of the information contained in the curves which make up this part of the work is very concisely put in the editor's introduction:—

"It has been deemed advisable to publish, for the convenience of scientific men, the whole of the deep-sea observations of temperature made during the voyage of the *Challenger*. These are given in detail in the accompanying series of 263 plates, which show the latitude and longitude of the station; the depth in fathoms of the bottom; the depth at which each temperature was taken; the number of the thermometer; the temperature actually observed read to quarter degrees; the error of the thermometer; and the temperature corrected for instrumental error only."

The temperatures have been plotted by Staff-Commander Tizard, and a free-hand curve drawn through the points. From this the "temperature by curve" which is employed in drawing the diagrammatic sections of the ocean showing the bathymetrical arrangement of the isothermals is taken. These sections will be published in vol. i. of the *Challenger* narrative, and to the general reader they will present a much more intelligible idea of the distribution of oceanic temperature than can be given by the study of tables of figures or curves for separate stations. The separate station curves are, however, of the utmost value to any one who wishes to make a detailed study of ocean temperatures. With a direct view to such a purpose the curves have been drawn with rigid adherence to the numbers in the observation books, even the most obvious cases of observational error being left uncorrected; for the specialist can easily discover and correct them himself, and no one else will notice them.

The temperature observations, like the specific gravity observations, form a rich mine of material with which good work may be done. It is shown by a glance at the charts that there are areas in the ocean of great salinity and areas of great dilution; it is shown that the pressure increases uniformly with the depth; it is known that the surface temperature of the water varies greatly in different latitudes, and that, as the depth increases, the temperature decreases, at first very rapidly, but after the first few hundred fathoms with increasing slowness, until at the bottom the temperature of the open ocean is everywhere the same, between 34° and 35° F.; it is known also that in inclosed seas, or in those where there are submarine barriers cutting them off from the rest of the ocean, the temperature assumes a constant value in its descent, and sometimes the bottom is nearly 20° F. warmer than that of the ocean at the same depth a few miles distant; but this is all that is known. It is evident that there must be an ocean circulation on a magnificent scale going on, a gradual onward sweep of the whole mass of the water, but the direction of this mass motion can only as yet be guessed at, and its rate is utterly unknown. The material for solving this, the great oceanographic problem, is rapidly accumulating, and when the physical and chemical reports of the *Challenger* Expedition have all been made public, it will be strange indeed if a large generalisation cannot be based upon them, and the discovery of the secret of ocean circulation be added to the many discoveries which have been made by the scientific men of the cruise.

The nature of this volume, both on account of the subjects with which it deals and the number of formulæ and long tables of numbers it contains, must have made the task of editing it no light one; and the accuracy of every part, the almost entire absence of typographical errors, and the beauty of the lithographed charts show that authors, editor, engravers, and printers have alike exerted themselves to produce a volume worthy of being the first to record the physical and chemical work of the *Challenger* Expedition.

HUGH ROBERT MILL

SPECIALISATION IN SCIENTIFIC STUDY[1]

THERE once was a science called "natural philosophy," which, like some old synthetic types of animals, held in itself all the learning that applied to physical facts. By the beginning of this century this science of natural things had become divided into physics and natural history. These divisions have since spread,

[1] From *Science*.

like the divisions of a polyp community, until now natural history has more than a dozen named branches; and in physics the divisions are almost as numerous. There are now at least thirty named and bounded sciences; each name designating a particularly limited field, in which there are able men who work their days out in labour that does not consider the rest of nature as having any relation to their work.

This progressive division of labour follows a natural law: and it is perhaps fit that science should itself give a capital illustration of the application of this law to forms of thought, as well as to the more concrete things of the world; but it is an open question whether or no it is advantageous to the best interests of learning. There can be no question that the search for truth of a certain quality is very greatly helped by this principle of divided labour. If a man wish to get the most measurable yield out of the earth in any way, the best thing for him is to stake off a very small claim, tie himself down to it, fertilise it highly, till it incessantly, and forget that there are blossoms or fruit beyond his particular patch; for any moment of consciousness of such impracticable things as grow beyond his field is sure to find expression when he comes to dig his crop, whether his crop in the intellectual field be elements or animals, stars or animalculæ. The harvest of things unknown is most easily won in this kitchen-gardening way of work.

The world needs, or fancies that it needs, this kind of work; and it is now of a mind to pay more of its various rewards for the least bit of special and peculiar knowledge than for the widest command of varied learning. In a thousand ways it says to its students, not only as of old, "Study what you most affect," but, "*Effect that study altogether*, know the least thing that can be known as no one else knows it, and leave the universe to look after itself."

This is the prescription of our time. We are now proceeding on the unexpressed theory that, because no man can command the details of all science, therefore he shall know only that which he can know in the utmost detail. We seem to be assuming, that, if many separate men each know some bit of the knowable, man in general will in a way know it all; that when, in another hundred years of this specialisation, we have science divided into a thousand little hermit-cells, each tenanted by an intellectual recluse, we shall have completed our system of scientific culture. No one can be so blind to the true purposes of learning as to accept this condition of things as the ideal of scientific labour. It may be the order of conquest, the shape in which the battle against the unknown has to be fought; but beyond it must lie some broader disposition of scientific life,—some order in which the treasures of science, won by grim struggle in the wilderness of things unknown, may yield their profit to man.

The questions may fairly be asked, whether we have not already won enough knowledge from nature for us to return, in part, to the older and broader ideal of learning; whether we may not profitably turn away a part of the talent and genius which go to the work of discovery to the wider task of comprehension; whether we may not again set the life of a Humboldt along with the life of a Pasteur, as equally fit goals for the student of nature.

Until we set about the system of general culture in science, it will be nearly impossible to have any proper use of its resources in education. A sound theory of general culture in science must be preceded by a careful discussion of the mind-widening power of its several lines of thought. This determination cannot be made by men versed only in their own specialties; it must be made by many efforts to determine by comparison what part of the sciences have the most important power of mind-developing. At present there are few men whose opinion on such a subject is worth anything, and the number constantly grows less.

The greatest difficulty partly expresses itself in, and partly rises from, the multiplication of societies which include specialists as members, and specialties as the subjects of their discussions. We no longer have much life in the old academies, where men of diverse learning once sought to give and receive the most varied teaching. The geologists herd apart from the zoologists: and in zoology the entomologists have a kingdom to themselves; so have the ornithologists, the ichthyologists, and other students. "That is not my department," is an excuse for almost entire ignorance of any but one narrow field. If naturalists would recognise this "pigeon-holing," not only of their work, but of their interests, as an evil, we might hope to see a betterment. Until they come to see how much is denied them in this shutting-out of the broad view of nature, there is no hope of any change. Special societies will multiply; men of this sort of learning will understand their problems less and less well; until all science will be "*caviare* to the general," even when the general includes nearly all others beyond the dozen experts in the particular line of research.

The best remedy for this narrowing of the scientific motive would be for each man of science deliberately to devote himself, not to one, but to two ideals, *i.e.* thorough individual work in some one field, and sound comprehension of the work of his fellows in the wide domain of learning—not all learning, of course, for life and labour have limits, but of selected fields. In such a system there will be one society-life meant for the promotion of special research, and another meant for the broader and equally commendable work of general comprehension.

It is in a certain way unfortunate that investigation is to a great extent passing out of the hands of teachers. This, too, is a part of the subdivision work; but it is in its general effects the most unhappy part of it. As long as the investigator is a teacher, he is sure to be kept on a wider field than when he becomes a solitary special worker in one department.

The efforts now being made for the endowment of research will, if successful, lead to a still further tendency to limit the fields of scientific labour. A better project would be to keep that connection between inquiry and exposition from which science has had so much profit in bygone times.

TWO GREEK GEOMETERS

DR. ALLMAN in his article "On Greek Geometry from Thales to Euclid," in the current volume of *Hermathena* (vol. v. No. 10), discusses in Chapter IV. the discoveries of Archytas of Tarentum, and in Chapter V. those of the Greek geometer Eudoxus of Cnidus.

Archytas was a contemporary of Plato (428–347 B.C.), probably senior to him, and saved his life when Plato was in danger of being put to death by the younger Dionysius. These particulars and others of interest are skilfully arrayed by the author; one only of these we recall, viz. Horace's reference to the death of Archytas by shipwreck in an ode (Book I. 28), in which he recognises his eminence as an arithmetician, geometer, and astronomer. Unfortunately no undoubted works of his have come down to us; the authenticity of some that have been attributed to him is here discussed, but these do not treat of geometry. In former chapters his contributions to the doctrine of proportion and his demonstrations of theorems as well as solutions of problems have been noticed. Here the question of his identity with the Architas of Boethius' *Ars Geometrie* is discussed, and a strong case made out for the same. The connection of Archytas with the Delian Problem (already touched upon in *Hermathena*, vol. iv.) next comes under consideration, and the passage in Eutocius is translated at length and accompanied by a figure. An enumeration of the theorems which occur in this passage is made,

whence we see that this geometer "was familiar with the generation of cylinders and cones, and had also clear ideas on the interpretation of surfaces; he had, moreover, a correct conception of geometrical loci and of their application to the determination of a point by means of their intersection." Dr. Allman further maintains that in this solution "the same conceptions are made use of, and the same course of reasoning is pursued, which, in the hands of his successor and contemporary Menœchmus, led to the discovery of the three conic sections. Such knowledge and inventive power surely outweigh in importance many special theorems." In arriving at these views he has to combat (which he does in some detail and apparently with success) the reasoning of Cantor, which is "based on a misconception of the passage in which the word τόπος occurs." Dr. Allman insists that τόπος means *place* and not *locus* (as used by mathematicians). The whole discussion is well worthy of the careful attention of all interested in the history of geometry: we must forbear to enter into the matter further.

Eudoxus (born about 407 B.C.), a pupil of Archytas, was an astronomer, geometer, physician, and lawgiver, and hence a noteworthy man in more ways than one. Here again Dr. Allman, one of whose great merits is his independence and his thorough examination of the original authorities, differs from Boeckh and Grote, but we cannot give details. A full discussion of the additions to geometry made by Eudoxus follows, and from it we learn how great he was as a geometer; his contributions to astronomy must be sought for elsewhere, though they too come under notice. "This eminent thinker—one of the most illustrious men of his age, an age so fruitful in great men, the precursor, too, of Archimedes and of Hipparchus—after having been highly estimated in antiquity, was for centuries unduly depreciated; and it is only within recent years that, owing to the labours of some conscientious and learned men, justice has been done to his memory, and his reputation restored to its original lustre." The article under notice will considerably conduce to this right placing of Eudoxus, amongst whose merits the least is not that he was a true man of science. "Of all the ancients, no one was more imbued with the true scientific and positive spirit than was Eudoxus." Five reasons for this statement follow, and the article closes. The whole paper is a most interesting as well as valuable one; indeed the interest grows as the author approaches his goal, and we venture to predict for Dr. Allman, when his articles appear in a volume, a most cordial welcome from all mathematicians.

THE ROYAL GARDENS AT KEW

THE Report of the Director on the Progress and Condition of the Royal Gardens at Kew for the year 1882 was unavoidably delayed. It bears date only from November 1, 1883, and was not published until well on in 1884. The date of the Report has, however, nothing to say to its interest and merit, and there is always plenty of both in these too short accounts of the great work carried on at Kew. Passing over some details, noting that the amount of damage which the collections have suffered has been, notwithstanding the unprecedented number of visitors, practically *nil*, and that the lecture-classes for young gardeners continue to give satisfactory results, we find an account of the formation of a Rock Garden at Kew. The site selected lies between the wall bounding the Herbaceous Ground on the east and the New Range on the west. The general idea in laying out this space was to imitate in some measure the rocky course of some Pyrenean stream; the dry bed is represented by the broad walk (8 feet wide and 514 feet long), while on either side are the rock-piled banks, in the interstices and pockets of which grow the Alpine plants, and above all are thickets of box and rhododendrons. Tree stumps have been somewhat freely used here and there. That some plants grow well on them will be admitted; that by their decay they require renewal is their chief drawback. The collection of 2630 plants bequeathed to the Gardens by Mr. Joad formed a splendid commencement to the Rock Garden series, and this section of the grounds has long since proved not only a centre of attraction to the general visitors, but has been a source of pleasure and profitable study to many an amateur gardener. An apology is made for not attempting some geographical arrangement of the Alpines; one was hardly needed. Where the plants grow best there ought to be their (artificial) habitat, and the practical gardener well knows what strange bedfellows plants often are, and how marvellously they vary in their tastes. Within the last six weeks we noted two finely-grown plants of that popular Alpine cudweed, the edelweiss; one was flowering out of a crack in a dry limestone wall, the other was on a deep clay bank.

The elaboration of the natural family of the palms for the "Genera Plantarum" of Bentham and Hooker led the Director to make a critical study of the species of palms in cultivation at Kew, the collection of which proved to be of unexpected richness. In an appendix is a classified list of 420 palms at present in cultivation at Kew. This collection has now but two rivals—the magnificent collection at Herrenhausen, Hanover, chiefly made by Herr Wendland, and that of the unrivalled tropical gardens at Buitenzorg in Java.

The report about the Arboretum shows an enormous amount of work accomplished. While the collection i one of the richest in existence, its importance is gradually more and more dawning upon those interested in planting, and its national importance in this respect should not be overlooked.

The part of the Report giving extracts from the large colonial correspondence that centres at Kew is full of interest, none the less so that much of the information is of a date often far on in 1883. The Argan tree seems likely to be acclimatised at Natal from seeds sent from Kew. The india-rubber (Ceara), introduced from Kew into Ceylon, seems in a fair way of paying as well as Cinchona. Dr. Trimen says it will grow anywhere up to almost 2500 feet, and its commercial success is most satisfactory. "About six months ago (October 24, 1883) some Ceara-rubber seed was imported from Ceylon into Southern India. The produce of these trees may now be seen flourishing in a wonderful manner at the foot of the Neilgherry Hills. The rapid growth of the trees is marvellous. Some which were six months old from seed were fully eight feet high; and a cutting, said to have been planted scarcely six months previously, was quite eight feet high, and was in blossom. It seems to thrive on poor soil, requires shelter but not shade, and very little rain. The demand for the produce seems to be unlimited." Of the mahogany seeds sent from Kew in 1868 to Mauritius, nine of the trees raised bore seeds in 1881, and numerous seedlings were found self-sown. In a report from the Seychelles allusion is made to "three different diseases which have seriously affected the cocoa-nut palms," whereby large forests of these valuable trees have been destroyed. No details are given as to what these diseases are, though they "have nearly stopped their depredations since 1882." In the same report it is mentioned that the remains of the clove plantations cover "about 250 acres"—surely a mistake. It is also stated that the Liberian coffee sent from Kew in 1880 has proved a success, and that about 100 acres of it have been recently planted. The report on *Cinchona robusta* quotes with approval Dr. Trimen's views on the hybrid forms of the Nilgiris—known under the names *pubescens* and *magnifolia*—now settled to be hybrids between *C. succirubra* and *C. officinalis*.

Among the more important additions to the Herbarium may be mentioned the collection of European and exotic lichens made by the Rev. W. A. Leighton, the type speci-

mens of Mr. Wilson Saunders's Refugium Botanicum, the Madagascar collection of the Rev. R. Baron—this latter of over 1100 species.

Reference is also made to the "North Gallery," an illustration of which is added to the Report. The collection of separate pictures of plants in the gallery amounts in number to 627, and has since been added to.

It will be seen from this brief sketch of Sir Joseph Hooker's Report that the work done at Kew is as varied as it is important, and that our colonies directly and our mother country indirectly are under lasting obligations to the zeal and energy of all concerned in the management of this great institution.

MR. THORODDSEN'S GEOLOGICAL EXPLORATIONS

ALTHOUGH situated at a comparatively short distance from Europe, and notwithstanding the frequent visits of late years by English tourists, Iceland is yet very far from being a well-known country. The upland is still, for the most part, an unexplored region, and there are whole districts where no man, native or foreign, ever set his foot, owing, chiefly, to the difficulties and dangers which attend travelling through these wildernesses. Foreigners travel mostly along beaten tracks; they come mostly without having acquired any previous knowledge of the peculiar nature of the country, consequently not knowing what parts are most worth visiting or exploring. Yet these regions are eminently interesting for students of natural science, being filled with innumerable glaciers, some of enormous magnitude, with multitudes of volcanoes, eruptive springs, &c., which it is of the greatest importance should be scientifically explored and described. In order to obtain reliable information about these upland wilds of the country, the Government of Iceland have commissioned Mr. Th. Thoroddsen to undertake systematic explorations with a view to establishing the geology of the country on a sound basis, and correcting its geography where necessary; for this purpose he has already undertaken various expeditions. In the course of last summer (1883) he explored the peninsula of Reykjanes and its upland connections. Although this part lies in close proximity to the inhabited parts of the country, it has hitherto remained for the most part a *terra incognita* on account of the innumerable waterless and utterly barren lavas which are crowded into it, and make travelling excessively arduous. Formerly people only knew that within historic times two volcanoes had been active in these parts. Mr. Thoroddsen has now determined the existence and site of no less than *thirty* separate volcanoes with at least *seven hundred* craters. In each case he has made all necessary measurements, and has constructed a geological map of the whole district.[1] The aggregate extent of the lavas covers about 44 square (geographical) miles. Out of the lavas up and down this tract there rise mountains composed of tufa and breccia, and through these the eruptions of the volcanoes proper have found their vent. Cases of individual volcanoes being built up in one spot by repeated eruptions are rare. The craters are in most cases traceable in distinct long rows, like beads on a string, along terraces of tufa, situated along chasms through which the lava welled out. In some places there are no craters, the lava having boiled out of the chasm over either side of it, in which cases the rift remains open with its brims covered with a glazed crust of lava. In other localities are found volcanoes of colossal size, broad sublevations or convexities of lava, with a large crater at the apex from 800 to 1000 feet in diameter, instances of which are Skjaldbreid, 3400 feet, and Heidin-Há, 2000 feet above the level of the sea. Throughout the lava stretches one comes upon enormous fissures all following the same direction as the rows of the craters, namely, south-west to north-east. All about this district there are also found numbers of hot springs, solfataras, and boiling clay-pits. This peninsula, Mr. Thoroddsen maintains, must be one of the most thoroughly burnt spots on the globe, and a pre eminently instructive tract for geologists who make volcanic manifestations the speciality of their study.

This summer Mr. Thoroddsen is engaged in exploring the enormous lava wilderness of Odádahraun, covering the central part of Iceland, and, as yet, for the most part entirely unknown. In the glaciers to the south of this wilderness great eruptions have taken place of late years, about which nothing is known, no one having as yet ventured into these wilds, lying 3000 to 4000 feet above the level of the sea. The difficulties of exploration here are enormously aggravated by the utter barrenness of the region, by scarcity of water, and by the frequent snow tempests by which the region is constantly harried even in the midst of summer. Even the compass is not to be relied upon, on account of the mass of iron which enters to such a large extent into the composition of the lava.

[1] published by the Geological Association of Stockholm.

Akreyri, June 24, 1884

Grimsey is the name of a small island, situated in the Arctic Ocean, about 22 English miles due north of the promontory which divides the bays of Eyjafjord and Skagafjord in Northern Iceland. It is inhabited by 88 human beings, debarred from all communication with the outer world, and equally ignorant of its motive thought as of its stirring events. Their intercourse with outward surroundings is confined to Arctic ice and ceaselessly recurring storms. Only once or twice a year they manage in their small open boats, at a perilous risk, to effect a landing on the mainland, for the purpose of obtaining by barter their necessaries of life at some of the north coast trading stations.

The island having never before been visited by a naturalist, I eagerly embraced the opportunity of joining the governor of the North District on an expedition to it, undertaken at the instance of the commander of the gunboat *Diana*, Capt. O. Irminger, of the Danish navy. In the evening of June 19 we steamed, in calm weather, from Akreyri down the broad bay of Eyjafjord, enjoying the imposing scenery of the mountains on either side, lit up by the subdued vermilion tints of the nocturnal sun glare; when we reached the mouth of the bay, we had a full, unintercepted view of the midnight sun, resting on the oceanic sky-line, like a ball of fire behind a veil of blood. Out of the inert calm of the deep, which looked like polished glass, there rose on either side of us black precipitous rocks that formed, as it were, the advanced basis of the snow-capped mountain-tops, which determined our sky-line in the landward distance.

We reached Grimsey at three o'clock in the morning of the 20th, still, as good luck would have it, favoured by the same calm weather and quiet sea—both being the indispensable condition of effecting a safe landing on the island. We took the shore just below the parsonage in a bight formed of precipitous rocks made of basaltic columns, here and there split up by yawning caves; and having succeeded in clambering to the top of the rocks, we set about exploring the island.

The formation of Grimsey is basaltic throughout, and, geologically speaking, resembles, closely on the whole, the stratification of Northern Iceland. From its non-volcanic nature one may therefore fairly assume that, once upon a time, it must have been connected with the mainland. But, though not volcanic itself, it seems that Grimsey is not very far removed from the lines along which the active subterranean fires in Iceland are operating. At various times the inhabitants state they have observed towards the south-east signs of submarine volcanic action, and towards Tjörnes (S.S.E.) a column of fire was distinctly observed breaking through

the surface of the sea in 1868; this, too (one of the northernmost promontories of Iceland), has frequently been visited by violent earthquakes, notably so in 1872. Towards the east the island rises precipitously out of the sea to the height of upwards of 300 feet, but slopes to the westward, where all the habitations of the people are scattered about. The flora is scanty, and the plants stunted in a remarkable degree; as far as I had opportunity to observe, the vegetation seemed to bear a distinct Arctic impress as compared with that of the mainland. The sward is covered with Arctic willow (*Salix herbacea*), resembling the same plant when met with on the mainland at an elevation of 1500 to 2000 feet above the sea-level. The flora of the eastern portion of the island is much more varied, as compared with that of the western, owing to the soil being much more fertile there from the guano deposited by the multitudes of birds which haunt that part of the island. Every ledge of rock is covered with the so-called "Skarfa-kál" (scurvy-kale, scurvy-grass, or spoon-wort, *Cochlearia officinalis*). Altogether I managed to collect here between fifty and sixty species of plants, all of which are also found on the mainland, only these are of a more stunted growth. No heath vegetation occurred, and no ligneous, if I except the above mentioned willow, which only grows to the height of one inch and a half.

The temperature of Grimsey is much milder than might be supposed from the geographical position of the island. Although it is visited every two out of three years by the Arctic ice, the average temperature of the year is + 1°·4 Celsius. August is the hottest month in the year, + 7½° C.; March the coldest, − 3½° C. The highest degree of heat in 1876 was + 20° C.; the greatest cold in 1880, − 30° C. The mildness of the temperature is accounted for by the fact, ascertained of late years beyond a doubt, that a small branch of the Gulf Stream splits off from the main current on encountering the resistance of the western submarine spurs of the rocky masses on which Iceland is built up, the flow of which branch, on wheeling round the north-western peninsula of the country, takes an eastward direction along the whole extent of the northern coast. The average temperature of the sea round Grimsey is about 4° C. in January and 3° C. in February. The pastor of the island, M. Pjetur Gudmundsson, has for many years been engaged in exceedingly careful meteorological observations on behalf of the Meteorological Institute of Copenhagen. This most worthy gentleman, living here in conspicuous poverty, like a hermit divorced from the world, though he has the comfort of a good wife to be thankful for, is not only regarded as a father by his primitive congregation, but enjoys moreover the reputation of being in the front rank among sacred poets in modern Iceland.

The inhabitants derive their livelihood, for the most part, from bird-catching, nest-robbing, and deep-sea fisheries. The precipices that form the eastern face of the island are crowded with myriads of various kinds of sea-fowl. On every ledge the birds are seen thickly packed together; the rocks are white with guano, or green-tufted with scurvy-grass; here everything is in ceaseless movement, stir, and flutter, accompanied by a myriad-voiced concert from screamers on the wing, from chatterers on domestic affairs in the rock-ledges, and from brawlers at the parliament of love out at sea, the surface of which beneath the rocks is literally thatched at this time of the year with the wooing multitudes of this happy commonwealth. If the peace is broken by a stone rolled over the precipice, or by the report of a gun-shot, the air is suddenly darkened by the rising clouds of the disturbed birds, which, viewed from the rocks, resemble what might be taken for gigantic swarms of bees or midges.

The method adopted for collecting eggs is the following:—Provided with a strong rope, some nine or ten stalwart men go to the precipice, where it is some 300 feet high, and one of the number volunteers or is singled out by the rest for the perilous "*sig*," *i.e.* "sink," or "drop," over the edge of the rocks. Round his thighs and waist, thickly padded generally with bags stuffed with feathers or hay, the "*sigamadr*," "sinkman," or "dropman," adjusts the rope in such a manner as to hang, when dropped, in a sitting posture. He is also dressed in a wide smock or sack of coarse calico, open at the breast, and tied round the waist with a belt, into the ample folds of which he slips the eggs he gathers, the capacity of the smock affording accommodation to from 100 to 150 eggs at a time. In one hand the "sinkman" holds a pole, 16 feet long, with a ladle tied to one end, and by this means scoops the eggs out of nests which are beyond the reach of his own hands. When the purpose of this "breath-fetching" "sink" is accomplished, on a given sign the "drop-man" is hauled up again by his comrades. This, as may readily be imagined, is a most dangerous undertaking, and many a life has been lost over it in Grimsey from accidents occurring to the rope.[1]

For the pursuit of the fishery the island possesses fourteen small open boats, in which the men will venture out as far as four to six miles cod-fishing; but this is a most hazardous industry, owing both to the sudden manner in which the sea will rise, sometimes even a long time in advance of travelling storms, and to the difficulty of effecting a landing on a harbourless island.

Now and then the monotony of the life of the inhabitants is broken by visits from foreigners, mostly Icelandic shark-fishers, or English or French fishermen.

Of domestic animals the islanders now possess only a few sheep. Formerly there were five cows in the island, but the hard winter of 1860 necessitated their extermination, and since that time, for twenty-four years, the people have had to do without a cow! Of horses there are only two at present in the island! Strange to say, the health of the people seems, on the whole, to bear a fair comparison with more favoured localities. Scurvy, which formerly was very prevalent, has now almost disappeared, as has also a disease peculiar to children, which, in the form of spasm, or convulsive fit, used to be very fatal to infant life in former years.

Inexpressibly solitary must be the life of these people in winter, shut out from all communication with the outer world, and having in view, as far as the eye can reach, nothing but Arctic ice. The existence of generation after generation here seems to be spent in one continuous and unavailing Arctic expedition. The only diversion afforded by nature consists in the shifting colours of the flickering aurora borealis, in the twinkling of the stars in the heavens, and the fantastic forms of wandering icebergs. No wonder that such surroundings should serve to produce a quiet, serious, devout, and down-hearted race, in which respect the Grimsey men may perhaps be said to constitute a typical group among their compatriots. However, to dispel the heavy tedium of the long winter days, they seek their amusements in the reading of the Sagas, in chess-playing, and in such mild dissipations at mutual entertainments at Christmas-time as their splendid poverty will allow.

TH. THORODDSEN

SEATS IN RAILWAY CARRIAGES

IN a recent article in *Science et Nature* the writer, after animadverting on the lateness of the day at which shoemakers have at length begun, though still very imperfectly, to take account of the osseous framework of the human foot, proceeds to investigate the relation between

[1] This is a fate that befalls too many of the "sinkmen" of Iceland, for there are numbers of them all round the coast. It would be easy, at a very small cost to the treasury of Iceland, to provide a perfectly safe movable apparatus for every district where life must be sustained at the above-described risk. The authorities would, no doubt, readily meet any reasonable request on the subject.—E. M.

the structure of the human trunk and that of the seat, more particularly in railway carriages, designed for its accommodation. In a sitting posture the pelvis has for its sole function the support of the upper part of the

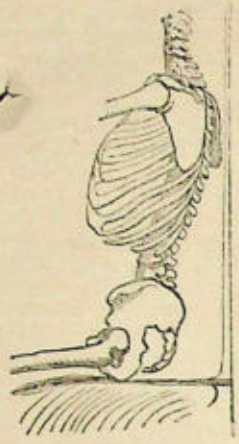


Fig. 1.

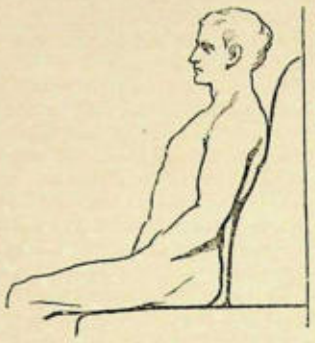


Fig. 2.

body. The spinal column, however, is inserted in the pelvis, not in the form of a straight line but of a curve (Fig. 1). This inflection on the part of the backbone, while adding to the mobility of the trunk, imposes on it

Fig. 3.

Fig. 4.

the necessity of a continual balancing movement, the centre of gravity being shifted every time the head and thorax sway to one side or the other. Such balancing

Fig. 5.

Fig. 6.

movement is necessarily also attended by a certain expenditure of energy. To allow the upper part of the body to remain comfortably at rest there must be supports for the back, the shoulders, and the head. So far as these are wanting, the body will tend of itself, unless counteracted by an effort of will and nervous force, to bend forward, till at last the forehead finds the knees to lean on. The position of the body in sitting is all the easier, and its rest all the more complete, the more decided is the inclination of the back of the seat and the more obtuse is the angle formed by the trunk and

Fig. 7.

the thighs. Seats such as the *dormeuses* realise the most favourable conditions in this respect.

Fig. 2 represents a man comfortably seated and propped. The back of the seat supports him principally under the shoulder-blades, offers the chest a depression to sink in, and altogether keeps the upper part of the body in a free and easy position. Fig. 3 shows the same person in a similar position, but with his head resting

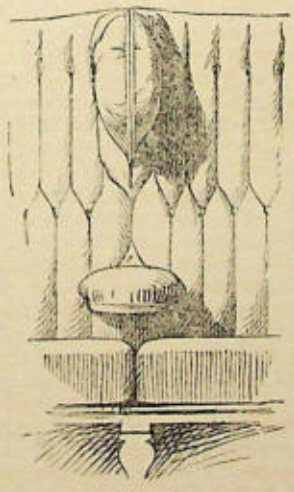


Fig. 8.

behind. In both these figures the back of the seat is seen exactly in profile, and to the writer of the article such seems the construction which is most convenient in railway carriages.

Fig. 4, on the other hand, represents the profile of a man seated as passengers are in many of our actual first-class carriages. His position is perceived to be a forced one in contrast with that just noticed, and alto-

gether disagreeable. Fig. 5 shows exactly the stiff attitude the head is compelled to take in order to rest.

Finally, Fig. 6 reproduces the comfortable position indicated in Fig. 3, and at the same time represents the profile of the back of the seat actually in use in our railway carriages. On comparing this profile with the position of the man comfortably supported, the following defects in the back of the seat are observed :—

1. It is too vertical.

2. It allows an empty space between the lumbar vertebræ and the lower extremity of the shoulder-blade exactly at the place where one is in the habit of putting a cushion "behind the back," as it is called.

3. It is at least half a foot too high, and so makes it impossible for the head to rest behind. It is customary to make the back of the seat tally with the height of a man of average size seated bolt upright.

Under the actual conditions, such as they have been

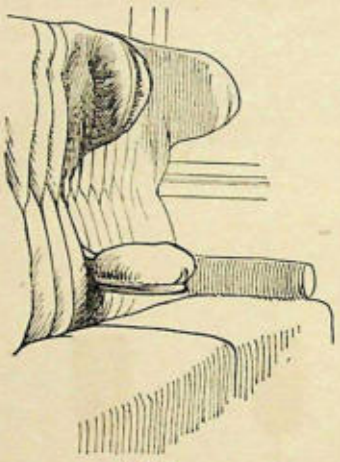


Fig. 9.

described, what becomes of the traveller when sleep at length overtakes him? Little by little he slides down on his seat till the lower extremity of his shoulder-blades, which has most need of support, finds the most sensible projection, which, as the backs of our railway carriages actually are, is precisely where it is least serviceable—at a point, namely, on a level with the region of the pelvis. Lastly, the head inclines forward or to the side, if it does not bury itself in the breast (Fig. 7).

Fig. 8 gives a front view of the face of the bench serving as the back of the seat. In the centre is seen a stuffed projection, on each side of which a passenger may rest his cheek. The shoulder, getting no separate support, must contrive to lodge itself between this stuffed projection and a kind of plateau fixed in the side of the back of the seat, and which, situated about a hand's breadth above the seat, offers a resting-place to the elbow (Figs. 8 and 9).

A NEW PRINCIPLE OF MEASURING HEAT

THE following method is intended to fulfil some conditions which probably will be more and more urgently required in the progress of modern science :—

1. *Measurements of heat should be executed at constant temperature, i.e. without the aid of thermometers.*—Every variation of temperature during calorimetric experiments causes unavoidable errors and necessitates corrections and compensations. The accuracy of the thermometric method ["method of mixture," of Regnault], which now predominates among experimentalists is unrivalled, only in those cases where the amount of heat to be measured is developed in the course of a few seconds or minutes ; it is seriously impaired whenever the experiment lasts longer, while the influence of the corrections for radiation, &c., increases proportionately with the duration of the operation. The first method used in thermo-chemical investigations, the ice-melting method of Lavoisier and Laplace, as well as the modern calorimetric method by Bunsen, avoids this inconvenience by executing all measurements at the melting-point of ice. Bunsen's ice calorimeter is, however, not exempt from corrections. Every physicist familiar with the use of this instrument will also, like the author, be well acquainted with its capriciousness. Bunsen prescribes that the calorimeter should be placed in a large vessel filled with absolutely pure snow. Although I have had abundant quantities of the purest snow at my disposal, I do not hesitate to declare, having tried, in company with Prof. Nilson, a whole winter to obtain reliable results with the original arrangement of the inventor, that the instrument would be impracticable for use without the improvement devised by Schuller and Wartha, viz. to immerse the calorimeter in a vessel containing ice and pure water at 0° C. Still the advantage of this arrangement is not to prevent variations in the position of the mercury index, but to make them quite *regular*. These variations are declared by some physicists to depend upon the vacillation of atmospheric pressure, but I think that the real

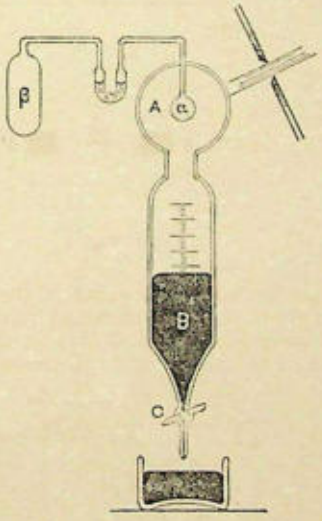


Fig. 1

cause of the unsteadiness of the index of the instrument lies in the peculiar behaviour of the ice in the vicinity of its melting-point. It was believed hitherto (and Bunsen's method theoretically rests upon this assumption) that ice at 0° C. suddenly changes its specific volume from that of ice [= 1·090686][1] to that of water [= 1·000000]. I admit that this assumption *may* be true with regard to *absolutely pure ice*, but in every kind of frozen water which contains the smallest trace of impurity (which is unavoidable if the water has been boiled assiduously in a glass vessel) the transition of ice into liquid water is not sudden, but gradual, *and begins already a little below* 0° *C.* Such ice does not attain its maximum of volume exactly at 0° C., but some hundredths or tenths of a Centigrade degree below 0° (dependent upon its relative purity). Graphic representation[2] shows that the co-ordinate of specific volume of the ice comes not to a *point d'arrêt* at zero, but moves upon the rapidly-sloping branch of a curve just in the immediate vicinity of the melting-point. Now suppose the water in the external vessel to be either a little purer than that of the calorimeter, or *vice versâ*. In the

[1] This number, which is almost identical with that of Bunsen, was found by the author in his research "Upon the Properties of Water and Ice," "*Vega*-expeditionens vet. iakttagels," Bd. ii. p. 275.

[2] See the paper "Upon Water and Ice," by O. Pettersson, *l.c.*

former case its temperature, *i.e.* its melting-point, will be situated a few thousandths of a Centigrade higher, and the volume of the ice in the calorimeter will move down-

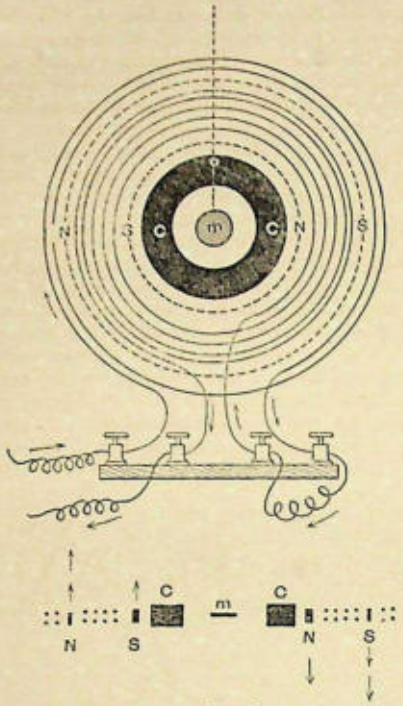


Fig. 2

wards on the branch of the curve in the attempt to gain the temperature of the surrounding medium. Then the index will move slowly backwards ; in the other case the co-ordinate of specific volume will move upwards on the

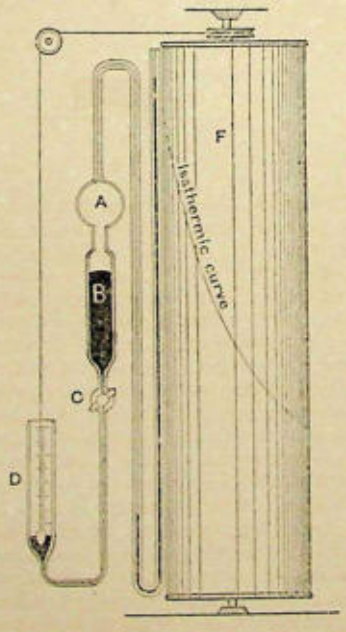


Fig. 3

sloping branch, and the index of the scale-tube will march forwards. These remarks may be sufficient to explain why there has been much dispute about the absolute magnitude of the caloric units indicated by the ice calorimeter of Bunsen, and why this instrument is always *empirically* graduated, although its principle ought to allow *of absolute* measurements.

II. *The amount of heat developed in calorimetric experiments should be directly transformed into work and measured in absolute units* [kilogramme-metres].[1]—In every branch of physical science this manner of measurement is beginning to introduce itself, as, for example, in electricity, magnetism, &c. In thermal determinations it has the great advantage that the mechanic units are 430 times greater than the thermic units, and can be far more accurately determined.

III. *The principle should be applicable to the measurement of all kinds of caloric energy: as, specific heat, radiant heat, the heat absorbed or developed by chemical reactions, &c.*—It must be remarked that I have hitherto experimented only with *radiant heat.* An apparatus intended for other kinds of heat is under construction,

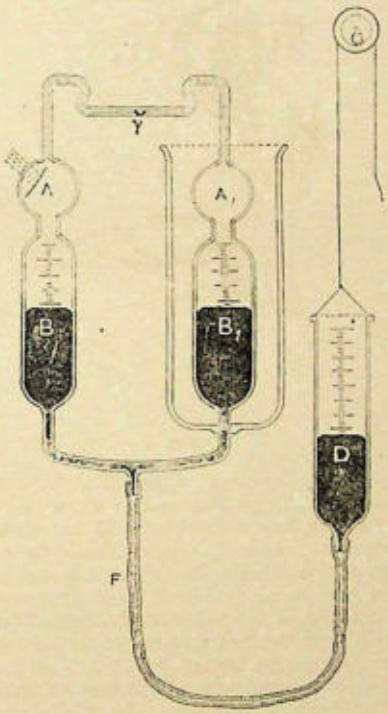


Fig. 4

but as this will take some time, and as I wish specially to direct my labour to the determination of the sun's radiant heat, I take the opportunity now of calling the attention of physicists to the principle of the method, which I foresee can be developed and varied in a multitude of ways. In case the matter should interest anybody sufficiently to make him try it experimentally, I will give some information in order that he may not be detained by those difficulties which have baffled my own efforts during nearly six years. The principle is extremely simple, and will be easily understood by a glance at the diagram (Fig. 1).

Let a beam of heat rays fall upon the thin glass wall of the reservoir A, which contains dry air. As soon as the thermometer $\alpha\beta$ indicates that the temperature of the air in A *increases*, let mercury escape through the stop-cock C. Thereby the air *expands*, and the heat received by radiation is transformed into mechanic work, as the level of mercury in B sinks under the influence of the expanding force imparted to the air by the radiant heat.

[1] I denote this in the following by the sign M:K.

As the air in A in this case has expanded *isothermically*, the mechanic work is represented by the equation

$$x = p_0 v_0 \log_{nat} \frac{v}{v_0},$$

where p_0 v_0 are the initial pressure and volume of the air in A, and v is its volume after the expansion. If we suppose that a beam of sun rays during a minute has fallen upon the blackened surface of A through a hole of a square centimetre, and that the experimenter has neutralised the tendency of the air to increase in temperature by careful manipulation of the stopcock C, which allows the air to expand its volume as it displaces the escaping mercury—suppose that in this way the cooling effect of the expansion has neutralised the tendency of the air to augment its temperature under the influence of the heat radiation, so that the index of the thermometer has been kept *constantly* at its initial point, then the *entire* amount of solar heat imparted to the glass reservoir A is converted into mechanic work by means of the isothermic dilatation of the air, and the value of x found by the above equation represents what is called by modern scientists "the solar constant."[1]

It is obvious that the chief difficulty lies with the thermometer. The indications of this part of the instrument must be *extremely sensitive* (up to some thousandths of a degree Centigrade) and *instantaneous*, in order that the experimenter may be able to regulate the expansion so that a real isothermic dilatation takes place. I judged that only two kinds of thermometers could suit the purpose, and tried first a differential glass thermometer. This is in fact very sensitive, but as the pressure in A diminishes during the experiment, the bulb *a* expands somewhat, and this has a disturbing influence upon the index. I next inserted in A a network of very thin thermo-electric elements (combinations of iron and German silver), and observed the alterations of temperature of the air in A by means of a mirror galvanometer. As I found the ordinary system of magnets in galvanometers far too heavy for the instantaneous deflections here required, I constructed a new kind of galvanometer, whereof I give a schematic view in Fig. 2, because I think that it may really do some good work in other cases, as it proved to be extremely sensitive. The dotted lines represent a system of two concentric (annular) magnets made of steel springs (from watches), each magnetised to saturation between the poles of a powerful Plücker electro-magnet. They are combined in the astatic manner, but the dimensions of the material are chosen so that the *inner* magnet has just sufficient force to keep the whole system in the magnetic meridian. The figure shows the position of the insulated copper wires relatively to the magnets. M is a mirror of very thin silvered glass; C C is a massive copper ring. I tested the sensibility of the instrument by adiabatic expansion of the air in A. This was effected by opening the stopcock C for a moment. The slightest dilatation of the air in this manner immediately showed its cooling effect by a deflection of the scale in the mirror, but as the deflection soon brought the magnets out of the electric field, the *amplitude* of the oscillation was, as I had calculated, not great. However, as the oscillations did not cease instantaneously, I found the method impracticable for *continuous* observation. I then abandoned the project of regulating the isothermic expansion *by means of a thermometer* altogether.[2]

The next arrangement, which succeeded better, was that shown in Fig. 3. Here the co-ordinates of the isothermic curve are traced out beforehand on the rotating cylinder F. As the mercury in B flows into D, it lifts a float, which, by a combination of wire and blocks, makes the cylinder rotate at a rate which is proportional to the expansion of the volume of the air in A. Thus the horizontal co-ordinate (v) of the isothermic curve is represented. The vertical co-ordinate of the pressure of the air in A (p) is represented by the height of the liquid in the open branch of the manometer. The operator only has the task to regulate the outflow of the mercury from B to D by means of the stopcock C, so that the level of the fluid in the manometer closely follows the isothermic line drawn upon the paper envelope of the rotating cylinder. This is not difficult after a little experimenting. Whenever the level in the manometer shows a tendency to rise above the isothermic line, there is a surplus of heat in A waiting for transformation into work, which can be effected by accelerating the outflow of the mercury through C. The area contained between the initial and final ordinates [p_0 and p, represented by the positions of the column of liquid in the manometer-tube relatively to the cylinder at the commencement and the close of the experiment] represents the value of the integral—

$$p_0 v_0 \int_{v_0}^{v} \frac{dv}{v}$$

or *the amount of mechanic work equivalent to the transformed caloric energy*. Thereby this method affords an elegant manner of showing the actual transformation of all kinds of heat into work to an auditory. In order to obtain indications on a grand scale I always used H_2SO_4 tinted blue with indigo in the manometer. The rotating cylinder is about 2 m. high, and a quantity of heat of not more than 8·76 gramme-calories, imparted by radiation or otherwise to the air in A, makes the cylinder rotate 360°, and the level of the liquid in the manometer sink 1·84 m.[1] The volume of A was 400 c.c., and the initial pressure equal to 1000 mm. (of mercury). But for scientific measurements I cannot recommend this method. The sulphuric acid *adheres* to the glass tube, and does not take up its definitive level *at once*, the dimensions of the apparatus become inconveniently large, the co-ordinate p cannot be traced out on the paper of the cylinder directly from the isothermic equation,

$$p v = R T_0,$$

but must be recalculated with the aid of some corrections arising from the influence of the atmospheric pressure upon the columns of liquid in the manometer and in D, too complicated to be mentioned here.

Fig. 4 shows a kind of calorimeter which realises the condition of isothermic dilatation of the air in the most simple manner and still is capable of the most accurate measurements.

A and A_1 are very thin glass vessels fabricated of equal shape and size by Franz Müller in Bonn. Both contain dry air over mercury, which stands at equal height in B and B_1. If the graduated glass tube D, which communicates with A and A_2 through a caoutchouc tube, is raised or lowered by means of the arrangement shown in the figure, the level of the mercury rises or sinks equally in B and B_1, and the air in A and A_1 is compressed or dilated equally, provided that the temperature is kept *constant* in both. This condition is realised in A_1 by the surrounding *large* mass of water, which imparts to the air and mercury in A_1 and B_1 its own constant temperature. *The air in* A_1 *therefore always expands or contracts isothermically.* If its initial volume and pressure are denoted by v_0 and p_0, the law of Mariotte,

$$v p = v_0 p_0,$$

will always regulate the expansion of the air in A_1. It is easy to see that this will also be the case in A, if the experi-

[1] Uncorrected.

[2] I think the thing will be very difficult to realise in this way. If another indicator could be substituted for the galvanometer, for example, the Lippmann capillary electrometer in the ingenious form devised by Chr. Lovén, the experiment would be very easy. But, unhappily, this instrument is insensible to thermo-electric currents.

[1] *i.e.* theoretically. This height is somewhat reduced by the corrections for the pressure, &c.

ment is conducted so that during the dilatation of the air in A and A_1 the index of the differential thermometer γ, which combines both instruments, is kept *constant*. Suppose then a beam of heat rays to fall upon a thin piece of platinum foil[1] in A *through the glass wall*. The immediate effect of radiation is to elevate the temperature of the air in A, but as an increase of only 0·0016 of a centigrade causes a displacement of the differential index γ of 1 mm.,[2] it is easy for the operator to compensate this tendency and transform the heat into work by lowering the graduated tube D, which makes the air in A and A_1 expand. This expansion is *isothermic* in both, because volume and pressure varies in the same way in A as in A_1, where it, as shown formerly, follows Mariotte's law.[3] The rate of expansion of the air is indicated by the rise of the mercury in the calibrated tube D. The sensibility of the differential index is so great that it requires a very steady hand to regulate the movement of D so that the index keeps constantly at its initial point, without making greater excursions to either side than 1 or 2 mm. Every irregularity in the movement changes the isothermic expansion into adiabatic dilatation or compression. I therefore prefer to regulate the sinking of D by means of a screw. During the experiment A must be protected by isolating screens, &c., from outward disturbing thermal influences. I think I have realised this in a satisfactory way, but as a detailed account of the arrangement would be too long, I must reserve the complete description for a future paper.

Lastly I will mention some examples of determinations of the radiant heat emitted by a regulation gas-burner at 22·5 cm. distance from A. The radiation was admitted through a screen with an opening of $4\frac{1}{2} \times 2\frac{1}{2}$ cm. The initial volume of the air in A[4] was 622·22 c.c. The pressure was brought to 760 mm. Experiment I. was made at noon, II. in the afternoon of the same day.

Experiment I.—Increase of volume by expansion during 6 minutes = 185·9 c.c. Mechanical equivalent of the radiation during 6 minutes = 1·680 M.K°. Mechanical equivalent of the radiation during 1 minute = 0·280 M.K°.

Experiment II.—Increase of volume, &c., during 5 minutes = 158·5 c.c. Mechanical effect of radiation in 5 minutes = 1·459 M.K°. Mechanical effect of radiation in 1 minute = 0·291 M.K°.

I have measured in this way the mechanical effect of radiations, the caloric energy of which was only 0·08 of a gramme-calorie in the minute. *This method is free from every kind of correction.* It is obvious that, by means of a thin test-tube hermetically inserted into A, calorimetric determinations of specific heat, &c., could be made, but I have not yet arranged the apparatus for this purpose.

OTTO PETTERSSON

Stockholms Högskolas Laboratorium, June 25

NOTES

THE Government have directed Dr. Klein, F.R.S., and Dr. Heneage Gibbes, to proceed to India to pursue a scientific inquiry into the nature of cholera. It is understood that these gentlemen will act in conjunction with the Commission nominated a few weeks ago by the Indian Government for the same object.

AT the meeting of the Council of the Marine Biological Association on Friday, July 25, Prof. Moseley in the chair, the names of Prof. Allman, F.R.S., and Sir John St. Aubyn, Bart., M.P., were added to the list of Vice-Presidents, and Mr. Spence Bate of Plymouth was elected on the Council. It was decided that, provided certain arrangements promised by a committee of the Town Council of Plymouth were carried out, the Association should proceed to erect its first laboratory on Plymouth Sound. Plymouth is not only the best position for the laboratory on account of its natural features, but the local committee has offered to the Association a free site on the seashore and a subscription of 1000*l*. A vote of thanks to H.R.H. the Prince of Wales for having become the Patron of the Association was carried. The financial prospects of the Association were reported as highly satisfactory. The building of the laboratory will probably be commenced in the spring.

THE eighth International Medical Congress is to be held in Copenhagen from August 10 to 16. President, Prof. Dr. P. L. Panum; Secretary, Dr. C. Lange, both of Copenhagen. Among the most eminent of the 658 medical men who have engaged to attend are:—Prof. Lister, Sir William Gull, Bart., Prof. Dr. L. Pasteur, Prof. Paul Bert, and Prof. Dr. R. Virchow.

THE Congress of the British Medical Association opened in Belfast on Tuesday. Prof. Canning directed his presidential address mainly to an analysis of the origin and causes of the spread of epidemic diseases.

THE prospectus has just been issued of the new "Società di Geografia ed Etnografia," founded in Turin in anticipation of the Italian Geographical Congress, which meets in that city on August 15. The Congress is a passing event, but the Society has probably a brilliant career before it, established as it is under the auspices of Prof. Guido Cora, its first President. The well-known *Cosmos* of the distinguished geographer becomes the authorised scientific *Journal* of the Society, a happy arrangement which cannot but prove mutually beneficial. In other respects everything is for the present provisional, and the council, including besides Sig. Cora such names as those of Luigi, Schiaparelli, Enrico Morselli, and Alessandro di Cesnola, holds office only till the beginning of next year, when the statutes will be definitely settled, and a permanent administration established. Meantime it is satisfactory to find that ethnology, a branch of geographical science so strangely neglected by existing geographical institutes, is to receive all due prominence and encouragement. Another important feature is the attention to be paid to commercial and industrial geography, especially as regards Italy in its relations with foreign countries. This idea also, *mutatis mutandis*, might be advantageously adopted by similar learned bodies elsewhere.

THE *Bollatino* of the Italian Geographical Society for July publishes the circular, regulations, and programme of the first Italian Geographical Congress, which meets in Turin from the 15th to the 19th of next August under the presidency of the President of the Italian Geographical Society. All except honorary members to be specially named will be expected to contribute towards the expenses sums varying from ten to thirty francs. In return they will have free access to all the scientific gatherings, and will be entitled to a copy of the *Proceedings* of the Congress. There will be two Sections—a Scientific and Commercial, and questions will be discussed in connection with mathematical, physical, ethnographic, political, economic, and historic geography. Amongst the subjects proposed for discussion are the following:—"What ethnological conclusions are to be drawn from the more recent anthropological and philological data, regarding the indigenous populations of East Africa?" "Considering the part already taken by Italy in scientific exploration in the Polar seas, what are the best means of organising an independent Italian expedition to the Antarctic regions?" "On the need of preparatory schools for training

[1] It is blackened in the following way. It is galvanically coated with a thin layer of metallic copper, and afterwards heated in a current of oxygen. This arrangement gives most sensitive indications.

[2] This is the case in the apparatus constructed by the author. The index there consists of a small drop of coloured alcohol. If H_2SO_4 is substituted for the alcohol, the sensibility of the apparatus is lessened considerably.

[3] In my last constructed apparatus I have substituted a vessel of thin copper instead of the upper part of the glass vessel A_1. This arrangement answers the purpose excellently.

[4] And also in A_1, which is of the same size. This condition is, however, by no means indispensable. A_1 can be greater or smaller than A, only the dimensions of A and A_1, B and B_1 are proportional to each other.

travellers in the work of exploration." "On the best means of turning to better account for science and commerce the work of Italian explorers." "On the importance of establishing commercial stations in the Barbary States as a means of gaining access to the Sudan"; and "On Geographical Education."

MR. RIVETT-CARNAC sends us a handy reprint of his valuable paper "On the Stone Implements from the North-Western Provinces of India," originally published in the *Journal* of the Asiatic Society of Bengal. The striking resemblance that the remains of the Palæolithic and Neolithic ages bear to each other wherever found in the Old and New Worlds, has often been commented on, and receives fresh illustration from the three plates of celts, arrowheads, hatchets, hammers, weights, and other objects, accompanying the brochure. These specimens are lithographed from photographs, and all made to scale, whereby their value is greatly enhanced for the comparative study of similar objects elsewhere. It is pleasant to learn that the best specimens have all been presented to the British Museum, while casts of some unique types peculiar to India have been made for the chief museums of India, Europe, and America, and even for some private persons interested in prehistoric research.

EVEN in Rome the aërial disturbances caused by the Krakatoa explosion were clearly indicated on the registering barometers. On examining the curves of the Richard barograph Prof. Tacchini found that, although the daily curves followed regularly in accordance with the normal barometrical conditions in Europe, those of August 27, 28, and 29, 1883, betrayed slight indentations, which, without changing the daily record of the pressure, show that for short intervals its precision oscillated abruptly, owing to the passage of the above-mentioned waves. These barometrical oscillations occurred at the following times:—12.7 of the 27th, 5.6 a.m. of the 28th, 1.48 a.m. of the 29th, and, lastly, about 4 p.m. of the same day. The time of the volcanic explosion was determined by Tacchini by the report of S. Raffo, captain of the Genoese brigantine the *Adriatic*. S. Raffo states that during the night of August 26–27 continual peals were heard, and that at eight o'clock next morning he heard one of extraordinary violence, accompanied by a shock to the vessel, which was then in 10° S. lat. and 105° E. of Greenwich. Tacchini accordingly concludes that the time of the explosion corresponded with 1.30 a.m. of the 27th at Rome. From these data he finds that the wave reached Rome from Krakatoa by the west, leaving the volcano at a velocity of 277 m. per second, and that moving in the opposite direction at a velocity of 296 m. He further calculated by the observations made at Rome that the complete atmospheric circuit round the globe was effected by the east, leaving Rome at a velocity of 295 m., and of 318 m. by the west. Captain Raffo has forwarded to Rome a quantity of the dust collected on board the ship on that day.

WE learn from *El Liberal* of Madrid, July 23, that D. Auguste Arcimis has been observing sunset phenomena very similar to those witnessed last autumn and winter. He has besides noticed an extremely brilliant silver-white corona around the sun, having a horizontal diameter of about 48°.

THE Afghan Frontier Commission will, we are glad to learn, include a geologist and native botanist, as well as three surveyors. But, as Mr. Sclater suggests in the *Times*, it is to be hoped that the scientific staff will also include a zoologist or at least a zoological collector. Mr. Sclater writes:—"The country to be passed through by the Afghan Frontier Commission, although probably in the main part bare and arid, is of the deepest interest to zoologists, as being situated nearly on the boundaries of the Palæarctic and Oriental regions. The numerous Russian and American Surveys which have been sent out of late years with similar objects have always given a place in the scientific staff to zoology as well as botany and geology. There is no reason, it seems to zoologists, why our Government should not follow such an excellent example, especially when there will be no difficulty among the numerous Indian officers who are now interested in zoology in finding a suitable person. Let me, therefore, express a hope in the name of British naturalists that a zoologist will be added to the 'scientific staff' of the Afghan Frontier Commission."

WE are glad to notice that the new St. Paul's School at Hammersmith includes physical and chemical laboratories.

IN a lecture on the Olympic Festival by Dr. A. Emerson at Johns Hopkins University, the lecturer stated that in the Olympic games uniform training, early registration, and fair play were required of the athletes, under penalty of exclusion, or, if fraud was discovered too late, of heavy fines. Dr. Emerson gave the following as the ancient and modern records of running and leaping:—

Day's run: Good Greek record, 150 km.;
Good modern record, 163 km.
Long running jump: Best Greek record, 55 feet;
Best modern record, 49 feet (Engl.) 3 inches.

As the victors in the horse-races, Dr. Emerson stated, were the registered owners of the animals, such victories could be and often were won by women.

MR. H. M. STANLEY arrived in England from the Congo on Monday.

THE Bangkok Correspondent of the *Times* telegraphs that Mr. Holt Hallett and his party have reached Bangkok after an arduous expedition, lasting five months and thirteen days, from Moulmein to Bangkok through North Siam. Mr. Hallett succeeded in reaching his destination, though severely fatigued. He will return and spend one month in England, and it is hoped that the sea voyage will recruit his health. On his arrival in London he will submit a preliminary report to the Chambers of Commerce and the Geographical Society, and will return and continue the surveying operations in November. The work completed comprises the surveying of over 1500 miles, the determination of the position of the Shan ranges, and a large series of observations on the vocabularies of the aboriginal races and the histories of the several Shan States. A mass of information throwing light on the interior of Indo-China, especially of North Siam, was gathered. The reception of the expedition was from first to last excellent. This fact was due mainly to the favourable attitude of the natives and the tact and conciliation of the leader.

THE Normanic coast of the Kola peninsula will be visited this summer by several explorers. MM. Enwald and Edgren will investigate its natural history; M. Kusheleff the fishing along the coast; M. Hartzenstein has undertaken researches into the fauna and flora of the neighbouring sea; M. Istomin is engaged in ethnographical researches; and M. Abels, of the Central Physical Observatory, is now at Archangel, in order to establish meteorological observatories in the north.

AT Forio, in the island of Ischia, a powerful shock of earthquake was felt on the 23rd inst. The tremor was proceeded by a loud subterranean rumbling like thunder, or the roar of artillery. The exact time when the event took place was twenty minutes to one o'clock p.m. Fortunately, the phenomenon lasted but momentarily, and passed off without doing any material damage to property, or causing any loss of life. An earthquake also occurred at Massowah on the 24th. Nearly all the houses in the town were destroyed or damaged by the shock. All the ships in the harbour were seen to rock violently.

THE employment of acupuncture and cauterisation by Chinese doctors forms the subject of an article in one of the last numbers

of the *North China Herald*. A native public writer not long since claimed that a skilful physician in this department of medicine could cure such diseases as imbecility, fits, cholera, &c. The principle of cauterisation is simply that of counter-irritation; and the English writer bears personal testimony to its efficacy in the case of a slight sunstroke, although the operator was a simple Manchu peasant, and instrument a couple of copper coins. Very extraordinary cures are attributed to acupuncture by the Chinese. It is first performed in the hollow of the elbow of each arm. If the puncture draws blood there is no danger, but if no blood appears the case is regarded as very grave. But before abandoning the sufferer, puncture of the abdomen is tried. Seizing a handful of flesh, the operator drives the needle right through it, and then draws it backwards and forwards a few times. If the patient manifests any sense of pain, or if any blood is drawn, a poultice of eggs and buckwheat flour is applied over the puncture, and recovery is regarded as almost certain; but if no pain is felt and no blood flows, the case is declared hopeless, and the sufferer is left to die. The case is then quoted of a young Chinese, educated abroad, who was attacked with cholera; his extremities became cold, and cramp set in in a somewhat alarming manner. The barber-surgeon who was called in commenced by running a needle into the pit of the patient's stomach, a jet of very dark blood following; he then punctured the calf, the two breasts, and the forehead of the sufferer, freeing a certain quantity of blood at each prick. The relief is said to have been instantaneous, and in two days recovery was complete. The Chinese explanation of this treatment is that, when the blood is in the poisoned condition which induces the choleraic symptoms, it becomes thick, and accumulates in certain portions of the body. A clever surgeon knows exactly how to put his finger on the particular spots, and, by skilfully "opening the mouth of the heart," as the operation is called, sets free the poisoned fluid which causes all the mischief. It is noteworthy that faith in the efficacy of this mode of treatment is not confined to the masses, but is shared by Chinese who have been abroad and have had ample experience of Western medical practice.

Mr. James Hopps, Indian Engineering College, Cooper's Hill, writes us with regard to his paper on the electric resistance of metals, read before the Physical Society (NATURE, vol. xxx. p. 283), that an *increase* of resistance on *uncoiling*, and a *decrease* on *coiling* takes place with lead, copper, German silver, aluminium, and magnesium, and also during the first few operations on soft iron. An *increase* almost invariably follows coiling and uncoiling with zinc, but the effects of coiling vary from ½ to ⅛ of the effects of uncoiling. The full paper will appear in the Society's *Proceedings*.

The additions to the Zoological Society's Gardens during the past week include a Malbrouck Monkey (*Cercopithecus cynosurus* ♂) from West Africa, presented by Mr. J. H. Harling; a Cape Sea Lion (*Otaria pusilla*) from South Africa, presented by Mr. John Hunt; two Daubenton's Curassows (*Crax daubentoni* ♂ ♀) from Venezuela, a Common Guinea-Fowl (*Numida meleagris*), British, presented by Mr. W. Burch; two Indian Kites (*Milvus govinda*) from Eastern Asia, presented by Mr. W. Jamrach; a Barn Owl (*Strix flammea*), European, presented by Mr. G. H. Garrett; three Angulated Tortoises (*Chersina angulata*), two Geometric Tortoises (*Testudo geometrica*) from South Africa, presented by the Rev. G. H. R. Fisk, C.M.Z.S.; two Smooth Snakes (*Coronella laevis*), European, presented respectively by Mr. W. H. B. Pain and Mr. F. H. Jennings; two Black-tailed Deer (*Cariacus columbianus* ♂ ♀) from North America, two White-backed Piping Crows (*Gymnorhina leuconota*) from Australia, two Common Cormorants (*Phalacrocorax carbo*), British, deposited; two Red-capped Parrots (*Pionotsitta pileata*) from Brazil, a White-bellied Sea-Eagle (*Haliaetus leucogaster*) from Australia, a Mohr Gazelle (*Gazella mohr* ♀) from North Africa, a Violet-necked Lory (*Eos rinciniata*) from Moluccas, a Black Tortoise (*Testudo carbonaria*), a Common Boa (*Boa constrictor*) from South America, two Electric Eels (*Gymnotus electricus*) from British Guiana, purchased; three Elliot's Pheasants (*Phasianus elliotii*), bred in England; a Mule Deer (*Cariacus macrotis*), a Mesopotamian Fallow Deer (*Dama mesopotamica* ♂), born in the Gardens.

OUR ASTRONOMICAL COLUMN

Schmidt's Variable-Star in Virgo.—On June 6, 1866, Schmidt remarked, east and south of Spica, a star which he at first estimated 4 m., subsequently 5·4, not found in Argelander's *Uranometria*; it was much better visible than *i* Virginis, the reddish-yellow fifth magnitude south of Spica. By observations during the next fortnight its light appeared to have slowly diminished, nevertheless on June 19 it was still visible with the naked eye, though there was strong moonlight. On examination of the catalogues, &c., it was found that Lalande estimated it 6·7 on May 10, 1795; Piazzi calls it 6·7 and 7 in the *Storia Celeste*, not 8 as in the printed catalogue: Bremicker entered it of the seventh magnitude on his Berlin chart, while Lamont calls it 8 m. in Zone 355, observed on May 22, 1846. Heis has it 6·7, while Gould says, "Var. 5½–6¼." Houzeau judged it a sixth magnitude at the date 1875·11. We have thus evidence that it has been pretty conspicuously visible to the naked eye, while, on the authority of Bremicker and Lamont, it has been at other times beyond average unassisted vision.

Schjellerup has raised a point of much interest in connection with this star. There has been a difficulty in identifying satisfactorily Ptolemy's 19th star in Virgo, which he calls a fifth magnitude (ε in his notation). Baily, in his notes to his edition of Ptolemy's Catalogue, published in vol. xiii. of the *Memoirs* of the Royal Astronomical Society, writes: "The star 68 Virginis agrees with the position given by Ptolemy; but it is difficult to make it accord with the description, as being in the 'latus sequens' of the quadrilateral figure." Schjellerup, in his translation of Sûfi, remarks: "A l'endroit où, selon la description détaillée que nous a fournie Sûfi, doit se trouver la 19e étoile, il n'y à aucune étoile aujourd'hui visible à l'œil nu, selon *Uranometria Nova* d'Argelander, pendant qu'il s'accorde très-bien avec celui de Lalande 25086, étoile qui est entre la sixième et la septième grandeur. En faisant la revision de cette note, je me rappelai l'étoile variable au sud-est de α Virginis, dont nous a donné avis M. Schmidt dans le nr. 1597, *Astronomische Nachrichten*. Quelle ne fut ma surprise en m'apercevant de l'identité entre cette variable et la 19e de Sûfi?"

This identification, however, is hardly so certain as may at first sight appear. Schmidt's star is in the Greenwich Catalogue for 1872, which gives its position for 1880·0—

Right Ascension 202° 4′·4 ... ... Declination −12° 35′·9

Ptolemy professes to have reduced his catalogue to the first year of Antoninus, A.D. 138, though it is well known that his longitudes are in defect to the amount of about 1° for that epoch. Unfortunately, for the 19th star of Virgo, though the longitudes agree, the latitudes given in the various editions of the Almagest and by Sûfi are materially different. Baily has it −3° 0′, with a note that in the Venice edition in Latin by Liechtenstein, in 1515, it is +0° 20′, which he thought might arise, as regards the difference in amount, from mistaking γ for γ′. While in the two manuscript copies of Sûfi (who adopted the positions of the Almagest, adding 12° 42′ to the longitudes) the latitude is −1° 20′.

To reduce the Greenwich position for 1880 to the year A.D. 138, we have in the usual notation—

$$A = 168^\circ\ 47'{\cdot}3 \quad \ldots \quad A' = 191^\circ\ 0'{\cdot}8 \quad \ldots \quad \theta = 9^\circ\ 40'{\cdot}6;$$

with which the position for Ptolemy's epoch is found to be—

Right Ascension ... 179° 36′·0 Declination ... −3° 5′·4;

and assuming the obliquity of the ecliptic to be 23° 41′·8, we have—

Longitude ... 180° 53′ Latitude ... −2° 59′

The longitude of the 19th of Virgo is apparently 178° in all the editions of the Almagest, and the latitude differs 1° 39′ from that assigned in the manuscripts used by Schjellerup.

If we similarly reduce the Greenwich position of 68 Virginis to Ptolemy's epoch, we find—

Longitude ... 178° 53′ Latitude ... − 3° 14′

and Baily's identification of the 19th of Virgo would thus appear the more satisfactory, at least if the reading he has adopted for the latitude is admitted; still there is the difficulty pointed out in his note which is given above; 68 Virginis is estimated a sixth magnitude both by Argelander and Heis.

In 1879 Mr. S. W. Burnham discovered that this star is a very close double, the mean of his measures giving—

1879·39 Position 81°·2. Distance 0″·47. Magnitude 6·1 and 6·6.

He remarks that hitherto close double-stars have not been found among the variables. It remains to be ascertained whether, if the variability of Schmidt's star be established, both or only one of the components vary.

A New Comet.—A telegram notifies the discovery of a comet by Mr. E. Barnard, on the 16th inst., though, probably from interruption from unfavourable weather in verifying it, the announcement appears not to have been made for several days subsequently. The position given is as follows:—

h. m. s.
July 16 at 15 21 2 G.M.T. ... R.A. 237° 40′ 0″ ... N.P.D. 127° 9′ 52″

It would be well within reach of the observatories of Southern Europe. From a telegram received at Dun Echt, Dr. Copeland conjectures that the comet has been seen at Melbourne, Madras, and Cape Town; Prof. Krüger has no allusion to this in his note in the *Astronomische Nachrichten*. The comet's motion is stated to be slow.

SCOTTISH METEOROLOGICAL SOCIETY

THE half-yearly general meeting of the Society was held on Monday, July 21, in Edinburgh, Mr. Milne Home in the chair.

Mr. Buchan read the report from the Council. As regards the Society's stations, one has been added since last general meeting at Glencarron, in Ross-shire. It has been established by Lord M'Laren, and from its position it is one of the most important additions recently made to the Society's stations. The effort made to increase the membership has been already attended with marked success. The membership now numbers 601. The first number of the new series of the Society's *Journal* is now mostly in type, and will shortly be in the members' hands. It has been arranged that in future the proceedings will appear annually in March. The Council referred with much satisfaction to the successful manner in which Mr. Omond and his assistants carry on the observations on Ben Nevis. The discussion of the past observations shows that paramount importance must be assigned to a continuous record, not only of the barometer, but also of the temperature, humidity, wind, cloud, and precipitation, on account of their intimate relations to the barometric fluctuations and to coming changes of weather. Every effort will therefore be made to secure to science a continuous hourly record of the weather phenomena of Ben Nevis. Arrangements have been made for the completion of the Observatory buildings during the course of this summer. A beginning of the work is made to-day (July 21), and it is expected that the whole will be finished some time before October. The new buildings include a tower, on the top of which will be placed anemometers, specially designed by Prof. Chrystal and Prof. Crum Brown, for registering the direction, velocity, and pressure of the wind, a correct knowledge of which is of supreme importance in carrying on the scientific and practical inquiries aimed at in the establishment of the Observatory. To the expenses connected with the erection of the anemometers a grant of 50*l*. has been made by the Committee of the Government Research Fund. An exit from the building has been made in the upper part of the tower, which will enable the observers to make outside observations during the winter months, on many occasions when they could not otherwise be attempted. The Council regret to intimate that their application to the Treasury for a grant in aid of the establishment of the Marine Station at Granton was not successful. Notwithstanding the refusal of the Government to give assistance, the Marine Station, to which the Society contributes 300*l*. a year from the Fishery Fund, was established in April. There is every probability that the subscriptions from the general public will shortly permit of very desirable extensions being made to the further equipment of the station. In response to an offer by the Scottish Sea-Fishing and Curing Company, Mr. Pearcey, of the *Challenger* Office, made observations on a cruise in the ship *Energy* in the North Sea, between Shetland and Norway. The specimens obtained during the cruise, and the observations made, are now under consideration.

A paper was read by Mr. Buchan on the meteorology of Ben Nevis, which we hope to give in an early number.[1]

Dr. Arthur Mitchell described a new instrument for collecting continuously any cosmic dust, volcanic dust, or other impurities mechanically suspended in the atmosphere, the essential part of the instrument being a series of filters of fine platinum wires, through which the air is continuously drawn by an aspirator.

A report of the work done at the Scottish Marine Station at Granton was submitted by Mr. J. T. Cunningham, naturalist in charge. He detailed the nature of the work since the opening of the Station in April. The method of working in the yacht *Medusa* was then described. The position of the yacht is ascertained by means of bearings at the time when the dredge or other apparatus is put down or taken up. At these points the depth of the water and the nature of the bottom are ascertained, and various physical observations taken, including the temperature of the air, and that of the sea at the bottom, at the surface, and at intermediate depths; samples of sea water are also secured from different depths. When the dredge or trawl is hauled on deck, the contents are examined and the relative abundance of the animals and Algæ noted down. Some of the specimens are preserved on the spot, and a number of them are brought alive to the Station, and placed in the floating cages or in aquaria in the laboratory, so that they may be more minutely examined in the living state, and form a stock which may be drawn upon for purposes of special research. The products of the fine tow-nets are treated in the same way; a microscope is always on board, and in calm weather the minute specimens can be examined in the cabin. Samples of the contents of the tow-nets are preserved and labelled on board, and the remainder are brought back to the Station alive and examined in the laboratory. The results of one day's work at sea usually provide material for two or three days' work on shore. The work of dealing with the preserved collections, identifying and separating the animals, goes on continuously at the Station. The materials for faunological and systematic zoological work soon became abundant, and in the inquiries continuously carried on special attention is given to identify the numerous kinds of fish spawn, both floating and attached, which occur in the Firth of Forth and neighbouring parts of the sea. In order that the systematic and general work of the Station might not be neglected, the services of Mr. John Henderson as zoologist have been secured. The study of the Algæ has been energetically carried on by Mr. Rattray. The work carried on by Mr. Mill has been chiefly physical. A regular system of meterological observations, both on land and in the "ark," has been set on foot. Up to the present time three biologists have availed themselves of the opportunities afforded by the Station for research—Prof. W. A. Herdman, University College, Liverpool; Prof. Haycraft, Mason's College, Birmingham; and Mr. J. R. Davis, University College, Aberystwith.

Mr. Hugh Robert Mill read a paper on the tidal variation of temperature at the Marine Station. He detailed the nature of the experiments, these including hourly and half-hourly observations by night and by day on three occasions, extending in all to ninety-seven hours. The results show interesting relations between the temperature, the time of day, and the state of the tide. Without attempting to generalise, the following facts observed in each series of observations may be stated:—The surface temperature rose when the air temperature rose, and fell when it fell, with no very apparent reference to the tides. The curve for bottom temperature also followed that of air temperature, though to a slight extent; but the crest of the heat wave was retarded for several hours, and the tide produced great modifications in the temperature. When the tide flowed early in the morning it cooled the bottom temperature; when it entered at a later hour it raised it. By day the bottom temperature was lower than that of the surface; by night it was equal to it or slightly higher. The causes which produced these various effects must be very complex. The contour of the bottom of the quarry, the rates of influx of the tide, the direction of the currents it originates, the duration and period of the sunshine, the direction of the wind, the heating of the sand by the sun and its cooling by radiation, the heating and cooling of the surface water by radiation, and

the bottom water by conduction and convection, must all be taken into account before a true explanation could be arrived at. It is intended to devote special attention to the effect of radiation on the sand, and of the heated or chilled sand on the tidal water which flows over it, it being probable that it is in this way the key to the curious tidal perturbations of temperature may be found.

THE PHILOSOPHICAL SOCIETY OF GLASGOW

THE *Proceedings* of the eighty-first session have just been published in the form of a volume of 428 pages, and consisting of twenty-four papers, three plates, and a map. The papers are: an address on some of the chemical industries of the country, by Mr. R. R. Tatlock, President of the Chemical Section; on technical education, by Mr. Henry Dyer, C.E.; a discussion of Mr. Dyer's paper, by Mr. E. M. Dixon, B.Sc.; an introductory address on the definition and scope of geography and ethnology, by Dr. W. G. Blackie, President of the Geographical and Ethnological Section; on the use of litmus, rosolic acid, methyl-orange, phenacetolen, and phenolphthalein as indicators, paris ii. and iii., by Mr. Robert T. Thomson; on an easy way of determining specific gravity of solids, by Dr. Dobbie and Mr. John B. Hutcheson; note on Mr. Joseph Whitley's centrifugal mode of casting steel plates for shipbuilding, &c., by Dr. Henry Muirhead, President; notes on Cleopatra's Needle, by the President, on the occasion of presenting a large bronze model of the Needle to the Society; on a new method of measuring the heat-conducting power of various materials, such as cotton, wool, hair, &c., by Mr. J. J. Coleman; on a new thermometer or thermoscope, by Mr. Coleman; on the measurement of electric currents and potentials, by Sir William Thomson; a sketch of the life and work of Dr. Allen Thomson, by Dr. McKendrick; note on modern forms of the microscope, by Dr. W. Limont; on the chief features of the physical geography of China, by Rev. A. Williamson, B.A., LL.D., Missionary in China; on the recent progress of chemistry at home and abroad, by Prof. J. J. Dobbie; on the analysis of commercial carbonate of potash, by Robert Thomson; on a new process for the separation of nickel and cobalt, by Dr. John Clark; on an endless solenoid galvanometer and voltmeter, by Prof. James Blyth; on the chemical composition of the methyl and ethyl alcohols, by Dr. Otto Richter; on the Island of New Guinea, by Dr. W. G. Blackie, illustrated by a map published by permission of the Royal Geographical Society; on the consumption of smoke, especially in great cities, by Mr. A. Pinkerton; on rickets in Glasgow and neighbourhood, and the relation of the disease to food and water used by the inhabitants, by Mr. James Thomson, F.G.S.; and the Graham Lecture by the late Dr. R. Angus Smith, prepared for publication by Mr. J. J. Coleman.

The last paper is probably the most interesting and important of all, inasmuch as it contains many unpublished letters of Thomas Graham, so full of information as to his work and the circumstances in which his work was done that it cannot fail to attract the notice of all engaged in physico-chemical research. The paper has a mournful interest also as being the last from the late Dr. R. Angus Smith. It will be published separately, in a small volume, for the use of those who desire to have a memorial of Thomas Graham.

The Society has a membership of 690. Its work is carried on not only by the parent Society, but by five sections—Chemistry, Biology, Architecture, Sanitary Science and Social Economy, and Geography and Ethnology.

SCIENCE IN RUSSIA

THE Kazan Society of Naturalists continues its useful work of exploration. The last volume of its *Memoirs* (*Trudy Obschestva Estestvoispytateley pri Kazanskom Universitete*, vol. xii.) contains two papers by the late M. Shell, on the botanical geography of the provinces of Ufa and Orenburg, being a list of 1054 Spermatophores already known from these two regions which have an intermediate flora between that of South-Eastern Russia and that of the Caspian Steppes. A most useful addition to the knowledge of the flora of these provinces is contained in the second paper by the same author, which gives a list of no less than 511 species of Sporophores (28 Vascular plants, 49 Mosses, 2 Charæ, 181 Algæ, 94 Lichens, and 157 Fungi). The importance of this addition may be seen from the fact that, before M. Shell's work, only 39 species of Sporophores were known from these two provinces. It is worthy of notice that M. Shell has found among the Algæ the *Asterionella formosa*, Hassel, which has been discovered in England and was found on the Continent only by Brébisson in France, and by Heiberg in Denmark. The death of M. Shell in 1881 at Vilno was a great loss to Russian science. In the same volume M. Bekarevitch publishes his "Materials for the Flora of Kostroma," being a list of 514 species of Phanerogams and 18 Cryptogams. M. Flavitzky publishes his researches into the pitchers of different Conifers. The author has studied the deviations of their planes of polarisation, and has found that the value of the angle of deviation is quite characteristic for different pitchers; it varies from $-42^{\circ}\cdot2$ (*Pinus abies*) to $-13^{\circ}\cdot1$, $-10^{\circ}\cdot9$, and $-9^{\circ}\cdot6$ for the *Pinus sylvestris*, *P. cembra*, and *Abies sibirica*, and from $+9^{\circ}\cdot1$ to $+27^{\circ}\cdot2$ for the *Abies balsamea* and *Larix europæa*. We must notice also the elaborate researches, by A. Dogel, into the structure of the retina of the Ganoid fishes. These researches fill a gap which was pointed out many times; they are accompanied by excellent plates engraved at Leipzig.

The minutes of proceedings (*Protokoly*) of the same Society are especially interesting for mathematicians, as they contain a number of notes by MM. Maximowitch, Klark, and others. They are followed by papers on the motion of liquids in elastic tubes, by Prof. Gromeka; on the ichthyology of Kazan, by N. Varpakhovsky; and on the dangerous insects of Samara, by E. Peltzam.

The new volume of the *Memoirs* of the Kharkoff Society of Naturalists (*Trudy Obschestva Ispytateley Prirody pri Kharkovskom Universitete*, vol. xvii.) contains a paper by N. Koultchitzky, on the structure of the "Grandry corpuscles," being a description of that special form of corpuscle by which the nerve is terminated in the tongue of the duck, which M. Grandry distinguished in 1869 from the corpuscles of Herbst (or Pacini's with other animals). The paper is accompanied by three lithographed plates. M. Byeletzky's posthumous paper, on the physiology of the aërial or natatory bladder of fishes is a very elaborate memoir on this subject. The author, who has taken notice of nearly all the researches made in the same direction during more than a century, gives a detailed anatomical sketch of the bladder, and a summary of all known as to its contents. His own researches have been made on fifty-four individuals belonging to the following six species:—*Cyprinus carpio*, *Carassius vulgaris*, *Tinca vulgaris*, *Abramis brama*, *Idus melanotus*, and *Perca fluviatilis*. The gases contained in the bladder are: nitrogen, from 81 to 96 per cent. of the whole (sometimes even 98); oxygen, mostly less than 10 per cent., and very seldom from 15 to 20 per cent.; and carbonic acid from 2 to 5 per cent., falling to 0·6, and very seldom reaching more than 7 per cent. The contents of carbonic acid depends very much upon the conditions which the fish has been kept in before the experiments; but it stands in no correlation at all with the contents of oxygen. The amount of both may be simultaneously small, or greatly above the average. As to the origin of the gases in the bladder, the author indorses the views of Configliachi (Schweigger's *Journal für Chemie und Physik*, Band i. 1811), and concludes that they are not indebted for their origin either to digestion or to the supposed "swallowing" of air on the surface of the water; individuals kept for months under water, without having the possibility of reaching its surface, having been found to have the same composition of gases in the bladder as free individuals. It would rather seem that, with the raising of the fish on the surface, which is accompanied by a diminution of atmospheric pressure, a part of the gas is expelled from the bladder. The most probable origin of the gases in the bladder seems to be—Configliachi said—that the air contained in the water and entering into the mouth of the fish is in some way (perhaps in that pointed out by Erman) eliminated from it; it is dissolved in the blood of the gills, and the oxygen is slowly assimilated by the blood; while the remainder, that is, nitrogen and some oxygen which has remained dissolved, are secreted from the blood into the bladder. This is also the opinion of M. Byeletzky, who considers that blood, as also the lymph, is the source whence the gases of the bladder originate. Contrary to Configliachi's opinion, they are not secreted, however, by the "red corpuscles," but rather by the capillary vessels of the mucous membrane of the bladder; such was also the opinion of Rathke and Johann Müller; however, the argument by which they tried to establish this view cannot be longer held. In

a paper on the microscopic structure of the coal of the Doltz basin, M. Jenjourist shows that the coal contains remains of Sigillariæ and Lepidodendrons, while several Russian geologists are inclined to consider it as having originated only from marine Algæ. M. Dybovsky contributes to this volume a description of a new species of fresh-water sponge from Southern Russia, which is closely allied to the *Dosilia baileyi* of Mr. Carter, and to which he gives the name of *Dosilia stepanowii*; it is figured in a plate. Finally, M. Shevyreff gives a list of *Hymenoptera terebrantia* of the Governments of Kharkoff and Poltava; and M. Yaroshevsky publishes his fifth supplement to the list of Diptera of Kharkoff.

The last two volumes of the *Memoirs* of the St. Petersburg Society of Naturalists (*Trudy Sanctpeterburgskago Obschestva Estestvoispytateley*, vol. xiii. fasc. 2, and vol. xiv. fasc. 1) contain, besides the minutes of proceedings (which unhappily do not go further than March-1883), several valuable papers. Geology is the most favoured branch. Thus we find in vol. xiii. an interesting paper on the waterfalls of Northern Esthonia, by P. N. Vemikoff. The orography of the country whose Silurian deposits are cut towards the north by the abrupt terrace of the Glint, the lower parts of which contain looser strata easily destroyed by the water (as in the Niagara), favour the development of waterfalls, the chief of which are described by the author. In the same volume MM. Koudryavtseff and Sokoloff publish a geological description (with a geological map) of the district of Kromy in Orel. The Quaternary formations are represented by the "black earth," loess, and mighty sheets of boulder-clay which cover the chalk, the Jurassic clays, containing spherosiderite, and the Devonian limestones, marls, and dolomites, appearing in the north. The paper is accompanied with a map on a large scale. In vol. xiv. we find a very interesting orographical sketch of the Kola peninsula, by N. Koudryavtseff. The author has devoted much attention to the leading features of this tableland, and the modifications its surface has undergone under the action of the ice-sheet of the Glacial period. The structure of the mountains; the parallelism of the valleys; the glacial erosion, which has covered the whole of the country with numberless depressions running in the direction of the glacial striation, and producing what might be called "telescopic striation"; the finer glacial striæ, which run north and south, or north-north-west to south-south-east; the "glacial landscape" of the country; and finally its upheaval, are dealt with by the author. Several indications led the author to admit that the peninsula is rapidly rising up, the surest of them being the find of colonies of Balanides at a height of 8 metres above the sea, and the discovery of the *Buccinum undatum* (which still inhabits the White Sea), together with broken shells of Brachiopoda and Lamellibranchiata, about 280 feet above the present sea-level, at Kandalaksha. N. A. Sokoloff contributes to the same volume a note (with a plate) on the find of teeth of *Mastodon arvernensis* in the Crimea, at Zamruk, which would imply a wider extension of Pliocene in the yet unexplored steppes of the peninsula; and on the find, also in the Crimea, of teeth of *Hipparion gracile*, which was so widely spread during the Tertiary period from the prairies of the Missouri to the Himalayas. We notice also a note by P. P. Kudryavtseff, on prehistoric man on the Oka; and another note by M. Polyakoff on the bottom-moraine at Wiborg, in Finland.

In other branches of science we have to mention a sketch of the Phanerogam flora of the Government of Minsk, by W. Paszkewicz (vol. xiii.). It contains 958 species, the whole number reaching probably about 1000; 40 of them are new for this region. In vol. xiv. we find a note by M. Szihowsky on the chemical constitution of different parts of the *Zea Mays*, and two preliminary reports, botanical by A. Krasnoff, and zoological by A. Nikolsky, about explorations in the Altai Mountains. The collections of 720 Phanerogams and 100 Cryptogams, which have been brought in by M. Krasnoff, will surely yield interesting data. As to M. Nikolsky, he gives a lively sketch of the fauna of the Altai, followed by a list of observed species: 50 mammals, one of which, *Talpa altaica*, is new; 169 birds, a few reptiles and amphibia, and 16 fishes. A plate gives the comparison of the *T. altaica* with the *T. europea*.

RECENT MORPHOLOGICAL SPECULATIONS[1]

III.—*Non-segmented Animals*

THERE are certain groups of animals about whose systematic position naturalists never seem able to remain long agreed. These groups are changed from place to place in our schemes of classification; and often each new discovery seems to confute a current theory only to confirm that which preceded it. More than any other groups, the Polyzoa, Brachiopods, and Mollusks have been shifted from point to point, and it seems almost too much to expect that they have even now found a permanent resting-place.

The Polyzoa were brought into connection with "Mollusks" more than fifty years ago, when Milne-Edwards exhibited their supposed affinities with Ascidians, and their Molluscan affinities were more fully admitted when Von Siebold compared the Polyzoan lophophore and tentacles with the arms of a Brachiopod. Milne-Edwards, in combining Polyzoa and Tunicates in his new group Molluscoida, argued the identity of the type in every detail of structure, and Huxley ("English Cyclopædia," 1855), laying more weight than previous writers had done on the affinities of Polyzoa with Brachiopods (as Mr. Albany Hancock was perhaps the first to suggest) definitely included this last class also in the group Molluscoida. The Brachiopods seemed, in the light of that time's knowledge, to take a very natural position among the "neural Mollusks," between the Polyzoa on the one hand and the Lamellibranchs and the Pteropods on the other (*Proc. Roy. Soc.* 1854, p. 117).

But in the course of the next ten years Kowalevsky's discovery of Loxosoma seemed to supply a link between the Polyzoa and Worms, and Gegenbaur, and afterwards Haeckel, emphasised this relation, and finally included the Polyzoa in the latter group. The Tunicata had by this time obtained, through Kowalevsky's researches, an established position far removed from their former allies in the "Molluscoida," and Gegenbaur now analysed more critically the differences between Polyzoa and Brachiopods, and (denying that either had any affinity with Mollusks) maintained the eminently isolated position of Brachiopods, and asserted that their arms could no more be compared with the tentacles and lophophore of Polyzoa than these could with the branchial tufts of the Tubicolæ. The discovery by Kowalevsky (1874) of the apparently segmented larva of Argiope, &c., seemed to reveal almost obscured genetic relations with the Chætopods, and at the same time Morse, working chiefly on Lingula, argued elaborately that the Brachiopods are much modified Annelides. Ray Lankester, on the other hand, upheld the Molluscan affinities of both Polyzoa and Brachiopods, and Huxley, in his "Anatomy of Invertebrates," kept the three groups in close juxtaposition. Lankester compared Rhabdopleura minutely with the embryo of Pisidium (*Phil. Trans.* 1874), and maintained the common origin from a primitive ciliated girdle of the gill-filaments of Lamellibranchs, the lophophore of Polyzoa, the arms of Brachiopods, the tentacles of Phoronis, the velum of embryo Mollusks and of Rotifers, and the ciliated proboscis of Gephyrea. Huxley ("Invertebrates," p. 674), influenced on the one hand by Lankester, and by Steenstrup and Morse on the other, proposed to combine Polyzoa and Brachiopods under the name *Malacoscolices*, to indicate relationship both with Mollusks and with Worms. Lastly, Caldwell (*P. R. S.* 1882), by his researches on Phoronis, has thrown new light on the structure of both Polyzoa and Brachiopods, and, in Lankester's words ("Encycl. Brit.," Art. "Mollusca," 1884), "has established the conclusion that the agreement of structure supposed to obtain between Polyzoa and true Mollusca is delusive; and accordingly they, together with the Brachiopoda, have to be removed from the Molluscan phylum."

We may examine this last important view more closely, and try afterwards to discuss the probable ancestry of these three much-debated classes.

Actinotrocha, the larva of Phoronis, is, according to Caldwell, a perfect and typical trochosphere. The larvæ of Brachiopods and Polyzoa are trochospheres in which, by a shortening of the "dorsal" surface, mouth and anus have been approximated, and the ventral surface has been enormously distended. The same change takes place, and to an even greater extent, in the "metamorphosis" of Phoronis: the adult animal has both mouth and anus situated at one end of a long body; the line joining them is the contracted dorsal surface; an epistome, said to be the persistent præ-oral lobe of the larva, lies between mouth and anus; a lophophore, whose new tentacles are added on either side of the median dorsal line, surrounds the mouth; within its concavity, on either side of the anus, lie two ciliated pits, whose homologue is found in Rhabdopleura. A single pair of nephridia exist. The body-cavity is traversed by mesenteries, one of which is ventral, and attaches the outside of both descending and ascending limbs of the alimentary canal to the body-wall; two are lateral, and pass from the side of the stomach to the body-wall, dividing the

[1] Continued from p. 227.

cavity into two anterior chambers and one posterior; and lastly a transverse septum shuts off the space within the epistome and tentacles from the rest of the body-cavity. The nephridia open into the posterior chamber of the body-cavity on the sides of the lateral mesentery. At no stage, either in the embryo or the adult, is any trace to be found of segmentation.

The parallelism between Phoronis and Brachiopoda is full and clear. An ectodermal post-oral nerve-ring exists in both. The body-cavity of the præ-oral lobe is in both separated from the rest of the body-cavity by a septum. The tentacles are arranged and developed similarly in both. In both the nephridia have the same relations and the alimentary canal is divided into the same four parts. And in both the præ-oral lobe of the larva is represented in the adult by an epistome. The Polyzoa, though immensely simplified in structure, seem undoubtedly to be built upon the same plan; and Caldwell considers it probable that the epistome of Endoproct and Hippocrepian Polyzoa and the so-called foot in Rhabdopleura represent, like the epistome of Phoronis and Brachiopods, the præ-oral lobe.

Mr. Caldwell closes the abstract of his yet unpublished paper with a remark upon the affinities of the Gephyrea. We know nothing to show that Sipunculus and Phascolosoma are not referable to the same type of structure as Phoronis, Brachiopoda, and Polyzoa.

But as regards the types from which all these mutually-connected forms sprang, we know little or nothing, and we look in vain for an unsegmented worm which shall show clear affinity with them.

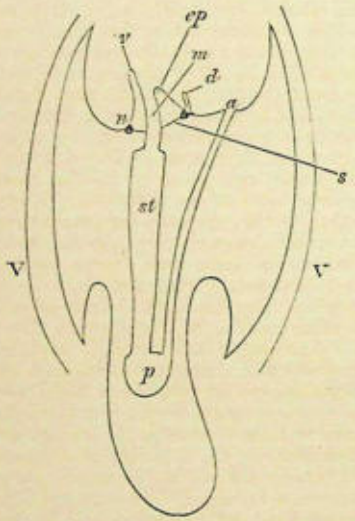
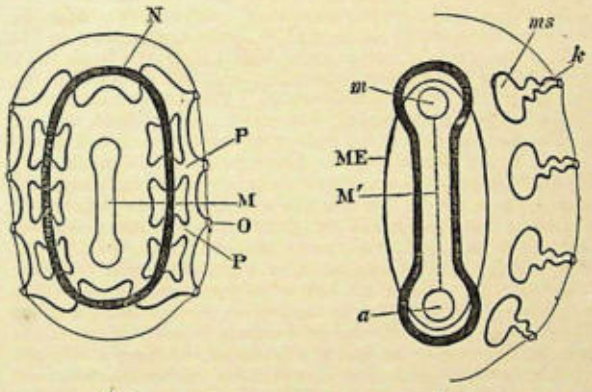


Diagram of body plan of *Brachiopod*, *Polyzoon*, and *Phoronis* (after Caldwell).—*m*, mouth; *a*, anus; *s*, septum; *n*, nervous system; *st*, stomach; *v*, second stomach; *ep*, epistome; *v*, tentacle of ventral series; *d*, tentacle of dorsal series; v v valves of Brachiopod skull.

Van Bemmelen, in a recent paper (*Jenaische Zeitschrift*, 1883) has compared at great length the Brachiopods with Sagitta, and arrives at the conclusion that the two types show such intimate agreement that they must be looked upon as very closely related. In the first place Dr. van Bemmelen recounts the histological resemblance between Sagitta and Brachiopods; and if he ascribes more weight to these than his readers may be inclined to do, he is not without weightier considerations in support of them. In both groups connective tissue is conspicuously scanty; in both a homogeneous intercellular substance or mesenchyme-layer is abundant. The epithelial layers are extremely simple and alike in both; the muscles in both are "built on an epithelial type;" the histological characters of the nervous system are identical in both. The chitinous hairs developed in ectodermal follicles on the mantle of Brachiopods are not without analogues in the Chætognatha. The three metameres of the larval Brachiopod are compared with the divisions of the adult Sagitta; the four genital glands of the former (Testicardines) are identified with the ovaries and testes of the latter. The gastro- and ileo-parietal bands of the Brachiopod are made homologous with the transverse septa of Sagitta, and the hood of Sagitta with the arms of the Brachiopod. It is obvious that the above characters, many of which are mentioned in the Hertwig's "Cœlomtheorie," are of very unequal value; and some are even wrong, for th gastro- and ileo-parietal bands of a Brachiopod are parallel with the gut, and in no way comparable to the transverse septa of Sagitta. But, on the other hand, there are other suggestive points of resemblance, and, though further developmental evidence in the case of Sagitta is sorely needed, I think that its possible affinity to the Phoronis type cannot be altogether passed over. Not only is the development of the mesoblast and body-cavity strikingly similar, but the dorsal and ventral mesenteries at first present in Phoronis agree with those of Sagitta, and the septum dividing off a part of the body-cavity within the head seems the same in both. Nothing in the nervous system offers great difficulty, and the relations of the hood in Sagitta seem not discordant with those of a lophophore. If we approximate the anus and mouth dorsally in Sagitta, the "olfactory organ" will assume the position of the two sense-organs of Phoronis and Rhabdopleura. The lateral mesenteries of Phoronis and Brachiopods arise late and secondarily, as does the transverse septum of the trunk in Sagitta. The anterior and posterior generative masses, arising first together, are no sign of true segmentation, and our embryological knowledge of the nephridia of Sagitta is too slight to permit us to make much use of them as arguments on either side.

If all this is true (and I am far from insisting upon it), it means that Sagitta (though extremely modified for a pelagic life) is akin to the unflexed, unsegmented worm, which, as it acquired a dorsal flexure and a more complex lophophore, gave rise to the proximate ancestors of the Phoronis type.



Sedgwick's theory of segmentation: A. Ideal ancestor of segmented animals; B. Invertebrate.—M, primitive mouth; *m*, mouth; *a*, anus; M', middle portion of primitive mouth or blastopore closed up; N, nervous system; P, pouch of gut; *ms*, mesoblastic somite; *k*, nephridium; O, external pore; ME, mesenteron.

And if we admit this even for a moment, it becomes worth while to consider the possibility of a distant Molluscan connection with the same line; for, possessing a trochosphere larva, a single pair of nephridia, and a nervous system with no trace of genuine segmentation, they are so far in agreement with our type. I cannot see that Caldwell's discoveries necessarily invalidate Lankester's old comparison of the Lamellibranch gills (and labial palps) with a lophophore; and even Lankester himself, in spite of his opinion already quoted, that, owing to Caldwell's research, Polyzoa, &c., must now be removed from the Molluscan phylum, yet still admits (*loc. cit.* p. 688) that "it is very probable that the labial tentacles and gill-plates are modifications of a double horseshoe-shaped area of ciliated filamentous processes, which existed in ancestral Mollusks much as in Phoronis and the Polyzoa, and is to be compared with the continuous præ- and post-oral ciliated band of the Echinid larva Pluteus, and of Tornaria;" and Langerhans' close comparison between the nervous systems of Sagitta and a Mollusk may be worth more consideration. The molluscan foot may, after all, be an epistome, as Lankester formerly said, and the "osphradia" of the Mollusk may turn out homologous with the sense-organs of Phoronis and Rhabdopleura. But the extreme modifications that the Molluscan type has undergone—the reduction of the body-cavity, the development of the foot, the various flexures, and so forth—leave any connection that we may trace with it and our Sagitta type at best a distant one; if such exists, a distant relationship will be again traceable between Mollusks and

Brachiopods, though every argument on which their former connection was based is demonstrably false.

But to a great extent the whole matter turns upon our conception of *segmentation*, a subject which Mr. Sedgwick's recent speculations (*Q. J. M. S.*, No. xciii. 1884) may very seriously modify. Sedgwick derives all metameric segmentation from a Cœlenterate-like ancestor, with a *pouched gut* like that of all the Actinozoa. The blastopore, including both mouth and anus, is derived from the Actinozoan mouth, the double nerve-cord from the aggregation of the nervous system round the mouth of the polyp, and the nephridia from specialised parts of the pouches represented now by the circular canal of Medusæ or the mesenteric perforations of Actinozoa and the pores leading to the exterior in those forms from the mesenteric chambers. But it is impossible to discuss this theory fully; it is enough to point out that it postulates segmented ancestors of all animals above Cœlenterates. Mollusks, Brachiopods, and Sagitta must according to it have been once segmented, just like Vertebrates, Arthropods, and Worms. But surely this is a violent assumption. There is no evidence of segmentation among Mollusks save in Nautilus, for even the pedal commissures of Chiton in no way indicate a truly segmented condition; nor any among Polyzoa or Brachiopods save the four nephridia of Rhynchonella. And it is by no means clear that the development of Sagitta indicates its descent from an ancestor with "*three pairs* of gut-pouches." The vast number of animals with a single pair of nephridia can scarcely all be derived from ancestors with many pairs; and Hatschek's description of the origin of segmented nephridia (in Polygordius) from a single pair seems far from supporting Sedgwick's view. The still insufficiently investigated excretory organs of Rhynchonella, and the four gills, &c., of Nautilus, seem not enough to indicate descent of the groups to which these forms belong from segmented ancestors. On the contrary, it seems far more likely that the types we have more particularly discussed are all derived from some unsegmented trochosphere; and that the segmentation of the Chætopods only became marked after the ancestor of the Phoronis type had severed his course from the common stock of Worms. The distinction of segmentation and non-segmentation would thus divide the Invertebrata.

As regards the Gephyrea, there is much reason for connecting such members of the group as Sipunculus, Phascolosoma, and Bonellia with the unsegmented Phoronis type. But Hatschek maintains that the development of Echiurus proves it to be a degenerate Chætopod; and if so, Caldwell (*loc. cit.*) is ready to admit that the others may be further stages in such degeneration. But even as regards Echiurus this degeneration is far from clear. The Platyelminths seem also never to have been segmented, and their "water-vascular canals" may give us some indication of the organs from which are derived the nephridia of Phoronis, Gephyrea, Brachiopods, and Mollusks. The larva of Thysanozoon has many points in common with the trochosphere, though its want of an anus is strange and difficult to explain. The Rotifers are acknowledged to be persistent trochospheres. And accordingly all these forms may be older and more primitive, by virtue of their lack of segmentation, than all the Chætopods.

D. W. T.

SCIENTIFIC SERIALS

THE *Journal of Anatomy and Physiology*, January 1884, contains:—A. Milnes Marshall, M.D., certain abnormal conditions of the reproductive organs of the frog.—S. A. Waddell, M.B., the urea elimination under the use of potassium fluoride in health.—B. C. A. Windle, M.A., M.D., primary sarcoma of the kidney.—R. J. Anderson, M.D., transverse measurements of human ribs.—Arthur W. Hare, M.B., a method of determining the position of the fissure of Rolando and some other cerebral fissures in the living subject.—G. Hoggan, M.B., new forms of nerve terminations in mammalian skin.—J. Symington, M.B., the fold of the nates.—W. Ainslie Holles, M.D., researches into the histology of the central gray substance of the spinal cord and medulla oblongata.—D. J. Cunningham, M.D., the musculus sternalis.—C. W. Catheart, M.B., movements of the shoulder-girdle involved in those of the arm on the trunk.—J. B. Sutton, the relation of the orbito-sphenoid to the region pterion in the side wall of the skull.—Anatomical notices.

April contains:—J. B. Sutton, the nature of certain ligaments.—F. Le Gros Clark, F.R.S., some remarks on nervous exhaustion, and on vasomotor action.—C. B. Lockwood, F.R.C.S. Lond., the development of the great omentum and the transverse mesocolon.—Arthur Thomson, M.B., notes of two instances of abnormality in the course and distribution of the radial artery.—Js. W. Barrett, M.B., the cause of the first sound of the heart, and the mode of action of the cardiac muscle.—Prof. Cleland, F.R.S., notes on raising the arm.—R. W. Shufeldt, M.D., osteology of *Ceryle alcyon*.—A. M. Patterson, M.B., notes on abnormalities, with special reference to the vertebral arteries.—Geo. Hoggan, M.B., on multiple lymphatic nævi of the skin, and their relation to some kindred diseases of the lymphatics.—Prof. Cleland, F.R.S., notes on the viscera of the porpoise and white-beaked dolphin.—W. Arbuthnot Lane, F.R.C.S., costal and sternal asymmetry.—Anatomical notices.

THE *Journal of Physiology*, vol. v. No. 1, contains:—E. Klein, M.D., F.R.S., the bacteria of swine-plague.—T. Lauder Brunton, on the rhythmic contraction of the capillaries in man, and on the physiological action of condurango.—J. Blake, on the connection between physiological action and chemical constitution.—H. H. Donaldson, and L. T. Stevens, note on the action of digitalis.—W. H. Gaskell, on the augmentator (accelerator) nerves of the heart of cold-blooded animals.

Archives Italiennes de Biologie, tome iv. fasc. 3, contains:—B. Grassi, the development of the vertebral column in bony fish.—L. Luciani, on the mechanical stimulation of the sensomotory centres of the brain-cortex.—A. Moriggia, on a new method of isolating the sensibility of the mobility of the nerves.—G. Magini, the induced unipolar current and the stimulation of nerves.—F. Marino-Zuco, upon the ptomaines with regard to toxicological investigations.—S. Richiardi, on the distribution of the nerves in the follicle of the tactile hairs of the ox, which are provided with a vascular erectile apparatus.—Ph. Lussana: (1) on the brain of the boa; considerations on comparative neuro-physiology; (2) on the sensibility of parts uncovered by skin; (3) on colour-hearing.—A. Marcacci, the arcola-mammillary muscle.—P. Foà, contribution to the study of the physiopathology of the spleen.—L. Griffini and G. Tizzoni, experimental study of the partial reproduction of the spleen; novel researches into the total reproduction of the spleen: an experimental contribution to the hematopoetic function of the connective tissue.—J. Bizzozero and A. A. Torre, upon the origin of red blood-corpuscles in the various orders of the Vertebrata.—J. Cattaneo, fixation, staining, and preservation of Infusoria.

Tome v. fasc. 1 contains:—C. Giacomini, the fascia dentata of the hippocampus major in the human brain.—A. Borzi, new studies in the sexuality of Ascomycetes (preliminary note).—L. Solera, contribution to the physiology of the succus intestinalis.—F. Selmi, tolerance of arsenic in domestic animals, and its distribution in the organism.—Ph. Lussana, on the quantitative and qualitative secretion of bile in the state of inanition after the section of the two pneumo-gastric nerves.—L. Camerano, (1) on the development of the Amphibia, and on what has been called their "Neotenia"; (2) researches on the prolongation of the branchial periods of the Amphibia.—G. Romiti, anatomical investigation of a case of death from the bite of a viper.—P. Fanzago, on the nest of *Goophilus flavus*.—E. Levier, the origin of the tulips of Savoy and of Italy.—P. Albertoni, critical and experimental studies upon the action and metamorphosis of certain substances in the organism, with respect to the pathogenesis of acetonæmia and diabetes.—L. Griffini, (1) an experimental study of the partial regeneration of the liver (preliminary communication); (2) on the total and partial reproduction of the follicular apparatus and of the calyciform papillæ in the rabbit (preliminary communication).—M. H. Peracca and C. Deregibus, note on *Coelopeltis insignitus*.—L. Vincenzi, histological note on the true origin of some cerebral nerves.—A. Mosso, employment of the balance in the study of the circulation in man.

SOCIETIES AND ACADEMIES

EDINBURGH

Mineralogical Society, June 24.—This meeting was held at the Museum of Science and Art, Edinburgh.—Prof. Jas. Geikie, F.R.S., in the chair.—The following papers were read:—On forms of silica, by Prof. John Ruskin, D.C.L. The Chairman and Dr. Dudgeon made some remarks.—On the application of the periodical law to mineralogy, by Prof. Thos. Carnelley of Dundee.—On the origin of the Andalusite schists of Aberdeenshire, by

Mr. John Horne, F.G.S.—On the occurrence of Prehnite and other zeolites in the rocks of Samson's Ribs and Salisbury Crags, by Mr. Andrew Taylor.—On a new locality for zoisite at Loch Garve, Ross-shire, by Mr. Hamilton-Bell.—On diatomaceous deposits in Scotland, by Prof. W. Ivison Macadam. The author drew attention to the vast extent of some of these beds, and gave particulars as to the proportions of silica, &c., contained in them. The deposits were being worked up to yield an absorbent for dynamite manufacture, and gave a material having double the liquid retaining power of samples of "kieselguhr" experimented on.—On the albertite beds of Strathpeffer, Ross-shire, by Mr. Wm. Morrison. Mr. J. Stuart Thomson referred to the fact that an allied jet mineral was found embedded in the oil-yielding bituminous shales of Midlothian. The substance only occurred in small quantities, the largest pieces not exceeding a pound in weight. It is capable of taking a fine polish, being similar to jet. In fact a jet-worker pronounced it at first to be Spanish jet.—On new localities for kyanite in Glen Urquhart, Drumlach Glen, Inverness-shire, and for staurolite at Tresholme, Enzie, Banffshire, by Mr. Thomas Walker.—On the crystallography of Bournonite, by Mr. H. R. Miers, British Museum. The paper criticised the history of the subject, and corrected various errors which have crept into the earlier literature. To those crystallographic forms hitherto recorded twenty-nine new forms are added as determined without doubt, and twenty-one as probable. A list of over 1000 angles, calculated from the elements of Miller, is given. The twinning (twin-plate the prism 110) is discussed; the observations of Hessenberg are supported, and it is concluded that the twinning is always by juxtaposition, not by interpenetration, but that Cornish crystals afford an example of composition perpendicular to, as well as parallel to, the plane of composition.—On a peculiar development of tourmaline from Lockport, New York County, by Mr. R. H. Solly, F.G.S.—Notes on the metallic veins of the Upper Hartz, Germany, by Mr. H. M. Cadell.—Scottish localities for actinolites, by Mr. Peyton.—On Welsh gold, by Mr. T. A. Readwin. A specimen weighing 160 grains, from the Mawddach Valley, Merionethshire, was exhibited.

DUBLIN

Royal Society, June 16.—Section of Physical and Experimental Science.—G. Johnstone Stoney, D.Sc., F.R.S., Vice-President, in the chair.—The following papers were read by Prof. G. F. Fitzgerald, M.A., F.R.S., Hon. Sec.:—(1) On a non-sparking dynamo. By applying the principles of Maxwell's modification of Thomson's electrical doubler to a dynamo in which the current passes through two or more coils in parallel circuit, it is possible to arrange the magnetic field and the brushes so that when the terminals of any coil come into contact with their brushes, the terminals shall be at the same difference of potential as the brushes, and that when they break contact there shall be no current running in the coil, thus avoiding all sparking. The energy of self-induction usually wasted on local currents and sparks will in this case be spent in producing useful current.—(2) On dust repulsion. Prof. Osborne Reynolds's theory of the action of the radiometer leads to the conclusion that a very small body in dense gas is subject to similar forces as the vanes of a radiometer in rare gas, and he made experiments which showed that silk fibres in air at considerable pressures were subject to apparent repulsion by radiation: a similar action on dust would explain the dust repulsion observed by Dr. Lodge.—(3) On currents of gas on the vortex atom theory of gases. As the momentum of a simple ring vortex is not proportional to its velocity and varies with its temperature, the momentum of a current of vortex rings would do so too. This and the variations with temperature of the velocity of sound and of the diffusion of gas through small apertures all point to the conclusion that a simple vortex ring is certainly too simple to explain the laws of material atoms. A difficulty is raised as to the amount by which the medium is carried forward by the translation and rotation of the earth.—(4) On a method of studying transient currents by means of an electrodynamometer. By comparing the initial swing of a ballistic galvanometer which depends on $S C dt$ with the initial swing of an electrodynamometer which depends on $S C^2 dt$ it is possible in many cases to determine, in addition to the total quantity of electricity that passes in the current, several matters as to the distribution of the current during its time of passage.—Prof. E. Hull, LL.D., F.R.S., on the geological age of the North Atlantic Ocean as bearing on the question of the permanency of continents and oceans. After referring to the views of those who hold the doctrine of "the permanency of oceans and continents" as opposed to those who, with Lyell, hold that continents and oceans have been interchanged during the past history of the globe, the author proceeded to consider how the formation of the North Atlantic Ocean might be adduced in support of one or other of these views. Remarking that this ocean was the only one at present known which could be used in evidence, inasmuch as we were in possession of sufficient knowledge of the geological structure of the regions by which it is bounded to the east and to the west, he proceeded to show how the distribution of the Silurian and Carboniferous rocks of North America, on the one hand, and of the British Isles and Western Europe on the other, pointed to the existence of the derivative lands in the direction of the Atlantic Ocean during these periods. In each case it was shown, by reference to details, that the sedimentary portions of these formations swell out towards the borders of the ocean, and tail out or become attenuated towards the interior of the continents in the opposite directions. From this it was inferred that the lands from which the sediment was derived occupied the region now overspread by the ocean; and, considering the great thickness of the sediments of these formations, the derivative lands were inferred to be of continental proportions. An additional argument in support of this view was also adduced from the distribution of the calcareous with the sedimentary deposits; for it was shown that the calcareous deposits (which were in the main of marine organic origin) swell out and sometimes replace the sedimentary deposits, as we recede from the borders of the ocean on either hand. From these considerations the author concluded that down to the close of the Carboniferous period the North Atlantic was for the most part in the condition of a continent, while the regions of Central and Eastern America, and of the British Isles and Western Europe, were submerged under oceanic waters. After this period, however, the relations were altered. With the upheaval of the Alleghanies at the close of the Palæozoic epoch, and with the terrestrial movement which at the same time affected the Carboniferous and older rocks of the British Islands and Western Europe, the Atlantic continent was converted into an ocean, in which condition it has remained to a great degree ever since. The author inferred from all this that the history of the North Atlantic Ocean might be adduced in support of the views of those who hold the doctrine of the "interchangeability of oceans and continents" rather than of the other.

Section of Natural Science.—Rev. M. H. Close, M.A., in the chair.—Rev. Dr. Haughton, F.R.S., on the possibility of the formation of coloured solar and lunar halos produced by the suspension in the air of volcanic dust caused by the explosion of Krakatoa in August 1883.—Prof. C. R. C. Tichborne, Ph.D., on an argentiferous galenitic blende found at Ovoca, Co. Wicklow. This mineral is very little known; it has been called "kilmacooite" locally in Ovoca, and it is generally termed "blue-stone" in the Island of Anglesey, the only two places in the United Kingdom where it is found. An analysis of the mineral made by the author gave the following results:—

Silver[1]	0·024
Zinc	25·27
Lead	25·18
Iron	5·51
Manganese	trace
Antimony	0·21
Arsenic	0·08
Copper	2·50
Alumina	0·60
Magnesia, with traces of Calcium	0·02
Sulphur	23·71
Silica	16·896
	100·000

This mineral contains various amounts of pyrites according to the situation of the lode. The specific gravity was 4·73—intermediate between blende and galena—but it was harder than either of these minerals, and was therefore raised by blasting. The author finds by experiments that this mineral is a mechanical

[1] Equal to about 8 troy ounces per ton, or 8½ ounces avoirdupois. The mineral may be said therefore to consist of—

Sulphide of zinc	37·68 per cent.
Sulphide of lead	29·07 ,,
Sulphide of silver	0·0275 ,,

mixture of microscopic crystals of blende and galena; it forms a fine-grained saccharoidal mass, very homogeneous in structure, except as regards the pyrites, and occurs in isolated crystals easily discernible by the eye. The author objected to the terms which had been applied to this mineral on the grounds that they were too local, and did not describe the ore. He explained his method of determining the actual physical as well as the chemical composition of the ore. In conclusion, he said that he was tempted to quote from his report upon the Dublin International Exhibition of 1865 in connection with the raising of silver in Ireland. At that time he found that this country was a large supplier of silver, but he was almost afraid to make the calculation now that he then made of the silver supplied by Ireland. He stated that in 1865 Ireland yielded 14,000 ounces of silver per annum, or 2·4 per cent. of the whole of the silver raised in the world, and its value might be estimated at 3850*l.* per annum, exclusive of the accompanying lead. If 1000 tons of this ore could be supplied, which represented of silver alone 8000 ounces, how lamentable it seemed that this valuable industrial resource should remain unworked.—G. H. Kinahan, M.R.I.A., notes on the earthquake that took place in Essex on the morning of April 22, 1884.

SYDNEY

Royal Society of New South Wales, June 4.—H. C. Russell, B.A., F.R.A.S., President, in the chair.—Three new members were elected, and forty-six donations were received.—The following papers were read:—On rain and its causes, by Edwin Lowe, in which he advocated the firing of cannon and of explosives for bringing about the precipitation of rain.—On the removal of bars from the entrances to our rivers, by Walter Shellshear, Assoc. M. Inst. C.E.—A specimen of scum from a pond near Campbelltown was exhibited. It had been noticed that the surface of the water was covered with a rich green growth in the mornings, and that this changed to a deep red in the afternoons. Messrs. Morris, M.R.C.S., and Wright, M.R.C.S., stated that it appeared to be due to *Astasia hæmatodes*, Ehr.

PARIS

Academy of Sciences, July 21.—M. Rolland, President, in the chair.—Presentation of two unpublished essays of Augustin Fresnel, found among the papers of Ampère, by M. Bertrand. The subjects of these essays are the following:—(1) Comparison of the hypothesis of electric currents round the axis of a magnet with that of electric currents round each molecule of matter; (2) Second note on the hypothesis of particular electric currents. These documents are both in the handwriting of Fresnel, but without title or signature, and one only bears a date, that of June 5, 1821.—A study of the geometrical deformations determined by the crushing of a straight cylinder in the direction of its axis between two planes (two illustrations), by M. Tresca.—On two theorems of Prof. Sylvester in connection with his complete demonstration of the rule of Newton in the form given to it by Newton himself, by M. de Jonquières.—Note on the equation in matrices $px = xq$ (continued), by Prof. Sylvester.—On the solution of the most general case of linear equations in binary quantities, that is to say, in quaternions or in matrices of the second order, by Prof. Sylvester.—Note on the maritime canals of Suez and Panama, by M. de Lesseps. In presenting the report of the International Commission on the widening of the Suez Canal, the author expresses the hope that it will soon be able to afford easy passage to ten or twelve million tons of shipping yearly. The Panama Canal, he expects on the report of Mr. Dingler, will be completed in the year 1888.—On the proposed formation of a so-called inland sea in Algeria and Tunisia, by M. E. Cosson. The author repeats the objections already urged against M. Roudaire's project, which, in the discussion that ensued, was supported by M. de Lesseps.—Remarks in connection with the last letter received from Lapérouse, dated Botany Bay, February 7, 1788, by M. de Jonquières.—On electro-capillary relations, by M. P. Garbe.—Direct measure of the two static components and of the dynamic component of the magnetic field of condensing-machines, by M. G. Cabanellas.—Researches on magnetism, by M. Duter.—On a new electric pile with carbon electrodes, producing an electromotor force equal to 0·6 volt, by MM. D. Tommasi and Radiguet.—On the numerical value of Poisson's coefficient as determined by experiments made with caoutchouc, by M. E. H. Amagat.—Temperature and critical pressure of nitrogen; boiling points of nitrogen and ethylene under slight pressures, by M. K. Olszewski.—On the properties of the liquefied vapour of ethylene, and on its employment as a refrigerator, by M. S. Wroblewski.—Action of the induction spark on benzine, toluene, and aniline, by M. A. Destrem.—On the production of a crystallised manganite of baryta, by MM. G. Rousseau and A. Saglier.—On the combinations formed by the sesquichloride of chromium with the other metallic chlorides, by M. L. Godefroy.—On a general reaction of the polyatomic alcohols in presence of borax, and of the paratungstates, by M. D. Klein.—Remarks on the disinfecting properties of borax applied inwardly, by M. E. de Cyon. From experiments continued over six years the author concludes that borax is a powerful antiseptic, and that it may be introduced in any required quantity into the system to preserve it from all contagions caused by parasites or microbes. As a prophylactic against cholera he recommends boric acid or a solution of borax to be applied to all the external mucous membranes, and about six grains of borax to be taken every twenty-four hours with the food and drink. It appears not only to act directly on the microbes contained in the intestinal canal, but also to attack the bacilli that may have penetrated into the blood.—Researches on the physiological development of *Cerocoma schreberi*, *Stenoria apicalis*, and other insects of the order of Cantharides, by M. H. Beauregard.—Remarks on the action of the heart in insects during their metamorphosis, by M. J. Künckel.—Note on the origin and distribution of phosphorus in coal and cannel-coal, by M. Ad. Carnot.—On the variation, under pressure, of the temperature determining the transformation of the iodide of silver, by MM. Mallard and Le Chatelier.—Researches on the influence of light on the respiration of vegetable tissues destitute of chlorophyll, by MM. G. Bonnier and L. Mangin.

VIENNA

Imperial Academy of Sciences, June 13.—E. Mach and T. Wentzel, on the fixation of a very transitory phenomenon by instantaneous photography.—E. Tangl, on the continuity of protoplasm in vegetable tissue.—M. Loewit, contributions to theory of blood-coagulation, ii., on the importance of the blood-disks.—B. Schudel, on propylidene-dipropyl-ether.

CONTENTS

	PAGE
Forestry	309
Lenses	310
Our Book Shelf:—	
Schwackhöfer's "Fuel and Water."—Prof. Fleeming Jenkin, F.R.S.	311
Mackay's "Elements of Euclid"	311
Jagnaux's "Traité Pratique d'Analyses chimiques et d'Essais industriels"	311
Letters to the Editor:—	
The Relation between the B.A. Unit and the Legal Ohm of the Paris Congress.—R. T. Glazebrook	311
The Yard, the Metre, and the Old French Foot.—Lieut.-Col. J. Herschel, R.E.	312
Fireballs.—W. J. Millar	312
The Swallowing of one Snake by another.—Baron C. R. Osten Sacken	312
The Red Sunsets.—Chas. Morris	312
The Saltness and the Temperature of the Sea. By Hugh Robert Mill	313
Specialisation in Scientific Study	314
Two Greek Geometers	315
The Royal Gardens at Kew	316
Mr. Thoroddsen's Geological Explorations. By Th. Thoroddsen	[illegible]
Seats in Railway Carriages. (*Illustrated*)	[illegible]
A New Principle of Measuring Heat. By Otto Pettersson. (*Illustrated*)	320
Notes	323
Our Astronomical Column:—	
Schmidt's Variable-Star in Virgo	325
A New Comet	326
Scottish Meteorological Society	326
The Philosophical Society of Glasgow	327
Science in Russia	327
Recent Morphological Speculations, III. (*Illustrated*)	328
Scientific Serials	330
Societies and Academies	330

THURSDAY, AUGUST 7, 1884

ELECTRIC LIGHTING

A Practical Treatise on Electric Lighting. By J. E. H. Gordon. (London: Sampson Low and Co., 1884.)

PRACTICAL treatises on this subject are very numerous, but they do not emanate from the right men. We want a book from a perfectly independent authority, unflavoured with the taint of invention, the result of practical experience. Mr. Gordon is in many respects well qualified for the task, but he is an inventor, and his book is strongly impregnated with prejudice and a green-spectacle view of the subject. He is, however, a staunch believer in the immediate future of successful electric lighting, and is very hopeful that the dark clouds that now envelop it will be dispelled by the enlightenment of steady progress.

After an introductory chapter on the general principles of artificial lighting, he deals with the conversion of electric currents into heat, and shows how carbon, when raised to incandescence, fulfils all the conditions required to give the maximum light with the minimum expenditure of heat. The problem is to concentrate the heat in a solid of the smallest possible size or with the smallest possible cooling surface. Electrical units—amperes, volts, ohms, coulombs—and their relation to each other and to the ordinary heat and work units are explained, though, curiously enough, that most useful and much employed unit the *watt* is not even mentioned. The rules that regulate derived currents lead to an investigation of the method of calculating the power wasted in a network of conductors—a matter of very serious consequence in the commercial aspect of electric lighting, though Mr. Gordon does not touch on any of the recent methods devised to reduce the excessive cost of mains. We then have a disquisition on the experimental measurements of currents, electromotive forces, resistances, and power developed, with a description of various indicators and measurers employed. No reliable instrument has yet been introduced for ordinary practical use, and there are many instruments now undergoing trial which Mr. Gordon has not touched upon—particularly those of Marcel Deprez in use on the Continent, and which were exhibited at Munich and Vienna.

A capital chapter is devoted to glow lamps. "The first public exhibition of incandescent lamps that was made in this country was made by Mr. Swan before the Society of Telegraph Engineers on November 24, 1880. The first exhibition in America was made by Mr. Edison" (p. 62). Mr. Gordon does not give the date! Arc lamps follow, Mr. Crompton's admirable lamp being that selected for description.

Perhaps the most valuable and certainly the most novel chapter in the book is that written by Mr. Crompton on carbons used in arc lamps. The following information is useful (p. 105):—

"The diameters most commonly used have been as follows:

For currents from	7–12	amperes	9 mm. to 11 mm.	diameter.
,,	12–18	,,	11 mm. to 13 mm.	,,
,,	18–25	,,	13 mm. to 15 mm.	,,
,,	25–40	,,	15 mm. to 18 mm.	,,
,,	40 upwards		18 mm. to 20 mm.	,, "

And the following is startling:—

Illuminating Power per Electrical H.P. of 13 *mm. Carbons of different Makers. Currents from* 15 *to* 20 *amperes*

Name of Maker	Candle Power per H.P.
Siemens (cored), pos. } Carré (cored), neg. }	4270
Siemens (cored)	3514
Barnsley Co.	3500
Johnson and Phillips	2986
Sautter and Lemonnier	2920
Carré (not cored)	2773
Silvertown (Gray's)	2580
Carré (cored)	1972

We then have a chapter on magnets and electro-magnetic induction, which leads to the general principles and theory of electric generators, including a very admirable account of that important subject, self-induction.

"*It is found experimentally, and can be proved mathematically, that if a coil of wire forms part of a circuit, and an alternating E.M.F. sends a current through it, that the current will be much less than it would have been had the same resistance been interposed in the form of a straight wire.*

"*Further, the proportional diminution becomes greater as the current is increased by the reduction of the resistance; and finally, for a given E.M.F., a given rate of alternation, and a coil of given shape, a limit is reached beyond which even reducing the resistance to zero does not increase the current*" (p. 123).

"*This diminution, however, does not, to the best of my belief, waste energy or diminish the efficiency of the machine; it only diminishes its output. Thus self-induction increases the size of a machine required to feed a certain number of lamps, but it does not perceptibly increase the H.P. required to drive the machine with that number of lamps on it.*

"The effect of self-induction increases as the current increases, and therefore *short-circuiting a coil of an alternating machine does not indefinitely increase the current in that coil, and seldom increases it enough to injure the insulation*" (p. 137).[1]

Of course we have a good description of alternate-current machines, and after some adverse criticism of the Ferranti type (which is imperfectly described), and not justified by the performance of the latter, Mr. Gordon describes his own form, which is chiefly distinguished by its size and weight. A few direct-current machines are described—not the best—and their regulation briefly referred to, with the curious conclusion (p. 183):—

"CONCLUSION.

"*The true secret of successful regulation is to have very large dynamos, because then, as we have said before, the maximum number of lamps that can be turned out at one time is a very small percentage of the whole,* and when there are a great number of lamps on one machine, the cost per lamp of regulating, either by hand or by an elaborate mechanical contrivance, is very trifling."

Goulard and Gibbs' secondary generators and the various secondary batteries are briefly despatched. *Apropos* of the latter he says (p. 191):—

"*There is no doubt that the interest and depreciation on a set of secondary batteries large enough to enable an electric light plant to work day and night, and so give*

[1] The italics are not ours.

out to the lamps no electricity in the day but a double quantity in the night, is vastly greater than the interest and depreciation on a complete duplicate set of engines, boilers, and dynamos."

Photometry has only one page devoted to it, and Chapter XIX. is so unique that we reproduce it in full (p. 201):—

"CHAPTER XIX

"CENTRAL STATION LIGHTING

"I had intended to write a long chapter with the above heading, but, for various reasons, I am not yet prepared to do so. I have, however, left in the heading, for the convenience of inserting such a chapter in a future edition of this book, should one ever be required."

This reminds one of the celebrated chapter about Snakes in Ireland: "There are no snakes in Ireland."

The book ends with the excellent rules and regulations for the prevention of fire risks prepared by the Society of Telegraph Engineers. Several useful tables are given in the appendix.

The book is disappointing not for what it contains but for what it does not contain. There is in it a strange mixture of the elementary and the advanced. After an algebraical description of the relations that exist between current work and power, we are told by a footnote (p. 19), "The symbol $\sqrt{}$ means 'square root of' the quantity under it." There is much hasty editing. At p. 30 we are promised in a footnote a mathematical proof in the appendix which does not appear there. At p. 25 the symbol for a battery is wrong—the poles are reversed. The present value of H at Greenwich is given at p. 40 as ·1794, and at p. 48 as ·181. The illustrations, it may be remarked, are excellent.

It is to be hoped that a second edition will soon be required, so that Mr. Gordon may be able to remedy the defects of the present one. A good practical treatise is very much needed. W. H. P.

OUR BOOK SHELF

A Text-Book on the Method of Least Squares. By Mansfield Merriman. (New York: John Wiley and Sons, 1884.)

THIS may almost be looked upon as a second edition of the "Elements" by the same author, which we favourably noticed in NATURE (vol. xviii. p. 299) soon after its appearance. The sale of the entire edition of the smaller book may be taken as evidence of its having met a want. The present work, though larger in appearance, covers about the same extent of ground, but, as is pointed out by the author, "the alterations and additions have been so numerous and radical as to render this a new and distinct book rather than a second edition."

In Chapters I. to IV., which present the mathematical developments of the principles, methods, and formulas, Dr. Merriman gives an introduction, and discusses the law of probability of error, the adjustment of observations, and the precision of observations at some length, and illustrates with numerous (for this subject) examples. In Chapters V. to IX. the application of the above to different classes of observations is made. These chapters are respectively headed: Direct Observations on a Single Quantity, Functions of Observed Quantities, Independent Observations on Several Quantities, Conditioned Observations, and the Discussion of Observations. These discussions are likely to be of use to engineers and others specially interested in this branch of mathematics. In an appendix, *inter alia*, there is a short statistical statement on the history and literature of the subject, but the fuller list of literature of the earlier book is not reproduced: there are also given here eight handy tables and some other useful material. It is the only work of the kind with which we are acquainted, and is even better adapted, in our opinion, for the end Dr. Merriman has in view than his earlier book was.

Some Propositions in Geometry. In Five Parts. By John Harris. (London: Wertheimer, Lea, and Co., 1884.)

WHEN we received the parcel containing this work with some others for review, we speculated upon what the Editor could have sent us, and hope rose within our breast that some *magnum opus* awaited our perusal. But as we had heard no whisper of such work being on its way, our expectation cooled, and again casting our eyes on the unopened packet, and remembering former works of similar dimensions, a chill seized us, and we thought to ourselves, "Aut H. aut..." Shade of De Morgan! what are we to do with a work occupying 144 + 8 quarto pages treating of a subject so thoroughly threshed out, we had hoped, in your immortal "Budget"?

The title is an attractive one, and much of the work appears to be sound, but when we come across such problems as the trisection of any angle, the inscription of heptagons and nonagons in circles, *et id genus omne*, one draws in one's breath, and one's hair stands on end! The tentative methods given we dare say would enable one to perform these several operations to a very close degree of approximation, but this is not what ordinary mathematicians want. But we must be careful here, for Mr. Harris puts the question, "What is a *mathematician?*" and in his answer splits the creature up into "sorts." There is, for instance, the very positive and readily incensed mathematician, the highly exalted mathematician, the profound mathematician, and the exclusive orthodox mathematician.

It is under this last "sort" that we fear we must be classed. With him "'Mathematics' is a sort of privileged religion, having its special *articles* and technical dogmas. None but the initiated must enter its temple, and woe be to him who dares to do so without a formal certificate from its priests. One of his most valued dogmas is that $\pi = 3{\cdot}14159\ldots$. This is called an approximation; and which if a man do not faithfully believe he will inevitably go—— Ah, well, never mind where he will go to; but, at all events, no mathematician must hold converse or communication with such a profane person."

It will be seen from this extract that Mr. Harris is a man of some humour, but even such oases do not render the vast Sahara of much of his book pleasanter reading. Indeed we have found it very hard work, and so we contented ourselves (for review purposes) with the careful reading of one of the "trisection" proofs; but we gave up in despair, as this proof involved the mastery of a previous proof, and we feared it would be a case of little fleas and lesser fleas, "and so *ad infinitum*." What did we do next? Why we applied a trigonometrical test, and found that the method in the text would not give the result at all, except in a special case. Life is really too short for such verification, and we must leave the task to others. The figures, as usual with Mr. Harris, are carefully drawn and very elaborate diagrams.

We regret more and more that so much labour should be bestowed upon such studies, which, we fear, an unbelieving world will never take up. What, then, is the value of π? It is here said to be (Mr. Harris would say, proved to be) equal to $\sqrt{8} \times \frac{19}{16} = 3{\cdot}142696\ldots$.

We lay down the book more in sorrow and pity than in anger and scorn.

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.]

"Gas-Burners, Old and New"

PERMIT me to point out a very obvious clerical error in the notice, in last week's NATURE (p. 270) of my little work having the above title, and to make a few remarks concerning your criticisms on the book. In the sentence, "'Owen Merriman' has taken pains to insist on the two great *desiderata* of gas-burners—high temperature and low temperature," the latter word is doubtless intended for *pressure*; and the sentence should read "high temperature and low pressure." It would have been scarcely necessary to make this correction, but that the notice may perhaps be read by many who are incapable of suggesting the correct reading, and to whom therefore the sentence as it stands will be absolutely meaningless.

While fully appreciating the kindly nature and intent of your criticisms, I cannot pass by, without a word of defence, your statement that you think I have "gone too far in attempting to give a popular theory of luminous combustion." I hope to be able to show that the particular extracts from that portion of the book to which exception is taken are practically correct, and, so far as could be looked for in a work addressed to miscellaneous readers, sufficiently precise. To this end I will deal with the various extracts *seriatim*. That "the various gases which constitute ordinary coal-gas do not all burn together in the flame" is a matter I had thought to be established beyond reach of dispute. But if evidence is required of the truth of the assertion, I need only point to a table prepared by Prof. Landolt, showing the composition of gases in the different parts of a gas flame, which is given by Prof. T. E. Thorpe, F.R.S., in a lecture on "Flame," forming one of the Manchester series of Science Lectures (Manchester: John Heywood). By this table it is clearly shown that in a gas flame, 3½ inches high, the olefines, or heavy hydrocarbons, do not diminish in amount until a height of 1·58 inches is reached; while the proportion of hydrogen is considerably diminished at a height only of 0·39 inch. Although it may not be mathematically correct to say that "the amount of light developed by any coal-gas flame is *directly proportional* to the degree of intensity to which the temperature of the carbon particles is raised," seeing that the light emitted is not in *exact* proportion to the temperature of heat, the statement is sufficiently correct for a popular treatise. What was chiefly intended to be enforced was that the amount of light evolved from a gas flame increases with its temperature, and in such a work a mathematical degree of exactitude is hardly looked for. Now, with regard to the other matters which are raised. To account for the destruction of luminosity which occurs when air is introduced into a gas flame, two theories have been put forward. According to the first, the heavy hydrocarbons at once meet with sufficient oxygen and are immediately consumed, without their carbon being first raised to a white-hot state; but this theory alone will scarcely explain the phenomenon, seeing that the effect of pure oxygen is to increase the luminosity of a flame. The other and more rational theory—and the one which is more generally accepted—supposes that the inert nitrogen which is thereby introduced reduces the heat-intensity of the flame "below the temperature required to decompose the hydrocarbons." It may be that to some extent both causes are at work. Lastly, as to the relative temperatures of a luminous and a non-luminous flame. Although the *average* temperature of the latter is higher than the former—as indeed it must be, seeing that the same *quantity* of heat is contained in a less space, the non-luminous flame nowhere develops so high a temperature as is found at certain of the hottest portions of the luminous flame. Mr. R. H. Patterson, in an article on the action of the blowpipe considered with reference to the principles of gas illumination (*Journal of Gas Lighting*, &c., vol. xxxv. p. 831), states that in the luminous region of an ordinary gas flame he has succeeded in melting a platinum wire: a result which he could never attain with a non-luminous flame."

July 21 "OWEN MERRIMAN"

[We thank our correspondent for pointing out the clerical error "low temperature" for "low pressure" in our article. We consider that the sentence, "The various simple gases which constitute ordinary coal do not all burn together in the flame; the temperature required to effect their ignition being lower for some of them than for others," is misleading. The ordinary reader would understand this to mean that the constituent having the lowest ignition point catches fire and burns away first, and then the constituent of next lowest ignition point catches fire and burns away, and so on; whereas Blochmann's researches show that the combustions are not distinct, but that the *rate* of combustion of the hydrogen is greater than the rate of combustion of the other inflammable gases.

We do not think it "sufficiently correct" to say that the intensity of light is *directly proportional* to the temperature of the coal-gas flame: perhaps it would be nearer the mark to say that the intensity of the light varies as the fifth power of the temperature within certain limits. The admission of air into the Bunsen flame destroys the luminosity more by *dilution* and *oxidation* than by *refrigeration*.—ED.]

The "Cotton-Spinner"

IN a note on this rare British Holothurian (published in NATURE on June 12, p. 146), I drew a distinction between the kind of observations that were possible to a student in a museum and to one who was working at a laboratory specially adapted for biological investigation and situated on the sea-shore.

The experiences of the last few days have shown me only too well that this distinction was not overdrawn or too refined. By the kindness of Mr. John Snell of Truro, I have been favoured with two consignments of the "Cotton-Spinner;" three specimens which reached me on Monday by parcels post gave very sufficient evidence of having died some hours before. This mishap induced me to propose to Mr. Snell that he should send me specimens by express, and entrust them to the charge of the guard of the train; for this suggestion I am indebted to Dr. Günther. Mr. Snell not only did this to-day, but he was good enough also to warn me by telegram that the specimens would reach Paddington at 8 p.m. this evening. I was at the station to meet them, and I have no doubt that the comparatively fresh condition of the sea water was due to the attention of the guard of the train. Notwithstanding all this care and trouble, the three "Cotton-Spinners" were dead.

I have given this detailed, and, I fear, tedious exposition of the whole case, because it seems to me to clench the argument that the problems of the physiology of marine forms, and especially of those less-known creatures which live at a depth of—like the "Cotton-Spinner"—ten to twenty fathoms, are not soluble at some distance from the coast, however great be the trouble or the care that is taken in forwarding them. We must have a laboratory on the sea-shore.

The only fact that I have been able to observe is that the threads of the "Cotton-Spinner" do undoubtedly attach themselves to objects in their vicinity: one of the specimens obtained this evening was attached to sea-weed; from the cloacal orifice a connected strand of threads, about one-fifth of an inch in width and an inch in length, spread out at its free end into a number of more free threads which had attached themselves to the sea-weed which had been placed in the water; they extended over about two inches in breadth. From what I have learnt of the extensile and swelling power of these threads, I should take it that about as much had been expelled as would occupy the greater part of the cloacal cavity. A woodcut illustrating the cloacal cavity so filled by tubes, and drawn from a spirit specimen preserved in the British Museum, will be given in my paper on this animal, which will be published in the next (October) part of the *Proceedings* of the Zoological Society.

August 1 F. JEFFERY BELL

Krakatoa

I MOST respectfully beg to point out to you a few errors made in the English version of my "Short Report on the Krakatoa Eruption," published in NATURE, May 1.

It says on p. 15:—"In this eruption very curious objects were ejected, *i.e.* very smooth, round balls, resembling marbles, to the size of 1½ to 6 centimetres in diameter. *They are full of acids;* they contain 55 per cent. carbonate of lime," &c.

The words italicised are wrong. The original says: *Zÿ Cruisen sterk met Zuren*, which means: "*they strongly effervesce when*

moistened by powerful acids. P. 11, column 1, line 34, "1860" should be "1680"; p. 12, column 2, line 28, and also p. 13, column 1, line 5, *steatite* should be *pitchstone* (a vitreous variation of pyroxene andesite).

R. D. M. VERBEEK,
Director of Java Geological Survey

Buitenzorg, Java, June 19

THE METEOROLOGY OF BEN NEVIS

AS regards changes of weather and many other problems of meteorology, a knowledge of the vertical variations which take place in the atmospherical conditions is of first importance; and the only way we can hope to arrive at this knowledge is by regular observations made at stations as near each other as possible in horizontal direction, but differing as much as possible in height. This point was very clearly seen many years ago by the late Mr. Allan Broun, and the idea was practically worked out by him in the elaborate series of meteorological and magnetical observations simultaneously made on the peaks and ridges and in the adjoining valleys of the Western Ghats. These observations are the best anywhere yet made to supply the observational data for the discussion of some of the more important problems of meteorology; and the science sustained no ordinary loss in the death of Mr. Broun before he had discussed the observations which had been collected by his genius, energy, and self-denial.

Next in scientific value to Mr. Broun's observations are those made on Ben Nevis since June 1881. The special advantages of Ben Nevis as a meteorological observatory are that it rises to a height of 4406 feet, and is little more than four miles distant from the sea at Fort William, and that it is situated in the track of the great storms which sweep over North-Western Europe from the Atlantic. Hence observations made on the top and at the base of Ben Nevis possess a value altogether unique in meteorology; particularly in discussing the atmospheric movements which accompany cyclones and anticyclones, and in investigating tornadoes and other destructive winds which originate when the air is abnormally warm and moist near the surface, while aloft the temperature and humidity diminish with abnormal rapidity.

For the preliminary inquiry which is necessary in order to determine the chief points in the meteorology of Ben Nevis, there are now available for a comparison of the climate of the top of the mountain with that of the sea-level at Fort William, simultaneous observations for twenty-two months, viz.: from June to October of the years 1881 and 1882, and from June 1883 to June 1884. As regards the temperature, the monthly means for Fort William were compared with the normal monthly temperatures of that place as given in the paper on the "Climate of the British Islands" (*Journ. Scott. Met. Soc.*, vol. vi. p. 33). From the differences thus obtained, the approximate normal temperatures at Ben Nevis Observatory were determined. The coldest month is February, the mean being 22°·0, and the warmest, July, 41°·3, August being nearly as warm, the mean being 41°·1; and the annual mean temperature 30°·9. Comparing the normals with those of Fort William, the greatest difference is 18°·0 in May, from which it steadily diminishes to 14°·9 in December, and then rises more rapidly to the maximum in May; the annual difference is 16°·3. The greatest difference, or the most rapid fall of temperature with height, is in the spring and early summer, when the climate of the west is driest, the temperature of the Atlantic lowest relatively to that of the air, and the top of the mountain still covered with snow. The least difference is in late autumn and early winter, when the climate of the west is wettest, Ben Nevis most frequently and densely clouded, and the temperature of the Atlantic highest relatively to that of the air. The observations of temperature at the high- and low-level stations show a variation with the hour of the day even more decidedly marked than that with season. Thus, in January the decrease of temperature, deduced from the mean maxima and minima respectively were 16°·2 and 15°·2, but in April these were 23°·1 and 12°·9, being thus in January nearly equal, whereas in April the difference of the maxima was nearly double that of the minima.

The annual means give, therefore, a decrease of temperature with height at the rate of 1° for every 270 feet of ascent—the most rapid decrease being 1° for every 245 feet in April, and the least rapid 296 feet in December.

But the individual observations show wide divergences from these rates of decrease. As disturbing conditions, the more important of these are the instances of abnormally large decrease, seeing that these imply a temperature near the surface much above the normal with respect to the higher strata, by which the equilibrium of the atmosphere is destroyed, and rapidly ascending and descending currents are generated, thus giving rise to some of the most destructive storms of wind. Of the illustrations the observations give of a rapid decrease, reference may be made to those of October 13, the day preceding the great storm which proved so destructive to the fishermen on the Berwickshire coast.

Even more striking, and, as regards their bearing on the theory of storms and weather changes, perhaps even more important, are those instances of abnormally small differences between the temperature at the top and base of the mountain, of which a good example which occurred on September 21, 1882, was given in NATURE, vol. xxvii. p. 176. All such cases have been accompanied with a high temperature and an excessive dryness of the air. It is these qualities of air which immediately connect the phenomena with the great cyclonic and anticyclonic systems in which or near to which Ben Nevis is for the time situated. The most striking case of all occurred on December 31, 1883, on which day the maximum temperature at Fort William was 30°·6, and minimum 27°·2, these being at Ben Nevis Observatory 32°·0 and 22°·8. At 11 a.m. the temperature at Fort William was 27°·5, but on Ben Nevis it was 32°·0, with a wet bulb as low as 24°·4. Hence at this hour the temperature of the air was 4°·5 higher at the Ben Nevis Observatory than at Fort William, 4406 feet lower down, and this relatively high temperature was accompanied with excessive dryness represented by the humidity of 33. From 6 a.m. to noon temperature was continuously higher on Ben Nevis than at Fort William. At 11 a.m. the abnormality in the vertical distribution of the temperature amounted to 20°·5. It is of importance to note that at this time of relatively high temperature and great drought, atmospheric pressure was very high at the Observatory, the reading of the barometer at 32° being 25·915 inches, being absolutely the highest that has occurred from November 28, 1883, to June 30, 1884. At Fort William the sea-level pressure was 30·608 inches.

Another peculiarity of the temperature is the small diurnal variation caused by the sun at all seasons, but particularly in winter; and the large variation due to the temperature changes which accompany the passage of cyclones and anticyclones over the Observatory. The means of the hourly observations show that even in May the difference between the mean warmest and mean coldest hour was only 3°·3. In January the difference was only 0°·8, and in this month the highest hourly mean occurred during the night, and the lowest during the day. On the other hand, the difference of the mean daily maxima and minima for January was 6°·7. In truth, the influence of the sun on the temperature of the air is all but eliminated during the winter months owing to the thick covering of mist, fog, and cloud, in which the mountain is almost constantly wrapped.

Since June 1881 the highest temperature on Ben Nevis was 59°·3 on August 8, 1882, and the lowest 9°·9, on Feb-

ruary 2, 1884. During these months the extremes at Fort William were 73°·8 and 27°·0.

The barometric observations at Fort William and Ben Nevis were dealt with in a similar manner, and a table of corrections of the Ben Nevis observations to sea-level was constructed directly from the observations of the two stations, the table giving the approximate corrections for each tenth of an inch of the sea-level pressure, and for each degree of mean temperature of the stratum of air from the Observatory to sea-level, which was assumed to be the arithmetic mean of the temperatures at the two stations. The normals of atmospheric pressure for Ben Nevis were then calculated. The lowest normal monthly pressure is 25·141 inches for January, and the highest 25·410 inches for June, and for the year 25·281 inches. Comparing the normal pressures at the high- and low-level stations, pressure on Ben Nevis is on the mean of the year 4·557 inches lower than at the sea-level at Fort William, the least monthly difference being 4·484 inches in July, and the greatest 4·620 inches in February.

The morning maximum of pressure was at 10 a.m. in January, at noon in February and March, 1.30 p.m. in April and May, while in June it was delayed to 3 p.m. From Mr. Wragge's observations in 1882, the same diurnal phase of the pressure occurred about 9 a.m. in the summer months at Fort William, being thus six hours earlier than on the top of Ben Nevis. From February to June the morning minimum of pressure was very large. On the other hand, the afternoon minimum was comparatively small; and as the season advanced it became less and less pronounced, till in June the diurnal oscillation approached closely to one single minimum and maximum. Owing to the low readings of the morning minimum and the high readings of the afternoon maximum, which have their explanation in the diurnal change of the temperature of the aërial stratum below the level of the Observatory, the diurnal range of pressure on Ben Nevis exceeds that of any other meteorological station in Scotland.

The rainfall on the top of Ben Nevis is very large. At Fort William the mean annual amount is about 83 inches. During the three years beginning 1881, while the rainfall at Fort William was 24·59 inches from June to October, it was 47·10 inches on Ben Nevis. During the two years 1882 and 1883, for the same months, the rainfall at Fort William was 21·96 inches; at the lake (1840 feet high), 28·42 inches; but on Ben Nevis, 44·35 inches: hence during the summer months the rainfall on Ben Nevis is nearly double that of Fort William, and the greater part of the increase in the rainfall from Fort William to the top of Ben Nevis takes place above the level of the lake. No inconsiderable proportion of the large rainfall collected on the top is due to driving mists and drifting wet fogs, during which, though often no raindrops are visible, or only a few small drops at wide intervals apart, yet everything is dripping wet, and the funnel of the rain-gauge is crowded with numerous runnels of clear water, steadily trickling down into the receiver of the gauge.

On plains and extensive plateaux the wind attains a diurnal maximum velocity shortly after noon which is generally nearly double the minimum velocity, which occurs shortly before sunrise. But on Ben Nevis, in common with other observatories which are situated on mountains rising to a considerable height above the whole of the surrounding region, the reverse of this takes place, the maximum velocity occurring during the night, and the minimum during the day. The difference between the mean minimum and maximum hourly velocities on Ben Nevis in each of the seven months ending June last was about five miles. A tendency to a secondary maximum was shown in May, but in March, April, and June no such tendency was apparent. A full gale from south-east blew almost continuously at the Observatory from February 15 to 21, and during these seven days there was a mean maximum of 58 miles from 5 to 6 a.m. and a mean minimum of 42 miles from 4 to 5 p.m. With an hourly difference of 16 miles, the daily variation in the velocity of the wind was maintained during the continuance of this great storm.

Another main object in constructing the table of corrections to sea-level for Ben Nevis Observatory was to afford a ready comparison between the atmospheric pressure at sea-level and that on Ben Nevis from the important bearings of the observed differences on the changes of weather which precede, accompany, and follow storms, and on such inquiries as the singular and opposite relations which obtain during storms of wind and during the remarkable weather which often occurs within, or on the confines of, anticyclones.

ALEXANDER BUCHAN

THE FORESTRY EXHIBITION

SINCE our last notice of the International Forestry Exhibition great progress has been made in the concentration and arrangement of the various products which testify to the importance of the subject. We believe that the juries have now met, and such names as Sir Joseph Hooker, Colonel Moncreiff, R.A., Profs. T. R. Fraser of Edinburgh, Bayley Balfour of Oxford, Dr. Lyons, M.P., with several Indian and Scotch Forest Officials, and others will inspire confidence in their work. We to-day give a description of one of the most interesting sections, which well repays a visit.

The Japanese Court occupies the eastern transept, and forms one of the largest and most important sections. The whole arrangements have been carried out in the most thorough and business-like manner. Immediately on the arrival of their goods, knowing beforehand the amount of space required, and working with a rapidity and skill which might put to shame some more civilised nations, the Japanese Commissioners have shown that they are far in advance of many countries in business capacity as well as in the science of forestry. In Great Britain the importance of forestry to the welfare of the country and its colonies has but lately been recognised. In Japan, on the contrary, it has long formed an important feature in national education. This is evident from the ingenious devices represented on the walls of the department, and which can only have been the outcome of long experience.

With excellent taste the Japanese have placed the timber in the most prominent position, and the products in the background, giving at once the impression that it is purely a forestry exhibit. The central tables are occupied with longitudinal sections of trees, with the surface planed so as to render the grain visible. Above these are similar sections, but showing the bark, and above these are coloured drawings of the trees yielding them. At the foot of these sections a paper explains in English the Japanese name, the botanical name and habitat, and the relative rarity or abundance of the tree, its girth and height at fifty years old and at maturity, the best mode of propagation, the quality and uses of its wood and of other parts. Each section, drawing, and description is marked with a corresponding number. On the wall of the Southern Court are some artistic drawings in monochrome of the various devices for felling and floating the trees along mountain streams, for slipping them over precipitous cliffs, and for stopping and collecting the timber at certain localities in its course for storage. The expedients adopted for floating the timber down narrow gullies, and the sledges used for sliding it down over the snow in winter, and other details of forest work and a forester's life, are depicted in a manner that is easy to remember from the quaint dress, the life-like attitude, and excessive energy thrown into the actions represented. These drawings are mounted in wooden frames, and the background

tastefully decorated in a simple manner with fragments of veneer of different colours. They are accompanied by models which still better illustrate the means adopted in mountainous countries, and must prove exceedingly instructive to students of forestry.

Next in order come the tools used in the various operations of cutting, transporting, and working the timber and peeling the bark. Some of the axes and saws are of extremely peculiar shape, but admirably fitted for the purposes for which they are intended.

According to a printed table hung on the end wall, the area of the Japanese Empire is 38,563,718 chos (a cho = 2'450 acres), the area of forest (excluding the islands of Okinawa and Hokkaido) being 11,866,626 chos, or rather less than one-third of the country. Of this area 5,259,182 chos are worked by the Government, and 6,607,443 chos by private individuals. About a quarter of the Empire has, however, not yet been surveyed; the above figures, therefore, only refer to the surveyed portion. Accompanying this table is a map giving the distribution of trees in Japan, and marking out certain zones, each indicated by some particular tree forming a prominent feature in the landscape. Of these zones *Ficus Wightiana* characterises the lowest, *Pinus Thunbergii* the second; then follow in order *Fagus sylvatica*, *Abies Veitchii*, and *Pinus Cembra*. The extent of these zones is marked in colours on the map, and on excellent coloured drawings representing the habit of the five trees, and their foliage, flowers, and fruit in life-size are presented at one glance. The less important productions of the forests are appropriately illustrated by smaller collections, a simple expedient by which an idea of their relative consequence is easily conveyed. Fungi, dried and preserved in pickle, and a dried lichen (a species of *Gyrophora*), and a collection of seeds of forest-trees, well preserved, and carefully named, are placed near. Several fungi are cultivated on special trees. According to notes affixed to the tree-sections, among the trees thus employed are *Celtis sinensis*, *Carpinus laxiflora*, *Quercus crispula*, *cuspidata*, and *glandulifera*.

Roots, barks, and seeds used in medicine are not so well represented as usual. Even menthol, now tolerably well known in this country as a remedy for neuralgia, is not exhibited. A beautiful specimen of insect wax resembling spermaceti in appearance, but much harder, and identical with that used in China to coat candles to prevent their guttering, is exhibited. The insect producing it is cultivated on *Ligustrum Ibotu* and *Fraxinus pubinervis*.

An exceedingly ingenious double chop-stick is here shown, consisting of a piece of white wood, slit two-thirds of its length; on pulling the pieces apart, a wooden toothpick is seen inclosed in the centre. As the wood has never been entirely split, it is puzzling to know how the toothpick was inserted. This is done by cutting it with a special instrument when the wood is wet and can be extended. The leaves of two other plants besides those of tobacco are shown, the one made into cigarettes, and the other simply dried for smoking (*Sterculia platanifolia*).

The cooperage work seems to be carefully done, the barrels having polished surfaces, and in some instances the bands are made of plaited bamboo. The polishing of rough surfaces appears to be effected by the rough leaves of *Aphananthe aspera* and the stems of a species of *Equisetum*. Japanese tooth-brushes are exhibited, made of the frayed-out ends of a piece of white wood; and combs, and even tooth-combs, are made of similar material of a harder character, such as the wood of *Olea Aquifolium* and *Hovenia dulcis*. Dyeing and tanning barks are comparatively few in number, and walking sticks do not present any great variety, only a few being engraved or ornamented. A simple flower-pot for the wall of drawing-rooms consists of two joints of a large bamboo, with a piece cut out at the side of each joint so as to permit of a fern or bouquet depending over it.

In the left-hand court may be seen some bent wood furniture that might fairly compete with that of Austrian manufacture. In one corner may be seen a series of young trees four or five years old, imported from France, Germany, the United States, and other countries; indicating that acclimatisation of the useful trees of other countries has already been commenced in Japan. Wood-engraving and printing in one or more colours is illustrated by the engravings placed side by side with the blocks. The celebrated Japanese lacquer is exhibited in the crude state, and also applied to knick-knacks and other articles, some specimens of lacquered slabs having so high a polish as to appear like glazed ornamental tiles. These are accompanied by a coloured drawing of the foliage and flowers of the lacquer-tree painted on the wood of the same tree and framed, with other portions having the bark attached. Several other useful timber-trees are illustrated in the same ingenious manner. The almost transparent yet strong and tough paper made from the fibre of the paper mulberry-tree (*Broussonettia papyrifera*) is shown, but its manufacture is not illustrated by drawings, the exhibits being limited to products. This paper rolled into the form of a spill is strong enough to be used like string. Exceedingly thin planed shavings of wood, scarcely thicker than the paper above alluded to, occupy a conspicuous position. These are used for packing butter or other goods of similar description. A cursory glance at the notes appended to the sections of wood reveals many interesting facts regarding some Japanese trees and shrubs commonly cultivated in this country. Thus an oil is obtained from the seeds of the common Camellia (*C. japonica*), and rope is made from the stems of *Wistaria sinensis*. Charcoal, for the manufacture of gunpowder, is prepared from the wood of *Paulownia imperialis*, and the wood of the deliciously-scented *Olea fragrans* is used for wood-engraving and combs. A shrub, also indigenous in this country, *Viburnum opulus*, furnishes tooth-picks. A very ingenious use of the trunks of trees is the hollowing them out into drain-pipes, each about 6 or 8 feet long, and fitting into each other at the end. On the walls of this court illustrations are given of the mode of preventing the slipping away of soil on mountain-sides, and of the trees and shrubs and herbs useful for binding sandy soil or embankments, &c. Altogether the Japanese section is an exceedingly interesting one, and offers many useful suggestions to the foresters of Western countries.

PRACTICAL TAXIDERMY

AMIDST the many criticisms which are passed by visitors upon the collections in the new Natural History Museum of South Kensington, there is always to be found a word of praise for the improved appearance of the mounted animals in that Museum, and it may fairly be said that the encomiums which are heard on all sides have been justly earned by Dr. Günther and the staff of the Zoological Department; that is to say, if an honest endeavour to present to the public something better than can be seen in other museums counts for anything. The officers of the British Museum, in transferring the zoological collections from Bloomsbury to South Kensington were heavily handicapped, for it was impossible to commence the mounting of the collections *de novo*, and therefore had upon their hands a vast number of interesting specimens unfit to exhibit to the public, but valuable to the naturalist, and worthy of preservation as forming a historical part of that great zoological collection which is admitted by naturalists to be intrinsically the finest in the world. For some time before the removal a careful selection of duplicate specimens had been made, and these had been distributed to various provincial museums, but all those which possessed any scientific value, such as types, &c., have been carefully unmounted and added to the collection of skins, and it was curious

to note the progress of the art of taxidermy which these specimens exhibited. It is notorious that for many years the authorities of the Zoological Department have been troubled with the preservation of antique specimens of natural history which seemed to be falling into a state of natural decay, although no actual reason could be assigned for their dissolution, and moths and beetles have never been known to do any harm to the collections, thanks to the constant care which is exercised in that department. But on dismounting some of the ancient specimens, such as those presented by Colonel Montagu, it was discovered that they had never been properly skinned, and with the exception of the extraction of the entrails, the bones and flesh of the birds had been left entire, and apparently without an attempt to further preserve the specimens. The result may be imagined, and the difficulty of preserving these interesting relics will be fully appreciated by the naturalist of to-day. It has often been a source of wonder to zoologists as to what has become of many of the types of species recorded by Latham and the older writers on ornithology as existing in the British Museum, which certainly are no longer in the national collection. The records of the Museum show that they never descended to modern times, and there can be little doubt that the defective preparation of a hundred years ago was inadequate for their preservation, and that they were allowed to fall into decay by the earlier custodians of the national Museum, in whom the sacred value of a type was not so inherent as it is in the age in which we live.

We may hope that the improved preparation of the specimens in the Natural History Museum marks the commencement of a new era in the art of taxidermy, for the skilful mounting of animals is a real art, and ought to be recognised as such. An artist who portrays animal life successfully reaps the full appreciation of his countrymen, and is well paid for his work, but hitherto the taxidermist has never been properly appreciated, and until adequate remuneration is provided for the artists who reproduce natural specimens, we can never hope for the success of taxidermy as an art which ought to rank as high as that of the animal painter. The undoubted success which has attended the production of the groups of British birds which now adorn the corridors in the Natural History Museum is a great encouragement to those who have at heart the welfare of the art of taxidermy, and it cannot be denied that the mounting of these groups does credit to all concerned. We are aware that Prof. Flower (himself no mean taxidermist) takes a great interest in the improvement in the mounting of animals in the Museum of which he is so able a Director, and the exertions of Dr. Günther in this direction have been manifest since his appointment as Keeper of the Zoological Department in the British Museum, while the frequent occurrence of Lord Walsingham's name as a donor of many of these beautiful groups of "British birds in their haunts," shows the practical utility of having as a trustee a naturalist who labours to supply the wants of the institution of which he is one of the guardians. In the Bird Gallery itself, as well as in that of Mammalia and Osteology, the same wish to improve the natural appearance of the specimens exhibited is seen at every turn, and it is to be hoped that the lesson thus taught by the British Museum will be imprinted on the mind of every provincial curator, who will feel henceforth that the value of the collection under his charge will consist not so much in the array of mounted specimens which he can muster on his shelves, as in the excellent preparation of the few leading types which are really all that are necessary for the instruction of the public.

The above thoughts have been inspired by a perusal of a little work which has fallen into our hands, viz. the second edition of Mr. Montagu Brown's Essay on Taxidermy. Mr. Brown is the Curator of the Leicester Museum, and he is a man of whom any provincial museum may well be proud. In a lecture delivered many years ago at Leicester Mr. Bowdler Sharpe gave some hints on what he conceived it to be the object of a County museum. It seemed to him that in the first place it was expected of every County museum to make as perfect a collection as possible of the natural productions of that County—that this should be the aim and object of every curator, and that all these exhibits should be arranged in the most popular and attractive form. It was impossible, he pointed out, for a local museum to attempt to show a perfect collection of all the classes of animals. This ought to be left to the British Museum; but he insisted that it was within the province of every such museum to exhibit a typical series of animals which would be useful for comparison with local species, and would educate the minds of an intelligent public towards an appreciation of the varied forms of animal life upon the globe, as compared with the zoology and botany of the county in which they lived. Shortly after the Committee of the Leicester Museum carried out this idea to a limited extent under the curatorship of Mr. Harrison, a most intelligent custodian, who is, we believe, now located at Birmingham; but the plan was fully developed by his successor, Mr. Brown, who has employed his talents as a taxidermist in a popular direction, and the result is that the collection of birds at Leicester is mounted in cases with the natural surroundings explaining their habits at a glance, and in a manner with which no guide-book attempting to illustrate a collection on a conventional plan can hope to vie. It may be a question for naturalists whether this will not be the museum of the future, but as evidence of the value of practical taxidermy this may be considered already *un fait accompli*; and in making these remarks it would be unfair not to mention the names of some of those who in England have contributed to the improvement of this art. Of these the honoured name of John Hancock stands first, for the influence of Waterton, who strove to import into this country an improved system of mounting animals, seems to have been but small among the generation which followed him. Mr. Hancock's groups in the Great Exhibition of 1851 left an indelible impress upon British taxidermy, and his rendering of a bird of prey is only equalled for life-like delineation by one of Wolf's pictures. Mr. A. D. Bartlett, the well-known Superintendent of the Zoological Gardens, is certainly one of the best taxidermists which this country has produced, while the art of mounting Mammalia has been studied with success by Mr. Rowland Ward and Mr. Edward Gerrard—most of the best examples of the latter class in the British Museum having been mounted by the last-named artist. Many provincial men, such as Mr. Swaysland of Brighton, Mr. Shaw of Shrewsbury, and Mr. Quartermain of Stratford-on-Avon, have proved their ability as taxidermists, and London itself possesses adepts in the art who are equal to the great taxidermist Termayer of Holland, whose masterpieces may be seen in the Museums of Amsterdam and Leyden; but we doubt whether anybody has exercised more influence on the improvement in the mounting of animals than Mr. E. T. Booth of Brighton, whose collection of British birds exhibited in the Dyke Road Museum is one of the sights of England. To him belongs the credit of being the first to attempt a collection of British birds with their natural surroundings, and it is upon the lines introduced by Mr. Booth that the beautiful groups of our native species in their natural habitats has been attempted at the British Museum; and if the genius of Mr. Pickhardt who has mounted the birds, and of Mr. Mintorn, to whose skill the beautiful modelling of the flowers and trees is due, does not satisfy the aspirations of British naturalists, we shall feel that the improvements in the taxidermy of recent years have no real existence.

NOTES ON THE CANADIAN NORTH WEST

THE excursion to the Rocky Mountains, along the Canadian Pacific Railroad, will probably prove a most attractive feature in connection with the British Association meeting this season. Living on the cars for several successive days and nights is a novel experience for most people, and one, it might be supposed, that would prove monotonous; but the alternation of forest, lake, prairie, and mountain scenery, each with its associated peculiarities, will probably prevent the trip becoming at all tedious. Some members of the Association may prefer taking the route through the United States to Winnipeg, but from thence all will proceed through the rich wheat lands of Manitoba, then over the rolling prairies west of Brandon, with their numerous alkali lakes and relatively unproductive soil beyond Moosejaw; through the cattle-ranching district at the eastern base of the Rocky Mountains, and up the winding Bow Valley to the summit-level in the Kicking Horse Pass. Here at Stephen, on the confines of British Columbia, the railway terminates for the present.

On crossing the prairies for the first time, many interesting peculiarities will arrest the attention; perhaps none so strongly as the general flatness and absence of timber, which as a rule only occurs skirting the rivers, or as a low scrub in certain wet or marshy lands, or in scattered individuals along the dry sand and gravel ridges. These are probably the patches of country that escape the prairie fires, owing to the vegetation being either too damp or too scanty to support a conflagration. Vegetation as a rule is luxuriant, especially on the rich lands, where the grasses grow to a great height. The soil is mostly a rich black loam of variable thickness, accumulating by the annual decay of the grasses or by the ash from the fires. The loam is thickest on those flat lands with clay subsoil that lie south of the Manitoba lakes: in the arid districts of the western sections it becomes very light.

The subsoil is for the most part stratified sand and subangular gravel, which often contain large boulders of gneiss and quartz; it appears to be in a great measure of glacial origin; but in many places, as in the vicinity of Winnipeg, the subsoil is a stiff brown clay which is probably the filling of an ancient lake: it is seen in the banks of the Red River and Assiniboine. In the high banks of the Saskatchewan at Medicine Hat the clay has more the appearance of a stiff boulder-clay.

A few miles up the River Saskatchewan from Medicine Hat there is an important outcropping of coal; another seam is exposed on the Bow River near Crowfoot Creek; but the most important is that on the Belly River, where there are active collieries, the fuel being conveyed down the river to Medicine Hat, whence it is distributed along the line of railway. These fuels are lignitic in character, and are considered to be either of later Cretaceous or early Tertiary age. They come to the surface in many localities, and evidently underlie a large portion of the western plains. Adjacent to the eastern face of the Rocky Mountains the strata in which the coals reappear are more indurated and highly inclined, and some of the beds contain silicified wood.

In the section of country between Moosejaw and Medicine Hat alkali lakes are numerous; the smaller ones evaporate during the dry season, leaving a flat surface covered by a thick, white, glistening deposit: from this district fine specimens of selenite are obtainable. Probably some of the largest of these bitter lakes are those called the Old Wives Lakes, which lie in a large, sterile depression, on Le Grand Coteau du Missouri, evidently representing the site of a former large inland sea. The fresh-water lakes and marshes, locally numerous along the track, generally teem with wild fowl. In many of them also the tall elevation of reeds, formed by the musk-rat, may be seen.

Of other animal life on the plains there is a great absence. However, the so-called "blackbird" or purple crakle (*Quiscalus*) is locally very abundant; during the early season they keep in pairs, but, on the ripening of the corn, immense flocks of them congregate about it; prairie chicken are also numerous, but of other birds there are very few. Snakes abound in some places; they are constantly to be seen basking in the sun along the railway track. Of mammals the most frequent is the little Gopher or "prairie dog." Almost the only other visible quadrupeds are foxes and a few antelope.

Of the former great numbers of the now practically exterminated buffalo there is abundance of evidence. Their wallowing holes and runs are seen in all directions; the latter, narrow furrow-like tracks, stretch in straight lines across the plains, being most numerous in the vicinity of water. Bleached bones and skeletons, which lie scattered about in great profusion, testify to the wholesale destruction effected, chiefly by the Indians and half-breeds. On the introduction of modern repeating rifles whole bands of buffaloes were ruthlessly slaughtered, solely for their tongues and skins, and often nothing save the tongues were taken from the carcasses.

This indiscriminate destruction has reduced the Indian of the plains to a state of the most abject poverty and destitution, for formerly most of his wants were supplied by the buffalo; now he is wholly dependent on the Canadian Government, which allows a grant to each individual for his support, amounting in all to about 200,000*l.* per annum. Alcohol is not permitted amongst them, and there is a very heavy penalty for bringing intoxicating liquors into the North-West Territories. Of the various tribes, Sioux, Crees, and Assiniboines are met on the eastern portions of the plains; the Blackfoot reserve is situated near the Blackfoot crossing on the Bow River, where an Indian supply farm has been established. The Sarsee reserve is near Calgary; and at Morley the Stonys have their reserve; the latter, however, migrate into the mountains early in the season, and spend the summer in hunting; and although game is now very scarce, they are better off in this respect than their brethren of the plains. From these they differ greatly in physique, being shorter and more thick-set. They are more tractable than many of the other tribes, and a mission has been for some time established among them at Morley.

The country of the plains does not appear to be wholly adapted for agricultural purposes; Manitoba and a great part of Assiniboia are very rich, producing magnificent crops of corn; but the most fertile belt appears to stretch away from Brandon towards Edmonton, the line of the railway traversing a less fertile district to the south. West of Moosejaw the agricultural prospects are indifferent, and in many cases very poor. About Calgary the season is short, but a good deal of cattle-ranching has been done, and the district is considered well suited for it, although two years ago about 75 per cent. of the imported cattle died; this mortality seems to have been the effect of bringing cattle from lower latitudes late in the season, as, on arriving, they were in such a poor condition that they were unable to bear the winter, which that year set in unusually early, and was particularly severe.

Further north, towards Edmonton, the climate is considered to be so harsh as about Calgary: this probably owing to the lower altitude of the mountains permitting the warm Pacific winds to be more beneficial.

Beyond Calgary the railway follows the valley of the Bow River through the district of the Foot Hills for a distance of about fifty miles, when it enters the Rocky Mountain by the Bow Pass at Padmore, or the Gap. Between Calgary and the mountains the character of the country is very different from the prairie districts: the surface is hilly, with patches of pine forest. The strata are more indurated and folded, being often highly inclined. Several well-marked river-terraces can be traced along

this valley, the uppermost extending far up the Bow Pass. In many districts on the plains the flies are so abundant as to interfere with surveying operations, alighting on the object-glasses in such numbers as to obscure the view. In all the houses the black flies literally cover everything. Earthworms do not occur in the north-west. To the botanist the plains are most attractive, there being an almost endless variety of grasses and pretty little flowers; many of our ordinary garden annuals growing wild over the plains.

To one who crosses the plains by the usual railroad route, the Rocky Mountains are first seen from near Crowfoot Creek, at the distance of about 150 miles. They appear as a serrated ridge on the south-western horizon, and numerous patches of snow can very soon be distinguished on them. The entrance to the Bow Pass, by which the mountains are entered, cannot be detected till one is close to the range. It is a comparatively broad winding valley, the direction of the bends being either south-west, across the strike of the strata, or north-west along that strike. The mountains rise precipitously on each side, but the valley itself presents a flat bottom, through which the river winds. This wide level plain, as a rule, is well timbered, the woods extending to a considerable altitude on the mountain sides; but forest fires have reduced the amount of available timber considerably. The trees are mostly either spruce or red fir, and, over the burnt areas, cotton-wood. Along the valley frequent large open untimbered spaces, locally called "parks," bear good pasturage. The removal of the timber from their surface was evidently effected by recurrent fires.

The strata which compose the mountains are regularly disposed, striking north-west and south-east, and having a regular dip to the south-west, which at the outskirts of the range is moderate, but gradually increases till the beds are almost vertical about Castle Mountain. Westwards, in the main divide, they lie more flat. The chief rocks are crystalline magnesian limestones, with calcareous slate, and locally, peculiar siliceous rocks containing opal; amongst the upper beds of the series there are quartzites, grits, and conglomerates.

Near Cascade Mountain an outlier of coal of the same age as the beds on the plains, but much more indurated, rests unconformably on the older rocks, showing that in all probability these Secondary or Tertiary rocks formerly covered most of this Palæozoic area. The older rocks which compose this part of the range are probably of Devonian or Carboniferous age; along the edge of the plains they are cut off by a large fault having a down-throw to the east, which brings the Cretaceous or Tertiary rocks into juxtaposition with them, while to the west they pass under newer strata. River terraces occur along the valley, and near Cascade Park there is a large accumulation of drift, apparently of glacial origin.

Many geologists will probably be disappointed in the Rocky Mountains of the Bow Pass section, for they hardly equal the familiar descriptions of the ranges further south. To the mineralogist, too, they promise but a poor field; the small amount of plication in the strata, and the absence of crystalline rocks, being unfavourable for the development of good mineral specimens. As to the industrial minerals, the resources of the valley have not been determined, but it appears that at least one argilliferous belt passes through the highly inclined rocks in the vicinity of Silver City: it bears copper pyrites and glance in veins running transversely to the general direction of the belt. Whether these veins are sufficiently rich, or whether there are large bunches of ore in the belt, has not yet been proved. Argentiferous galena is also known to occur in the grits and quartzites.

The climate of these mountains is very enjoyable in summer-time. During the day it is sometimes rather hot in the valleys, and the flies prove very troublesome, while at night there are often severe frosts. On the hills the temperature is much more equable, there being usually a cool breeze during the day, and at night the air feels warm and balmy. The timber line here is about 6000 feet above sea-level, and although it is only the highest peaks that rise above the line of perpetual snow, yet there are large accumulations of snow on the northern slopes and in many of the valleys, extending some distance below the timber line. On warm days snow-slides may be constantly heard descending with a loud roar. Glacial lakes occur in several of the valleys and cooms.

Fish abound, but they are difficult to catch except in the small rivers and lakes, where, however, they are small.

To the botanist the mountains would probably prove even more attractive than the plains, as there is such variety in the flora according to the altitude. Above the present timber limit vegetation rapidly diminishes, only scattered individuals occurring at a distance above it, one of the most remarkable of these being the forget-me-not, bright blue patches of it not uncommonly occur right up alongside the snow banks.

GERRARD A. KINAHAN

NATIVE AMERICAN LITERATURE AND ETHNOLOGY[1]

OUR apology for grouping together so many valuable works on native American literature must be the extraordinary rapidity with which such productions are accumulating. Unless dealt with in this somewhat summary way, they run the risk of not being noticed at all. The great activity recently displayed in this department is largely due to the personal efforts of Dr. Brinton, whose spirited attempt to form a "Library of Aboriginal-American Literature" has already made some progress towards realisation. The first book on our list is practically a reply to those who may be sceptical as to the existence of sufficient materials to warrant such an enterprise. Based on a paper laid before the Congress of Americanists at Copenhagen last year, it takes a summary but comprehensive survey of all the still extant monuments of native literature in the various branches of history, legend, ritual, oratory, poetry, and the drama. In some of these branches the quantity of available matter is considerable. Hundreds of native tales and legends have been committed to writing by the Christian Eskimo of Greenland, and Dr. Heinrich Rink's manuscript collection of their historical traditions fills over two thousand pages. But the quantity of folk-lore and tribal myths floating about in the oral state amongst the Dakotahs, Athabascans, Algonquins, and other North American nations is alone sufficient to supply abundant materials for Dr. Brinton's undertaking. These, however, cannot be properly utilised until the natives have been educated and taught to write their own language, as, for instance, some of the Eskimo, Cherokees, and Iroquois have already learnt to do.

A brilliant result of such education is the "Iroquois Book of Rites," second on our list, which is now printed for the first time from native manuscripts recently brought to light by the editor, Mr. Horatio Hale. In the introduction a curious account is given of these manuscripts, of which there are three extant, two in the Canienga dialect procured at the Iroquois Reserve near Brantford, and one in the Onondaga dialect found at the Reservation near Syracuse, New York. The former are duplicate copies of the "Book of Rites" proper, and one of them appears to be traceable to an original, composed during the latter part of the last century, probably by the

[1] "Aboriginal American Authors." By Daniel G. Brinton, M.D. (Philadelphia, 1883.)

"The Iroquois Book of Rites." Edited by Horatio Hale, M.A. (Philadelphia, 1883.)

"The Güegüence: A Comedy Ballet in the Nahuatl-Spanish Dialect of Nicaragua." Edited by D. G. Brinton. (Philadelphia, 1883.)

"Sixteenth and Seventeenth Annual Reports of the Peabody Museum of American Archæology and Ethnology." (Cambridge, 1884.)

Canienga Chief, David of Schoharie. The other, written by one "John Green," of the Mohawk Institute at Brantford, and dated November 1874, is based on an unknown text differing in some respects from that attributed to Chief David. The Onondaga is not a copy of the Canienga work, but its complement, comprising the speeches addressed by the younger to the elder nations when a chief of the latter is mourned, and hence named the "Book of the Younger Nations." All the original texts may possibly have been composed about the middle of the eighteenth century, by which time several of the natives had been sufficiently instructed by the English missionaries to read and write their mother tongue fluently.

Such is briefly the history of the "Book of Rites" in its written form, which consists mainly of the speeches, songs, formulas, and ceremonies performed at the meetings of the Great Council, or "Council of Condolence," of the Iroquois Confederacy, when it met for the combined purpose of mourning the death of a chief and celebrating the induction of his successor. The proceedings to be observed on this important occasion had evidently been handed down orally from the time of the formation of the famous League, or "Great Peace," an event usually referred to the middle of the fifteenth century. Much of the contents of the "Book of Rites" may therefore fairly claim to date from that period. But although the strictly ceremonial portions may have been written down in the very words in which they had been orally preserved for some three hundred years, the text as it now stands has obviously been coloured by the spirit of the eighteenth century, and is, so far, not a faithful reflection of the social ideas and inner life of the Iroquois nation in pre-European and pagan times." Such passages as "The Great League which you established has grown old"; "Hail, my grandsires! You have said that sad will be the fate of those who come in the latter times"; "ye are in your graves who established it [the League]. Ye have taken it with you and have placed it under you, and there is nothing left but a desert," were written by men who felt that the Confederacy was already a thing of the past. The whole tone of the work is in fact pervaded by a spirit of sadness and despondency, and its very scope seems to have been the preservation of the empty forms and ceremonials of an institution whose days were already numbered. This point should be borne in mind in reading the comments of the editor on the present text, and especially the arguments drawn from it in favour of the superiority of the Iroquois race over "the Aryans of Europe" in humanity, public spirit, and political sagacity. The curious theory is even advanced that the fine qualities of the European Aryan, as compared with his barbarous Asiatic kindred, "may have been derived from admixture with an earlier population of Europe, identical in race and character with the aborigines of America" (Introduction, p. 98). And in an unfortunate appendix, where this idea is worked out at some length, it is suggested that the time is approaching when the "servile Aryans will cease to attract the undue admiration which they have received for qualities not their own; and we shall look with a new interest on the remnant of the Indian race, as possibly representing this noble type of man, whose inextinguishable love of freedom has evoked the idea of political rights and has created those institutions of regulated self-government by which genuine civilisation and progress are assured to the world" (p. 190).

Mr. Hale is more instructive in the section of his erudite introduction devoted to the genius and inner structure of the Iroquois language. Here he shows, against the general conclusions of philologists, that Iroquois really abounds in true abstract terms. Such are *otariténsera* = heat, *atariatitsera* = courage, *kanaiésera* = pride, *kanakwenséra* = anger, regularly derived by the affix *sera* from verbal forms. He also makes it clear that true grammatical gender exists, forming, as in the Semitic system and in some neo-Sanskritic idioms, a distinctive feature of verbal conjugation. But its use is entirely restricted to the third person singular, dual and plural, as in *watkahtos* = she sees, *kiatkahtos* = they two see (fem.), *kontkahtos* = they see (fem.). This point is of great importance as affecting the various psychological systems of linguistic classification that have been proposed by certain German theorists. It may be incidentally remarked that in Africa also the distinction between gender (Hamitic and non-gender (Negro) languages no longer holds good, for it now appears that gender is also characteristic of the Masai, and of many Nilotic negro tongues.

Dealing with the tendency of Iroquois and so many other American languages to fuse the terms of the sentence into a single compound word, Mr. Hale observes: "The notion that the existence of these comprehensive words in an Indian language is an evidence of deficiency in analytic power, is a fallacy long ago exposed by . . . Duponceau. As he has well explained, analysis must precede synthesis. In fact, the power of what may be termed analytic synthesis—the mental power which first resolves words or things into their elements and then puts them together in new forms—is a creative or co-ordinative force indicative of a higher natural capacity than the act of mere analysis. The genius which framed the word 'teskenonhweronne,' ['I come hither again to greet and thank'] is the same that, working with other elements, produced the steam-engine and the telephone" (p. 150). Here again it is to be feared that bias has got the better of reason. Certainly the world would have had to wait very long indeed for the steam-engine and the telephone had their invention depended on the natural evolution of the people who "framed the word" in question. Prof. Sayce ("Science of Language") has also made it tolerably evident that analysis does not precede synthesis, and that the unit or starting-point of speech is rather the sentence than the word. Hence the American polysynthetic is an infantile compared with the English analytical process in the example appealed to. But, apart from these eccentric views, it is a great pleasure to be able to say that Mr. Hale has given us an admirable edition of the "Book of Rites"—a priceless treasure opportunely rescued by him from the imminent danger of destruction.

An equal share of praise is due to Dr. Brinton as editor of the "Güegüence," which forms the third volume of his Library Series. This curious document presents considerable interest, both from the ethnological, philological, and literary points of view. An original native drama in the strict sense it can hardly be called. But although dating no further back than the last century, and composed in a strange medley of bad Spanish and Nahuatl (Aztec), it may be regarded as almost the last surviving specimen of the aboriginal semi-dramatic compositions which appear to have been in common use amongst the Central American peoples long before and after the Conquest. Such compositions, prepared for oral recitation at the public feasts and ceremonies, were so far dramatical that they took the form of dialogue, and turned on some simple incident with a happy *dénouement*. In the present instance the Güegüence, that is, the elder or village headman (from the Aztec "*huehuentzé*" = "dear old man"), is brought with his two sons before the provincial governor charged with entering the province without a pe[rmit]. This leads to a good deal of repartee, some broad jokes, and intentional misunderstandings on the part of the hero, who in the end comes off best and manages to bring about a marriage between one of his sons and the governor's daughter. The language of the piece is very peculiar, and will doubtless be appealed to by the advocates of mixed forms of speech in favour of their views. Yet a careful study of the text shows that here the Spanish and Aztec elements are not harmoniously fused, as are, for instance, the Saxon and Latin elements in

English. Thus we have sometimes two or three tolerably correct consecutive Spanish sentences with due observance of its grammatical forms, as, for instance, Pues, ome! Uno, dos, tres, quatro. Ha! mi plata, muchachos! ntro cientos y tantos pesos le he dado á mi amigo Alguacil. But beyond abrupt exclamations such as *scamayagna, Gueguence*" = "at your service, Güece," complete grammatical Aztec sentences never ir, and the composition may on the whole be regarded ssentially Spanish copiously interlarded with native rds and phrases. Hence it is rather a medley than a true *lingua franca*, or a jargon, such as "Pigeon-English," and the Chinook of the Columbia river, which involve a total destruction of the relational forms of all the constituent elements, thus preparing the way for a fresh grammatical departure. Thus only is it conceivable that true mixed languages can be developed, and the conditions favourable for such combinations are necessarily so exceptional that they must in any case always remain the rarest of linguistic phenomena.

Little space is left to speak of the last "Reports of the Peabody Museum," which are more than usually rich in original ethnological materials. Conspicuous amongst these are the graphic descriptions at first hand of the "White Buffalo Festival of the Unepapas," the "Elk Mystery or Festival of the Ogallala Sioux," the "Religious Ceremony of the Four Winds as observed by the Santee Sioux," the "Shadow or Ghost Lodge: a Ceremony of the Ogallala Sioux," and the "Wa-Wan or Pipe Dance of the Omahas," all by Miss Alice C. Fletcher, who has recently been spending some profitable time in the midst of these North American tribes. By taking up her residence amongst them, sharing in their domestic joys and sorrows, making herself one of them, this enterprising and benevolent lady has enjoyed rare opportunities of penetrating into the inner life of the aborigines. Hence the great value of her remarks, especially on their religious views, a correct appreciation of which can only be had in this way. On the vexed subject of nature-worship and animism some current misconceptions are combated and fresh light thrown on the attitude of the native mind towards the outward and invisible world. "Careful inquiry and observation," she writes, "fail to show that the Indian actually worships the objects which are set up or mentioned by him in his ceremonies. The earth, the four winds, the sun, moon, and stars, the stones, the water, the various animals, are all exponents of a mysterious life and power encompassing the Indian, and filling him with vague apprehension and desire to propitiate and induce to friendly relations. This is attempted not so much through the ideas of sacrifice as through more or less ceremonial appeals. More faith is put in ritual and a careful observance of forms than in any act of self-denial in its moral sense as we understand it. . . . To the Indian mind the life of the universe has not been analysed, classified, and a great synthesis formed of the parts. To him the varied forms are all equally important and noble. A devout old Indian said: "The tree is like a human being, for it has life and grows; so we pray to it and put our offerings on it that the god may help us." Here we have placed in a vivid light the very essence of Anthropomorphism—ultimate base and starting-point of all primitive religions.

In the Curator's Report reference is made to the imprints of human feet discovered by Dr. Flint on December 24, 1883, in the volcanic rock some fourteen feet below the surface soil in Nicaragua. The tracks are in several series running nearly parallel with the banks of Lake Managua, within 300 feet of the present margin. Above the prints is a bed of clay and volcanic material containing fossil leaves, and over this four distinct beds of more recent volcanic matter. Blocks of rock containing the prints have been cut away and forwarded to the Museum. "That they were made by the feet of men while the material of which the rock is formed was in a plastic condition there is not the least doubt. The imprints are from nine to ten inches long and about four wide across the ball of the foot . . . with heel-ball and toes perfectly distinct. Dr. Flint states that the stride was only from eleven to eighteen inches, which indicates slow walking over the plastic substance." It is hoped that a clue to the geological age of the deposit may be obtained from the fossil leaves, a report on which is expected from Prof. Lesquereux. A. H. KEANE

NOTES

THE International Conference on Education was opened at the Health Exhibition on Monday by the address of Lord Carlingford, and has been continued during the week. There is a very large attendance both of English and foreign educationists, while the papers and discussions have been of much interest and importance. We hope to speak in detail of the Conference in our next number.

THE summer meeting of the Institution of Mechanical Engineers began at Cardiff on Tuesday with the address of the president, I. Lowthian Bell, F.R.S. The papers to be read are all of a technical nature. The meeting will be continued during the week, and many excursions have been organised, and visits to engineering and other works.

THE French Association for the Advancement of Science will hold its next meeting at Blois from September 4 to 11 next. The lecturers and subjects of lectures have not yet been decided upon.

DR. SCHWEINFURTH will return to Africa in a few weeks, on a commission from the Berlin Academy of Sciences; but the field of his exploratory labours has not yet been finally selected.

THE Government having decided to appoint a Royal Commission for the Exhibition of India and the Colonies, which is to be held in London in 1886, the Prince of Wales has issued a certain number of invitations to those persons whom it is desired should serve on this Commission.

THE death is announced of Mr. Charles Manby, F.R.S., M.Inst.C.E., for forty-five years identified with the Institution of Civil Engineers, for seventeen as the paid secretary, and for twenty-eight years as the honorary secretary. He was born on February 4, 1804, and was the eldest son of Aaron Manby, the founder of the Horseley Iron Works in Staffordshire, and later of the Paris Gas Works, and of ironworks at Charenton, near Paris, and who re-organised the now famous ironworks at Creuzot. For his father he was also engaged on the design and construction of the first pair of marine engines with oscillating cylinders, upon the building of the *Aaron Manby*, the first iron steamship that ever made a sea voyage, and upon the several works in France before enumerated. In 1839 he was appointed secretary of the Institution of Civil Engineers, and soon afterwards threw himself, heart and soul, into a movement which revolutionised the Society. As evidence of the appreciation in which he was held it may be mentioned that when, in 1856, he relinquished the position—which has since been filled by his pupil, James Forrest—he was presented with a service of plate and a sum of two thousand guineas, "as a token of personal esteem, and in recognition of the valuable services he had rendered to the members individually and collectively." Again, in 1876, Charles Manby received from the members of the Institute of Civil Engineers a silver salver and a purse of upwards of 4000*l*. "in friendly remembrance of many years valuable services."

ON Monday, August 4, taking advantage of Bank Holiday, the Essex Field Club held a meeting at Colchester. The party,

about fifty or sixty in number, were met at the station by Mr. J. Horace Round, who conducted them through the older parts of the town to the Castle, the history of which was lucidly sketched and the main points of interest shown by Mr. Round. A hurried visit to the Castle Museum, with its splendid collection of local antiquities and natural history objects, was next made under the guidance of the Rev. C. L. Acland and Mr. Round. The party then proceeding to lunch at the Cups Hotel. After lunch, a drive of about eight miles along the Mersea Road, passing through the villages of Abberton and Peldon, the scenes of the earthquake of April 22, brought the party to West Mersea, where Mr. H. Lauer addressed them upon the history of this and the surrounding districts during Roman times, suggesting that the Roman town of Othona may have been situated on the opposite shore of the River Blackwater in the neighbourhood of Bradwell. Mr. Lauer next called attention to the interesting and mysterious "salting-mounds" or "red hills," which occur also on the Norfolk coast and along the rivers in Suffolk and Kent, and of which eighteen still exist between Strood and Virley in Essex. These, according to Mr. H. Stopes, F.G.S., often cover as much as 10 to 30 acres, and are from 2 to 4½ feet deep, being composed of red burnt clay mixed with rude broken pottery, charcoal, ashes, and often bones. A ramble eastward along the coast of Mersea Island brought the party to the "decoy" for the capture of wild-fowl, the working of which in former times was explained by Mr. Lauer. Here Mr. J. C. Shenstone gave a short demonstration of the interesting coast flora. Driving homewards the party stopped at the ruins of Langenhoe Church, wrecked by the earthquake, where Mr. R. Meldola gave a short statement on this subject in anticipation of the detailed report which he proposes to present to the Club. He stated that the area of structural damage covered about fifty square miles. After tea an ordinary meeting was held, Mr. R. Meldola in the chair, and the evening concluded with a *conversazione* at the Hotel, collections of insects, dried plants, and living insectivorous plants being exhibited by Mr. W. H. Harwood, Mr. Shenstone, and Dr. Alexander Wallace. The Mayor and many of the townspeople were present during the evening to listen to the short addresses on natural history subjects given in explanation of the various exhibits.

THE repeated failures of steamers to reach Siberia from Europe do not seem to have deterred M. Sibiriakoff, the well-known Russian merchant, from again despatching two steamers this year. Early last month the steamers *Nordenskjöld* and *Obi* left Tromsö (Norway) to attempt, it is stated, for the last time to reach Siberia. When in lat. 70° 55′ N. and long. 52° 15′ E. the engines of the *Nordenskjöld* broke down, and she was with great difficulty towed back to Vardö.

A SUBSCRIPTION has been opened at St. Petersburg, in order to raise the money for instituting at the University five bursaries in the name of Charles Darwin, to be employed for the maintenance of five students in the five chief branches of natural science.

THE Russian review, *Russkaya Starina*, and the *Journal* of the Russian Chemical and Physical Society have lately devoted some attention to the first steam-engine that was made in the Russian Empire, in 1763, at the ironworks of Barnaoul, in Western Siberia, by a mining engineer, Polzunoff. It appears from M. Woyeikoff's description of this steam-engine, the model of which exists still at Barnaoul (both reviews have figured it on plates), that Polzunoff's engine was a reproduction of the "fire-engine" of Newcomen, with some original improvements. Thus it has two cylinders, instead of one, and, instead of the beam, Polzunoff made use of a wheel which received the chains of the pistons, and transmitted the circular movement, transformed again into a rectilinear one, to a pair of bellows, used for blowing air into a high furnace. The distribution of vapour was automatic, as in Newcomen's engine, but with several improvements. The engine, which had cylinders 9 feet long and 9 inches in diameter, worked during two months from May 20, 1766, and 3100 cwts. of silver ore, yielding 5 cwts. of silv[er] were melted with its help. But Polzunoff did not see his en[gine] at work, as he died from consumption four days before. [He] obviously was a remarkable man for his time, several of [the] physical remarks he made in the description of his engine sho[w]ing not only a wide knowledge, but also a serious spirit of tr[ue] physical reasoning, together with a notable skill for determining the limits of knowledge of that time. In his theoretical remarks about "Air, Water, and Vapour," he notices also that physicists are not yet agreed as to the origin of heat, some of them seeing in it a much-divided, fine moving matter, while others "see the origin of heat in friction and in the vibratory motion of the particles inaccessible to our senses, of which the bodies are constituted." He obviously quotes here the words of Lomonosoff, who stated in these very words the mechanical origin of heat in his most remarkable but unhappily little-known memoir, written as an instruction to Tchitchagoff's Polar Expedition.

SEVERAL severe shocks of earthquake were felt on Sunday afternoon at Foca, in Bosnia. The duration of each shock was over two seconds.

A BROCHURE just issued by M. Ch. Montigny at Brussels contains in convenient form the result of his studies on the state of the atmosphere as affecting stellar scintillation, with a view to forecasting the state of the weather. From the fact determined by W. Spring, that the colour of pure water in great bulk is blue, he explains the predominance of this colour in the scintillation of the stars just before and during wet weather. The luminous rays, he argues, traversing the air charged with large quantities of pure water are necessarily tinged with the blue colour of this medium. The excess of blue thus becomes an almost certain means of predicting rain. This theoretic conclusion corresponds with the results of his observations continued for several years past on the appearance of the stellar rays in connection with the state of the weather. During the few months of fine weather in the present year blue has been much less conspicuous than in the corresponding months of previous years since 1876, when wet weather prevailed. It also appears that green, which had always coincided with clear skies during the fine years before 1876, has recently again become predominant. Hence he thinks it probable that we have got over the cycle of bad seasons, and that dry weather and more normal summers may be anticipated at least for some time to come.

PROF. F. NEESEN publishes a reprint of his paper in the *Archiv für Artillerie- und Ingenieur-Offiziere* for 1884 on a generalisation of Sebert's method of registering the velocity of shot within the tube of a gun. Sebert's apparatus necessarily registers for a space somewhat shorter than the diameter of the ball. This defect is remedied and the registration extended to the whole length of the tube by means of a revolving appliance to which the registering tuning-fork is attached, and disposed parallel with the periphery of the cross-section of the shot. Pencils fastened to the prongs of the tuning-fork and vibrating with it are thus made to describe curves indicating the velocity of the ball in its course through the tube. The only objection to the process, which is made perfectly clear by several accompanying illustrations, is that by the concussion the registering apparatus may get deranged or jammed with the shot. This danger it is proposed to obviate by making the apparatus of the best steel, and diminishing the effect of the concussion by filling the shot with some fluid when fired for experimental purposes.

IN the last number of the *Bollettino* of the Italian Geographical Society, Dr. G. A. Colini continues his valuable

paper, already noticed in NATURE, on the Indians of the Upper Amazon regions. Much original and curious information is supplied regarding the Caribos, Shipivos, Amahuacs, Campas, Shetevos, and many other Christian and Pagan tribes, especially of the Ucayali and Huallaga basins. Thus we are told that most of the Christian women in the Ucayali villages don a European smock to attend mass, but after the service lay it aside for the native *pampanilla*, a scanty garment, white at first, but afterwards dyed blue or red with geometrical designs to save the trouble of washing it. Here also the men carefully pluck out the beard with pincers made of two shells, because the women consider this appendage as a sign of old age. Hence bearded youths are regarded as superannuated, while clean-faced old men are still eligible in the matrimonial market. The South American Indians are usually described as altogether beardless, an inference due probably to this custom, which appears to be very general.

THE principal articles in the current number of *Petermann's Mittheilungen* are on Arctic subjects. Prof. Mohn of the Norwegian Meteorological Institute writes on the hydrography of the Siberian Arctic from the observations of the *Vega*, while Lieut. Hovgaard, a member of the expedition, contributes a paper on the ice in the Kara Sea, and M. Lauriasen of Copenhagen on the point reached by Behring in his first expedition. In addition to these we have papers on the names of places in the Niger region, on the new map of Germany prepared by the general staff, and the usual notes.

THE plague of rabbits in our Australasian colonies is one of which much has been heard, and it appears that another European animal, the dog, is about to follow the example of the rabbit, and make himself a pest in place of a pet. It appears that the number of wild or semi-wild dogs has recently increased largely in Victoria and New South Wales, and the consequence is a great slaughter of sheep by these nomads. The Government has already offered rewards for their destruction. In New Zealand some enterprising people have hit on the idea of importing weasels and stoats from England to keep down the rabbits; but if the former increase in their new habitat as rapidly as the latter have done, the last state of New Zealand will be worse than the first, for a plague of rabbits must be as nothing compared to a plague of weasels, and a great increase of the latter, from their predatory and destructive habits, must be followed by a considerable alteration in the distribution of the fauna of New Zealand. In Jamaica, according to the last report of the Director of Public Gardens in that colony, the planters suffered greatly from the depredations of rats among the sugar-canes. The rat-eaten canes were good for nothing except rum, and accordingly large sums were spent in poison and dogs to keep down the rats, but apparently without much success. At last an enterprising planter determined to import the mongoose from India to destroy the rats on his sugar estate. The sugar-planters, Mr. Morris says, have unquestionably benefited greatly by its introduction, and rat-eaten canes are now hardly known where formerly they were found in large quantities. But the new importation continues to multiply and spread, not only on sugar estates, but on the highest mountains, as well as along shore, even amidst swamps and lagoons; and when the sugar-cane rat is wholly exterminated, the mongoose will still go on increasing, and what then? Must the colonists find something else to exterminate the mongoose, and save their poultry, and so on *ad infinitum*? As it is, negro settlers and persons not connected with sugar estates complain of its ravages amongst their poultry and even accuse it of destroying fruit and vegetables; and, although Mr. Morris doubts whether these complaints are all well founded, he acknowledges that the mongoose is the cause of great disturbance in the animal life of Jamaica. Harmless yellow and other snakes, lizards, ground-hatching birds, rabbits, and many members of the indigenous fauna of the island are likely to become extinct at no distant date. It will be interesting to watch the effect of the introduction of the mongoose, and we hope Mr. Morris will enlighten us from year to year on the subject.

AT the last meeting of the Asiatic Society of Japan (as reported in the *Japan Weekly Mail*) a paper was read by Dr. Whitney on "Medical Progress in Japan." The first era in Japanese medicine was the mythological age, when the treatment of disease appears to have consisted in the use of charms and the employment of the simplest remedies originated by the "Great-name-possessing Deity"; the next period covers nearly 900 years from the middle of the second century B.C., during which Corean and Chinese medicine was introduced, as well as Buddhism and the useful arts. At the close of the eighth century the University and a medical school were established, and here commences the third period in the history of Japanese medical progress, which lasts down to the middle of the sixteenth century. In the medical college of those days the students pursued a seven years' course, and appear to have received a thorough and systematic training in Chinese medicine, which, as then taught, was embodied in works consisting chiefly in numerous dissertations and philosophical deductions based upon incorrect notions as to the anatomy of the human frame and the relation of its various viscera with one another and with the different phenomena of nature. In the fourth period, from the middle of the sixteenth century, when the Portuguese first appeared in Japan, down to the restoration of 1867, occurred the revival of both the Japanese and Chinese schools, and the introduction of Western medicine, which appears to have played no unimportant part in the temporary success of the missionaries. They received at one time a grant of 7500 acres of public lands for the purpose of cultivating medicinal plants. In 1775 was published the translation into Japanese of a Dutch work on anatomy, which was the first of its kind published in Japanese. Vaccination was introduced in 1824 from Russia by some Japanese fishermen, and in 1858 a medical school was founded in Nayaski, in which Western medicine only was taught. With the effects of the revolution of 1868 on medicine, as on most other things in Japan, most people are familiar. The physicians and surgeons of new Japan are required to go through a three years' course of study, and to pass examinations in the manner familiar in Europe. Apothecaries, dentists, and midwives must similarly be provided with diplomas, which can only be obtained after satisfactory examination. Contagious diseases acts, the examination of drugs, a strict control of the sale of opium for medicinal purposes, and the numerous other measures by which governments seek to protect the public health, are now found in full working order in Japan.

DR. R. LENZ describes, in the last *Bulletin* of the St. Petersburg Academy of Sciences, a new application of the telephone to the measurement of temperatures at a distance. Let us imagine two stations, A and B, connected together by an iron and an argentan wire, which are looped together at both stations. If the looping at A has a different temperature to that of B, a thermal current will circulate through the wires; and if a silent interrupter and a telephone be introduced into the system, the telephone will emit a sound, which will cease immediately the observer at B has raised or lowered the temperature of his looping place, so as to render it equal to that of A, and to destroy thus the thermal current. The exactness of this method depends on the exactness of determination of the moment when the lull ceases in the telephone, which moment is influenced by a remnant of lull in the instrument after the equalisation of temperature at both ends of the apparatus. In a series of experiments where the points A and B were one metre distant, Dr. Lenz

determined temperatures by this method with great accuracy, the errors being only from 0°·01 to 0°·17; and he concludes that, by using iron-argentan wires two millimetres thick, the measurements could be made at a distance of five kilometres, which distance could be still increased, say to twenty-five kilometres, if antimony and bismuth wires were used.

THE last number (12) of the *Journal* of the Straits Branch of the Royal Asiatic Society has the continuation of a paper on Malayan Ornithology, by Capt. Kelham, and an official report by Mr. L. Wray, of Perak, on gutta-producing trees. Mr. Maxwell writes on "Shamanism in Perak," the term in this instance being applied to the incantations and ceremonies employed by the Malays to cure the sick. But surely Shamanism in its home in Thibet is something more than this. Mr. Ferguson contributes some notes on the curious changes which consonants undergo in passing from one Malay dialect to another. The papers, properly so called, conclude with a report on the Meteorology of the Straits. In the Annual Report of the Council of the Society we notice that it is intended to republish in a collected form valuable papers published in the Eastern Archipelago at one time or another, but now either out of print or difficult of access; also a text-book of the geography of the region, under the editorship of members of the Society, and a skeleton map of the Malay Peninsula, on a scale of a quarter of an inch to a mile, upon which all new information will be entered from time to time as exploration advances.

SEVERAL honorary promotions have been recently made by the French Government for scientific services. Dr. Cornelius Herz, director of *La Lumière Electrique*, has been nominated Commander in the Legion d'Honneur at the request of M. Cochery, Minister of Postal Telegraphy, for his works on Electricity. The Minister of Public Instruction has appointed Madame Camille Flammarion an officer of the Academy for having acted as a secretary to her husband in all his work in connection with astronomy. The Municipal Council of Paris has decided that one of the new streets of the Thirteenth Arrondissement shall be named Giffard, in commemoration of the inventor of the injector.

AN experiment has been made in Vienna which proves that even with incandescent lights special precautions must be taken to avoid any risk of fire. A lamp having been enveloped with paper and lighted by a current, the heat generated was sufficient to set fire to the paper, which burnt out and caused the lamp to explode.

ON July 27 there was celebrated at the Trocadéro Palace the centenary of the death of Diderot, the celebrated French philosopher, who was also a man of science in his time and editor of the famous *Encyclopædia*.

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus rhesus* ♀) from India, presented by Miss A. E. Sturge; a Bonnet Monkey (*Macacus sinicus* ♂) from India, presented by the Rev. T. Rickards; a Common Fox (*Canis vulpes*), British, presented by Mr. Thomas Legg; a King Vulture (*Gypagus papa*) from South America, presented by Mr. August Strunz; two Red-tailed Buzzards (*Buteo borealis*) from Jamaica, presented by Mr. D. Morris; a Martinique Waterhen (*Ionornis martinicus*), captured at sea, presented by Mr. A. Jones; two Jackdaws (*Corvus monedula*), British, presented by Mrs. Frank; a Kestrel (*Tinnunculus alaudarius*), British, presented by Mr. G. Westrup; a Crested Curassow (*Crax alector*), an Anaconda (*Eunectes murinus*) from British Guiana, presented by Mr. G. H. Hawtayne, C.M.Z.S.; a Grey Amphisbæna (*Blanus cinereus*) from Portugal, presented by Mr. W. C. Tait, C.M.Z.S.; a Golden-crowned Conure (*Conurus aureus*) from South-East Brazil, deposited; a Black Hornbill (*Sphagolobus atratus*) from West Africa, purchased; a three-quarter bred Mesopotamian Deer (between *Dama mesopotamica* ♂ and hybrid *Dama vulgaris*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

THE NEW COMET.—A circular issued from Dun Echt on July 31, contains the following approximate elements of the comet discovered by Mr. Barnard on July 16, calculated by Mr. S. C. Chandler of Harvard College Observatory:—

Perihelion passage, 1884, August 17·63 G.M.T.

	°	′
Longitude of perihelion	302	4
,, ascending node	357	52
Inclination	7	2
Logarithm of perihelion distance	0·14780	

Motion—direct.

The comet will probably be observable in this country after perihelion passage, as will appear from the subjoined positions resulting from Mr. Chandler's orbit:—

12h. G.M.T.		R.A. h.	m.	N.P.D. °	′	Distance from Earth	Intensity of Light
September	3	18	27·2	123	8	0·682	1·06
,,	7	18	44·2	122	6	0·701	0·98
,,	11	19	0·2	120	58	0·722	0·91
,,	15	19	15·9	119	46	0·747	0·83

At discovery on July 16 its distance from the earth was 0·627, and that from the sun 1·480, consequently the intensity of light was 1·16.

The supposition that this comet had been observed at Melbourne, Madras, and the Cape, arose from a mistake in telegraphing. M. Trepied (Algiers) calls it "nébulosité sans queue; condensation centrale."

PERIODICAL COMETS IN 1885.—During next year three comets of short period will return to perihelion. Encke's comet is due in March, probably in the first or second week, according to the elements of 1881. The next is Tempel's comet, 1867 II., in the case of which it is not possible to assign the time of perihelion passage without the calculation of the perturbations due to the attraction of Jupiter, near which planet the comet was situated during the last half of the year 1881; the least distance of the two bodies having been about 0·57 in October. The third comet referred to is Tuttle's, last observed in 1871, the perihelion passage probably in September or October.

A VARIABLE-STAR IN AQUARIUS.—Attention has been already directed in this column to a star, the position of which for 1884·0 is in R.A. 22h. 29m. 48s., N.P.D. 98° 12′·4, on the score of variability from the ninth magnitude to invisibility, or at least to below the twelfth magnitude. Mr. Knott has just made an observation which confirms the variation of the star, as notified by Mr. Hind some thirty years since. On August 1, by the method of gauging, Mr. Knott found its magnitude 11·7. It was 9m. according to the Markree Zones on October 27, 1848, and on four occasions was estimated 9·5 at Bonn. It was considered a ninth magnitude, probably in August 1855, at the late Mr. Bishop's observatory. Generally it seems to have been about 11·5m. There is some reason for supposing that it does not continue very long at maximum. Argelander was inclined to think that there was a mistake as to the variability of this star, but the evidence in favour of it appears now to be too strong to be thus set aside. It has not been included in Schönfeld's catalogues of known or suspected variables.

PTOLEMY'S 30TH OF CENTAURUS.—In Sûfi's "Description of the Stars," according to Schjellerup, we read: "Ptolemy has reported that there are in this constellation (Centaurus) thirty-seven stars, but in reality there are only thirty-six, the thirtieth is wanting." The star is No. 964 of Baily's edition of Ptolemy's Catalogue, and is rated 7, the twenty-ninth star immediately preceding (ε Centauri) being called β. From Ptolemy's longitudes and latitudes we find that the thirtieth star followed the twenty-ninth 0° 34′ in R.A. and 1° 10′ to the south of it. Q Centauri follows ε 26′·5, and is south 1° 5′·7; it is estimated 5·7 m. in Gould's *Uranometria*, but is a double-star, the components 6½ and 7½. Notwithstanding the difference in brightness, the approximate agreement of positions seems to point to Q Centauri as Ptolemy's thirtieth star.

OBSERVATIONS ON A GREEN SUN, AND ASSOCIATED PHENOMENA[1]

THE rarity of the phenomenon of a green or blue sun makes it desirable to record with the greatest accuracy and detail the observations made during its appearance in India during several days of September 1883.

The notes taken at Madras at the time of the appearance will best illustrate the general features of the phenomena :—

On September 9, the sun, before setting, assumed a peculiar silvery appearance, and its brightness was so much decreased that for about half an hour before sunset it could be observed with the naked eye. This was observed, I believe, though to a less extent, on the two days preceding, but I did not myself see it on these days. On September 10, from 5 to 5.30 p.m., the sun could easily be looked at with the naked eye, yet the limbs were sharply defined. At 5.30 the sun entered a low bank of clouds, and did not fully appear again ; but a narrow strip seen through a rift in the cloud at 5.43 was coloured a bright pea-green. Round Madras this colour had been seen in the morning, but in Madras itself clouds concealed the sun till it had risen to a considerable altitude. Of the morning of the 11th I have no record, but in the evening the green colour was brilliant, and was visible for more than half an hour, being preceded, as on the former night, by the silvery white appearance of the sun's disk. On this evening a large sunspot about 1' long was so conspicuous an object that it attracted the attention of even the most casual observers.

September 12.—At 12.35 a.m. the moon, which was near the horizon, appeared a pale green. Bright stars near the horizon showed the same tint. From 5.15 to 5.30 the clouds to the east were coloured reddish brown. At 5.55 the sun rose with a yellowish green colour, but was almost instantly lost in clouds. It reappeared at 6'4, and was then of a bright green colour : this colour rapidly got fainter, but was quite perceptible till 7 o'clock. In the afternoon the phenomena of the previous nights were repeated, and, the horizon being free from clouds, the actual sunset was observed. The entry in my notes is : "6.3.—The sun set as a greenish yellow ball ; cumulus, stratus, and nimbus clouds near the horizon, but moon fairly clear ; some blue sky, but hazy." The change from green to greenish yellow was evidently due to the great increase in the strength of the low-sun-band close to the horizon, which left the strip of yellow between that band and the rain-band by far the most prominent feature in the spectrum.

September 13.—In the early morning there was a good deal of distant lightning. The sun rose of a bright, golden yellow colour ; no green was seen. In the afternoon there were slight showers.

A most remarkable observation made this morning by Mr. Pogson seems very difficult to explain, except by some form of auroral display. I give his notes in full :—

"1883, September 12, 17h. 0m. Madras mean time.—The sky a most remarkably intense reddish yellow, unusually bright. A dark cloud-bank from about east to south, and the vivid light above uncommonly auroral in appearance, more so than anything I have seen here before.

"At 17h. 10m. the red hue considerably diminished, and bright orange yellow the prevailing tint. The light quite bright enough to make notes by.

"At 17h. 20m. the dark blue-black stratum, now from about north to east, and very near the horizon. Sky tolerably clear to about 20° altitude, but of a rich red tint, with bright yellow clouds above, beginning at about 30°, and covering the rest of the sky.

"At 17h. 30m. all changed within the last four or five minutes, and writing now difficult without a lamp ; a thick dark red stratum over the sunrise point, and everywhere else a very greenish yellow.

"At 17h. 40m. the low cloud stratum now sea-green. Light only enough to write by with difficulty.

"At 17h. 50m., sun rising a bright yellowish white, and otherwise nothing extraordinary, all unusual tints having disappeared with the sunrise."

September 14.—Before sunrise the clouds were blue and gray, with patches of red clouds of all sorts—cirrus, nimbus, stratus, cumulus, and mares' tails. Two bright flashes of lightning about 5.30 a.m. In the evening there was a slight green tinge, and after sunset the sky was golden red till 6.50, while Mercury, seen through the red haze, was twinkling strongly.

September 15.—The sun rose golden. In the evening the sunset was very fine : in the west the colour was golden to orange-yellow, in the east it was greenish ; red clouds remained till 7.5. There were very brilliant red "rayons de crépuscule."

From September 15 to September 20 the sunrises and sunsets were very fine, with red and gold, for more than half an hour before sunrise and after sunset.

September 21.—Sunset normal.

September 22.—The sun rose as a yellow ball, and showed distinct greenish yellow afterwards. From ten minutes before till sunset the sun was greenish yellow, but the sun was much brighter than on the 10th and 11th.

September 23.—The sun rose very green. At 5.37 p.m. the sun appeared from under clouds, very green ; strong absorption in the red end of the spectrum to C ; low-sun-bands weak. 5.45.—Clouds grayish purple. There was only one bank of clouds which was near the horizon ; above this was a peculiar grayish haze. At 6 the clouds were of a marked purple colour ; breaks near the horizon were reddish brown. During the night there was a great deal of sheet-lightning in the south.

September 24.—The sun rose bright yellow. The spectrum showed complete absorption up to B ; the rain-band α and β were very thick, and the low-sun-bands less marked than usual. There was lightning all night, beginning in the south, and working round to the south-east. It consisted chiefly of sheet-lightning, with occasional zig-zag flashes, but no thunder ; the stars were fairly clear except near the horizon. Saturn and the moon, when near the horizon, were both very dim.

September 25.—Sunrise golden green. In the afternoon the shadows cast on white paper were still quite pink, but the sunset was bright yellow.

September 26.—Much the same as yesterday.

September 27.—Before sunrise C, β, α, the rain-band and the dry-air-band were very strong, but the dry-air-band was less than half as dark as the rain-band. The sun rose golden red. The spectrum showed signs of clearing up ; glimpses of A could be obtained. After dark there was very bright lightning in the west.

September 28.—Spectrum still showed great absorption. Lightning at night.

September 29.—Spectrum absorption still very strong. After dark there was a display of luminous clouds specially towards the east. After 11 p.m. there was very heavy rain with much lightning and some thunder.

September 30.—Sunrise golden. The spectrum *on* the sun showed A clearly, a was very thick.

October 2.—In the morning from about 7 to 9 there was a thunderstorm, in which the thunder was almost continuous for about an hour and a half, but although the storm was almost vertically overhead, hardly any lightning was visible. . . . The total rainfall for the day was 4·88 inches.

Accounts were collected from trustworthy observers in various parts of India. All describe the brilliant sunsets of the first week of September, and record the appearance of a green sun on several days. It was seen at Muttum in the south of Madras on the 9th, and continued for several days both in the morning and the evening. The green colour was then lost, but reappeared from the 22nd to the 28th inclusive.

At Bellary the sun was seen "emerald-green" at rising and setting from the 10th to the 14th inclusive. The observations were not carried on longer.

At Coonoor on the Nilgiris the abundance of green tints in the sunsets was noted, but the sun itself was merely described as of a "shimmery" appearance.

The observations at Ongole have been already noticed in NATURE.

The Spectrum.—The spectrum of the sun when green was repeatedly observed and photographed with the large zodiacal-light spectroscope, which is furnished with one large prism of dense glass and a very long collimator permitting the use of a wide slit. The main features of the spectrum taken *on* the sun when green were—

1. A very strong general absorption in the red end.

2. A great development of the rain-band and of all other lines that are ascribed to the presence of water-vapour in the atmosphere, more especially of the group C_1 of α and of the band at W.L. 504.

The absorption in the red end was of very varying intensity,

[1] Abstract of a paper read before the Royal Society of Edinburgh, July 7, by Prof. C. Michie Smith.

but when the phenomenon was at its maximum phase it gradually crept up from about B till past C, as the sun sank towards the horizon. On the 12th, when the sun was within a few degrees of the horizon, the absorption was well marked up to W.L. 621, *i.e.* to beyond a, while at the violet end the visible spectrum ended at W.L. 428, or just beyond G.

The lines A and a were never visible even *on* the sun, when it was green, and even B could be made out with difficulty from half an hour before sunset onwards, and before it vanished it grew intensely prominent with enormously thick bands on the less refrangible side. The band C_1 on the more refrangible side of C became very broad and black, while the fine line between this and C remained thin and sharp, and C itself thickened out on the less refrangible side. The rain-band was stronger than I have ever before observed it on the plains, and even with the dispersion produced by a single prism at least eight lines could be measured in it, while many more were visible. The low-sun-band was not very conspicuous, but this was partly due to contrast with the very strong rain-band. The line W.L. 568 at the more refrangible side of the low-sun-band was very well marked, and the band itself seemed to consist of a series of equidistant lines.

The apparently much stronger absorption in the red than in the blue end was a very marked feature, which became still more conspicuous when a photograph of the blue end was examined.

Since the passing away of the abnormal conditions I have made careful observations of the sunset spectrum with the same apparatus, and I find that ordinarily A and *a* are clearly visible as well as B, though at times they are strongly marked, and a good deal of shading is observable between them; C_1 is much thinner, and the rain-band is less prominent than the low-sun-band, which however does not now have the appearance of a number of fine lines. The nearest approach to the green-sun spectrum was observed recently during a severe thunderstorm, which was accompanied by a fall of about 1½ inches of rain. A very similar though less intense spectrum can be observed almost any evening by taking advantage of the passage of a small thin cloud over the sun's disk. If a lens is used in front of the slit of the spectroscope, the absorption due to the cloud will be seen as a band in the middle of the bright spectrum from the unclouded part of the sun, and owing to the strong contrast, the details of the absorption will be well seen, just as in the case of the spectrum of a sunspot.

Meteorological Phenomena.—The electrification of the air was carefully studied during the green sun period, and the results are rather curious. From September 3 to 6 the potential of the air was positive in the early morning, diminished to zero between 9 and 10 a.m., then became negative, and remained so until the sea-breeze came on in the afternoon, when the charge was positive again, and continued so all night. The amount of electrification varied greatly and rapidly. On the 7th and 9th the potential was positive all day, on the 8th it was negative for a short time. From the 10th to the 12th it varied in the same way as from the 3rd to the 6th, and this state of matters was repeated from the 20th to the 27th; the electrometer readings from the 13th to the 19th having been normal. All the negative readings were got during a hot land wind from the west. Between the 6th and 9th of September a storm of unusual violence swept over the Madras Presidency from the south-west to the north-east, making itself felt in different ways at different places. The rainfall for September was unusually small all over Madras. The average for fifteen stations was 3·24 inches, not quite half the average for this month during previous years.

The barometric curves for Colombo, Madras, Belgaum, Allahabad, and Calcutta (Alipore) have been drawn and found to resemble each other closely. All over India there was a minimum between the 6th and the 7th, a maximum about the 18th, another minimum on the 21st, then a rise, and a third minimum on the 27th.

The first essential in any attempt to arrive at an explanation of the cause of the green sun is to ascertain the precise dates at which the phenomenon was first observed in various parts of the world. It is difficult to do this, for people are apt to make more precise statements than their observations warrant. For instance, the sun certainly set with a peculiar silvery gleam, but no greenness, at Madras on September 9, and yet many persons have assured me that they saw it set green there on that evening. The reason evidently was that after their attention had been arrested by the green sunsets of the 10th and 11th they remembered having noticed something peculiar about the sunset on the 9th, and immediately concluded that the sun had been green on that occasion also. In consequence of this tendency of the mind, the evidence for all the dates given has been carefully tested, and has been found in all cases sufficient to justify the opinion that these dates are correct.

It appears that in Ceylon, in the south part of the Madras Presidency, and at Ongole in the north, the sun was first observed to be green on the evening of the 9th, and that over the east of the Presidency, when seen at all, it was first seen green on the morning of the 10th. The green sun was reported at Belgaum on the 8th, but although the observer was trustworthy, he did not make a note of the fact until afterwards, and it is just possible that it may be a mistake.

The captain of the *Clonmene* reports a green sun and moon on the 9th, 10th, and 11th, when his position was from lat. 8° N. to lat. 16° N., and from long. 83° 30′ E. to long. 88° 40′ E. The chief officer of the s.s. *Pelican* saw the moon greenish on the night of the 9th, and the sun green on the morning of the 10th. The steamer was more than 1000 miles away from Madras, in lat. 10° 4′ N. and long. 64° 12′ E., wind south-west.

The green sun was not seen further north than Ongole, except at Vizagapatam, Rajamundry, and Simla, and the dates of observation at these stations are not preserved. It was seen at Bombay, but was so inconspicuous that it escaped notice at the Observatory.

In Honolulu the sun's disk was seen to be green before it set on September 4 and 5 (NATURE, vol. xxix. p. 549). On September 4 the master of the *Jennie Walker* "noticed the strange appearance of the sun, which was greenish," in lat. 8° 20′ N. and long. 155° 28′ W. A passenger three days out from Honolulu for Sydney saw it blue on the 5th and 6th (*Ibid.*, p. 181). On September 2 it was observed bluish green in Venezuela and in Trinidad (*Ibid.*, vol. xxviii. p. 577, vol. xxix. p. 77). It was seen at Panama on the 2nd and 3rd, and at Cape Coast Castle apparently on the 1st of September. So much for the first appearance.

The sun was again seen green on September 20, in lat. 12° 50′ N. and long. 48° 26′ E. At almost all stations in Southern India the greenness reappeared on the 22nd, and Hicks Pasha noticed the sun green in the Soudan on the 24th.

The phenomena of the green sun must be distinguished from those of the remarkable sunsets that occurred all over the world some time later, and the reasons for considering them essentially different are:—

1. The general appearances of the sunsets were quite different. The sunsets accompanying the green sun were lurid, and the horizon so misty that stars were lost in it; the subsequent sunsets were remarkable for the play of delicate tints, the rose-coloured after-glow, and the unusual clearness of the horizon.

2. The spectra were totally different. In the latter case the red end was unusually free from absorption; A, a, and B stood out clearly, the rain-band was slight, and the low-sun-bands strong. This contrasts in every way with the description of the spectrum of the green sun already given.

Three hypotheses have been put forward to account for the phenomena of the green sun:—

1. That it was due to vapours or dust from the volcanic eruption at Krakatao. This was at first proposed by Mr. Pogson.

2. That the cause was the presence of an abnormal amount of aqueous vapour—an explanation which I offered at the time of the occurrence.

3. That it was caused by a cloud of meteoric dust.

The supporters of the Krakatao theory view the phenomena of the green sun and the remarkable sunsets as due to the same cause. The two great difficulties with regard to that hypothesis are (1) that there is no proof of the existence of an air current travelling at the enormous velocity required by the dates of the appearances of the green sun at various places, and (2) granting that there was such a current, how it was that the dust was such a long time in reaching India. Mr. Lockyer gets over these difficulties by assuming the existence of an upper current from east to west along the equator, and an under current from south to north. If, however, Mr. Manley's observations are accurate, as there seems every reason to believe they are, the green sun appeared at Ongole as soon as in Colombo, and at least twelve hours sooner than in Madras; and, if the Belgaum observations are correct, it appeared there a day before it was noticed at Colombo. Taking, however, only those observations about

which there can be no doubt, we get the following velocities, taking the shortest lines between Krakatao and the various stations:—

To Colombo	2000 miles,	6·7	miles per hour
,, Madras	2240 ,,	7·3	,, ,,
,, Bellary	2450 ,,	7·9	,, ,,
Lat. 10° 4′ N., long. 64° 12′ E.	3100 ,,	9·8	,, ,,

These required velocities increase with the distance, and, taking along with them the rate of forty miles an hour demanded by the Japan observations, it is difficult to believe that dust could have travelled in these various directions with such different velocities.

There is also the negative evidence that rain-water collected in Madras during the period of the green sun contained no volcanic dust, as far as a careful microscopic examination of the residue could determine it. On the dust hypothesis, too, it is difficult to understand the cessation and reappearance of the phenomenon.

There is some definite evidence on which to base the argument for the water-vapour theory. The observations detailed at the beginning of this paper show that the spectrum of the green sun had the absorption-lines of water-vapour very well marked, and that there was also a general absorption in the red. This absorption might indeed be accounted for by supposing a number of dust particles of a certain size to be suspended in the air; but a precisely similar absorption has been observed when the sunlight traversed the very thick clouds of a violent thunderstorm. The fact that water-vapour may make the sun appear green is proved by the numerous observations of a green sun through the escaping vapour from the funnel of a steamer, and through mist. The abundance of water-vapour in suspension was proved by the very heavy monsoonal rains which followed the appearance of the green sun. In Madras the rainfall was 19·17 inches above the average.

The green sun, although uncommon, is by no means so rare a phenomenon as is generally supposed. Since my attention has been directed to it, I have observed it several times, very conspicuously on May 13 and 14. But there is a reason why it should not appear much more frequently, and that is that, supposing the absorption producing it to be brought about by an abnormal amount of water-vapour, that vapour must be in suspension, while in fact it generally partly precipitates, forming clouds that conceal the sun as its hour of setting approaches. An interesting question arises as to whether the clearness of the atmosphere, when a large amount of aqueous vapour was in suspension during the appearance of the green sun, might not be due to an abnormal electrical state. The numerous and intense thunderstorms that occurred during the period showed that all the clouds were highly electrified, and the electrometer observations already referred to also indicated an unusually electrified atmosphere; but I am not prepared to lay much stress on the electrometer readings until I have made a more extended series of observations in ordinary weather.

The presence of abundance of aqueous vapour at the time of the appearance of the green sun may be explained naturally enough by the setting in of the moist monsoon currents in the upper parts of the atmosphere, or at least by the conflict between the north-east and south-west monsoons, which had commenced by that time.

It is not at all improbable that the Krakatao eruption had some influence on the direction of these currents. The ejection of a large volume of heated vapour would produce a centre of low pressure and set up a cyclonic influx of air from other places. It is possible that the peculiarities observed in the Indian barometric curves for some time after the eruptions were due to this cause. The eruption, too, might have something to do with the electrical conditions; for it is known from Prof. Palmieri's observations that electricity is generated by the eruptions of Vesuvius.

I was once inclined to view with favour the theory of the appearances being produced by cosmic dust, supposing the dust to act either by its mere presence or by forming nuclei for absorption; but considerations of the amount of solar radiation during the greenness have shaken my faith in this explanation.

We must, therefore, I think, give up any theory involving the presence of sufficient dust to render the sun green. Whether or not the following sunset glows were due to dust I cannot discuss here; but I would point out that an amount of dust sufficient to produce these effects would probably not materially affect the transparency of the atmosphere.

EDUCATION, SCIENCE, AND ART

THE Select Committee of the House of Commons appointed to consider how the Ministerial responsibility under which the votes for Education, Science, and Art are administered may be best secured, have agreed to the following report:—

Your Committee have examined the present and several former Presidents and Vice-Presidents of the Council, Secretaries to the Lord Lieutenant of Ireland, permanent heads of the Education Department in London, the present Resident Commissioner of National Education in Ireland, and also other gentlemen conversant with the matters referred to your Committee. They have also considered the evidence taken before the Select Committee appointed in 1865 and 1866 to inquire into the constitution of the Committee of Council on Education.

The first question considered by your Committee was whether primary education in Great Britain and in Ireland should be placed under one supervising Minister. Your Committee are satisfied that under present circumstances it would be undesirable to disturb the existing arrangements as to the Ministerial responsibility for primary education in Ireland.

They are also of opinion that primary education in England and Scotland should be under the control of the same Minister.

The Lord President of the Council, almost always a peer, is nominally the head of the Education Department for Great Britain.

The Vice-President represents the department in the House of Commons, and really transacts almost all the business requiring authority above that of the permanent officials.

Your Committee are of opinion that this arrangement is neither logical nor convenient. They see no sufficient reason why there should be any more real connection between the Education Department and the Privy Council than between the Board of Trade and the Privy Council; but as it may be convenient that the Minister for Education should have occasionally the assistance, whether as to English or Scotch Education, of other Privy Councillors specially summoned for consultation with him, they recommend that a Board of (or Committee of Council for) Education should be constituted under a President, who should be the real as well as nominal Minister, in this respect holding a position like that of the President of the Board of Trade. Hitherto there has been a separate Scotch Department of the Privy Council, and your Committee consider that it would be well to have a distinct permanent secretary appointed for Scotland, responsible to the Minister of Education.

Whether the Minister of Education should always be a member of the Cabinet or of the House of Commons, and what should be his salary, are questions upon which it is hardly within the province of your Committee to make absolute recommendations. They think, however, that the duties of this Minister should be recognised as not less important than those of some of the Secretaries of State.

The Minister of Education should have the assistance of a Parliamentary Secretary, able to sit in either House of Parliament.

While on the whole preferring the plan they have suggested, your Committee do not deny that there are objections to the constitution of an administrative department in the form of a board which has no real existence. The permanent secretary and his assistants bind by their signature, nominally the board, really, the political chief.

This system, it must be admitted, tends to lessen the direct control and responsibility to Parliament and the public which is apparent in the office of a Secretary of State.

The second question discussed by your Committee was whether, and if so what, authority should be exercised by the Minister of Education over endowed schools. Your Committee recommend that when schemes for endowed schools, whether in England or in Scotland, have come into operation, the Minister of Education should have full authority to call on the governing bodies to furnish him with such reports and information as he may require, and to direct any inquiries or inspection to be made which he may deem necessary.

As to public schools, your Committee recommend that the Minister of Education should be authorised to call for such reports and information as he may require from the governing bodies, but they are not of opinion that his powers should extend to directing inspection.

With respect to the Universities in Great Britain receiving grants charged on the votes of Parliament or on the Consolidated

Fund, the Minister should be authorised to require from them an annual report in such form as he may order.

Your Committee have not taken any evidence as to reformatory and industrial schools, considering that these have so recently formed the subject of an inquiry by a Royal Commission, the report and recommendations of which are before Parliament. They see no reason for altering the present responsibility for workhouse schools or for the primary schools connected with the Army, the Navy, or the Marines. The responsibility for the administration of the votes for military and naval colleges do not appear to come within the reference to your Committee.

Your Committee see no reason to disturb the existing arrangements as to the supervision of the Science and Art Department.

There are various miscellaneous votes for science and art, such as those for scientific research, distributed through the Royal Society, votes for meteorology, and votes in aid of the Royal Society of Edinburgh and the Royal Irish Academy. These votes, your Committee think, should be moved by the Minister of Education, and reports, when necessary, should be made to him.

Your Committee do not propose to bring the British Museum and the National Gallery into closer relations with Her Majesty's Government than those now existing, with this exception, that, in their opinion, the Minister of Education and the Parliamentary Secretary should be *ex officio* trustees of each of those institutions. The President of the Council, your Committee notice, is now an *ex officio* trustee of the British Museum. The House of Commons would then look to the Education Department for explanations when the votes for the British Museum and the National Gallery are discussed in Committee of Supply.

The Committee, of which the Chancellor of the Exchequer was chairman, included, among other members, Sir J. Lubbock, Mr. Salt, Mr. Raikes, Sir L. Playfair, Mr. S. Morley, Mr. Pell, Mr. Sclater-Booth, and Mr. J. Collings.

THE MARINE BIOLOGICAL ASSOCIATION

THE Council of the Marine Biological Association adopted the following statements at its meeting held on July 25 last :—

MEMORANDUM No. I.

The Marine Biological Association was founded in March, 1884, at a meeting held in the apartments of the Royal Society of London, Prof. Huxley, P.R.S., in the chair. Its officers and council include the leading naturalists of the country, as well as noblemen and others who took an active part in the late Fisheries Exhibition. H.R.H. the Prince of Wales has consented to be Patron of the Association, and has given evidence of the importance which he attaches to the success of its objects by contributing a handsome donation to its funds. The following is a list of the Executive of the Association :—

President : Prof. Huxley (President of the Royal Society).

Vice-Presidents : The Duke of Argyll, K.G. ; the Duke of Sutherland, K.G. ; the Marquis of Hamilton ; the Earl of Dalhousie, K.T. ; Lord Walsingham (Trustee of the British Museum of Natural History) ; Prof. Allmann, F.R.S. ; Sir John St. Aubyn, Bart., M.P. ; Edward Birkbeck, M.P. (Chairman of the Executive Committee of the International Fisheries Exhibition) ; George Busk, F.R.S. ; W. B. Carpenter, C.B., M.D., F.R.S. ; W. H. Flower (Director of the British Museum of Natural History) ; J. Gwyn Jeffreys, F.R.S. ; Sir John Lubbock, Bart., M.P. (President of the Linnean Society).

Council : Prof. Moseley, F.R.S. (Oxford), Chairman ; C. Spence Bate, F.R.S. (Plymouth) ; Prof. Jeffrey Bell, F.Z.S. (British Museum) ; W. S. Caine, M.P. ; W. T. Thiselton Dyer, C.M.G., F.R.S. (Royal Gardens, Kew) ; John Evans, D.C.L. (Treasurer, R.S.) ; A. C. L. G. Günther, F.R.S. (British Museum) ; Prof. Herdman (Liverpool) ; E. W. H. Holdsworth ; Prof. McIntosh (St. Andrew's) ; Prof. Milnes Marshall (Manchester) ; Sir Philip Cunliffe Owen, K.C.M.G., C.B. ; G. J. Romanes, F.R.S. (Secretary of the Linnean Society) ; P. L. Sclater, F.R.S. (Secretary of the Zoological Society) ; Adam Sedgwick (Cambridge).

Hon. Treasurer : Frank Crisp (Vice-President and Treasurer of the Linnean Society), 6, Old Jewry, E.C.

Hon. Secretary : Prof. E. Ray Lankester, F.R.S., 11, Wellington Mansions, North Bank, N.W.

The object of the Association is to erect one or more laboratories on the coast of the United Kingdom, where studies may be carried on by naturalists, leading to an improvement in zoological and botanical science, and especially to an adequate acquaintance with the food, habits, spawning, and propagation of our marine food-fishes and shell-fish.

Great scientific and practical results have been obtained in other countries, notably in the United States of America, in Germany, France, and Italy, by studies carried on through such laboratories as the Marine Biological Association proposes to erect in this country. The knowledge which can be thus and thus only gained is precisely that knowledge which is at present *urgently* needed in order to regulate and improve British Sea Fisheries, and it therefore seems to be not inappropriate that public bodies as well as individuals interested in the progress of natural history science should take in hand the promotion of the first attempt to institute an efficient sea-coast laboratory in these islands.

It is estimated by the Council that a sum of 10,000*l.* will be required to build and equip an efficient laboratory, and to insure a successful start for the Association. This sum does not include any payment to the naturalists who may conduct the operations of the laboratory, since in the first instance, at any rate, such services will be rendered gratuitously. The money which is now asked for will be expended entirely upon the laboratory, its equipment, and necessary service.

As the result of an appeal to scientific men and their immediate friends the Association has raised a sum of about 2000*l.* In order to obtain the rest of the money which is required it is necessary to appeal to a wider circle.

The Council of the Association feel that they have undertaken a work of national importance, and therefore confidently appeal to those who have pecuniary resources at their disposal to give them substantial aid in its realisation.

According to the bye-laws of the Association adopted at a meeting of members on June 17, 1884, donors of 500*l.* to the Association become governors and permanent members of the Council of the Association. The Council hope that they may receive some contributions of this amount or of larger sums, and would suggest that it might be found convenient by those who may intend to assign sums of large amount to the Association to do so in the form of a payment of so much a year spread over a term of years.

The donor of 100*l.* to the Association becomes a "Founder" and life-member. An annual subscription of 1*l.* 1*s.*, or a composition fee of 15*l.* 15*s.*, is required of ordinary members. Members of the Association have the right to take part in the government of the Association by electing the Officers and Council at their annual meeting : they will receive the printed reports of the Association, and enjoy special privileges in the use of the laboratory and its resources.

It is intended to require an entrance fee of 5*l.* 5*s.* from members who join the Association later than June, 1885.

Signed (on behalf of the Council of the Marine Biological Association),

H. N. MOSELEY, M.A., F.R.S.,
Chairman of the Council,
Linacre Professor of Anatomy in the University of Oxford

July 25, 1884

MEMORANDUM No. II.—*Nature of the Building, Management, and Work of the Proposed Marine Laboratory and Experimental Aquarium.*—The Council of the Marine Biological Association cannot as yet definitely pledge itself as to details, but the following is a sketch of the nature of the building which it proposes to erect, of the probable management of the Laboratory, and of the kind of work which may be expected to be accomplished by its aid.

The most complete institution of the kind is that at Naples, which is supported by contributions from various European States, and is especially subsidised by the German Imperial Government. The buildings, fittings, and boats belonging to this institution have cost 20,000*l.* It is proposed to *start* such an institution in this country with half this sum.

1. *Building.*—The first laboratory of the Marine Biological Association will probably be erected on the shore of Plymouth Sound. Plymouth is not only by its natural features one of the best possible localities for the purpose, but a Committee of the Town Council has offered to the Association a suitable site free of cost and a contribution of 1000*l.*

With regard to the building, the Council of the Marine Biological Association contemplate erecting a solid brick structure

of about 100 × 40 feet ground area, and of two stories. The exterior will be simple and unpretentious. The building will be placed close to the sea-shore, so that sea water can be readily pumped into the laboratory tank, and in order that there may be easy communication with fishing-boats. It will also be desirable to have a floating barge anchored near the laboratory for special experiments on the breeding of fish, &c., and, in close proximity, it will be necessary to erect tanks on the foreshore, open to the tidal water, but arranged so as to prevent the escape of the animals confined in them for study.

The basement of the building will contain a reservoir tank holding several thousand gallons of sea water; on the ground floor there will be two large rooms paved with stone; one fitted with large tanks and a service of sea water, the other used for the reception and examination of a day's trawling or dredging, and also used for keeping stores and for carrying out the pickling and proper preservation of specimens to be sent, as required, to naturalists at a distance. The upper floor will be divided into a series of larger and smaller working rooms fitted with suitable tables, with reagents and apparatus required in microscopy, and with a constant supply of sea water pumped from the reservoir tank. Accommodation for ten workers will be thus provided. One of the rooms on this floor must be set apart as a library and writing-room, and must contain as complete a series of works on marine zoology and botany, pisciculture, and such matters as can be brought together. The provision of such a library is one of the special conveniences which would be offered to naturalists working in the laboratory.

The building must also necessarily contain bed-room and sitting-room for a resident superintendent, and accommodation for one servant or caretaker.

2. *Apparatus and Boats.*—These need not at first be very extensive. Glass tanks, pumping engine and supply tubes are essential. There will be necessarily one small steam-launch for dredging in quiet weather at no great distance from shore, and a row-boat. For special expeditions larger boats or steamers could be either hired or borrowed from time to time. The local fishermen would also greatly aid the laboratory if regularly paid, and thus supplement the special boats of the Association.

3. *Salaried Staff.*—The Council would propose to begin work with the smallest possible number of permanent *employés*. These would be—(*a*) a resident superintendent, who should be a man of fair education and some knowledge of natural history, at a salary of 150*l.* a year, supplemented by free quarters; (*b*) a servant of the fisherman class, who would look after the tanks and workrooms, go out in search of specimens, and manage a boat and dredging apparatus when required. Other fishermen and boys might be hired from time to time. A sum of 100*l.* a year would be required for such service at the least.

4. *Conditions of Admission to Use of Laboratory: Work to be done there.*—The Council would propose to admit to the use of a table and other resources of the laboratory, so far as the space shall permit, any British or foreign naturalist who might make application and furnish evidence of his capability to make good use of the opportunities of the place. A preference would be given to a member of the Association. A fee might in some cases be charged for the use of a table, and other tables might be let out at an annual rental to such bodies as the Universities, this being the system adopted at Naples by Dr. Dohrn.

The Council will endeavour, when the laboratory is erected and in operation, to obtain grants of money from scientific societies, and from the Government, for the purpose of carrying out *special* investigations on a given subject, *e.g.*, the conditions affecting the fall of oyster-spat, the reproduction and general economy of the common sole, the complete determination and enumeration of the fauna and flora of the marine area adjacent to the site of the laboratory, its distribution within that area, and its relation to physical conditions. Naturalists will be nominated by the Council of the Association or by the authorities who find the money by which such naturalists are paid, to make such researches at the laboratory of the Association. When some special investigation is thus started at the laboratory, the other naturalists, who from time to time come there, will be sure to take part in the inquiry, and so help to carry it on to completion. It would be the business of the resident superintendent to facilitate this continuity of work, whilst the Council of the Association will make it a special object to bring together the results attained in the laboratory each year, in the form of a report, so as to gradually organise and direct towards definite ends the work done through its agency.

In the course of time, and with increased provision of funds for the special purpose, the Association might expect to be the means of producing—

1. A thorough knowledge of the life and conditions of the marine area adjacent to the laboratory.

2. A complete and detailed account of the natural history of certain fishes, molluscs, and crustaceans of economic importance with special reference to their increased supply.

3. Contributions to the knowledge of the growth from the egg, adult structure and physiology of such rare or otherwise scientificially interesting animals and plants as occur near the laboratory.

It is not supposed that this can be immediately accomplished by the 10,000*l.* which the Association now seeks to raise. That sum will be expended in erecting the laboratory and in starting it on its career of activity. The laboratory will necessarily attract support and increased means of usefulness as, year by year, its work becomes known, and the facilities which its offers to working naturalists appreciated.

Signed (by order of the Council of the
Marine Biological Association),

E. RAY LANKESTER, M.A., F.R.S.,
Hon. Secretary

July 25

THE METEOROLOGICAL CONFERENCE

A METEOROLOGICAL conference was held at the Health Exhibition on July 17 and 18; the following is an abstract of the leading papers read at the conference.

Dr. J. W. Tripe read a paper of much interest on some relations of meteorological phenomena to health.

In ages long past these relations excited much attention, but the knowledge concerning them was of the vaguest kind; and indeed, even now, no very great advance has been made, because it is only quite recently that we have been able to compare a fairly accurate record of deaths with observations taken at a number of reliable meteorological stations. The more useful and searching comparison between cases of sickness, instead of deaths, and meteorological phenomena has yet to be accomplished on a large scale in this country, and especially as regards zymotic diseases. In Belgium there is a Society of Medical Practitioners, embracing nearly the whole country, that publishes a monthly record of cases of sickness, of deaths, and of meteorological observations; but the only attempt on a large scale in this country, which was started by the Society of Medical Officers of Health for the whole of London, failed partly from want of funds, and partly from irregularity in the returns. My remarks, which must necessarily be very brief, will refer to the relations between (1) meteorological phenomena and the bodily functions of man, and (2) between varying meteorological conditions and death-rates from certain diseases.

As regards the first, I will commence with a few brief remarks on the effects of varying barometric pressures. A great deal too much attention is paid to the barometer if we regard it as indicating only, as it really does, variations in the weight of the column of air pressing upon our bodies, because, except at considerable elevations, where the barometer is always much lower than at sea-level, these variations produce but little effect on health. At considerable elevations the diminished pressure frequently causes a great feeling of malaise, giddiness, loss of strength, palpitation, and even nausea; and at greater heights, as was noticed by Mr. Glaisher in a very lofty balloon ascent, loss of sight, feeling, and consciousness. These were caused by want of a sufficient supply of oxygen to remove effete matters from the system, and to carry on the organic functions necessary for the maintenance of life. On elevated mountain plateaus, or even in high residences amongst the Alps, an increased rapidity in the number of respirations and of the pulse, as well as increased evaporation from the lungs and skin, occur.

For some years past, many persons suffering from consumption, gout, rheumatism, and anæmic affections have gone to mountain stations, chiefly in Switzerland, for relief, and many have derived much benefit from the change. It must not however, be supposed that diminished atmospheric pressure was the chief cause of the improvement in health, as its concomitants, viz., a diminution in the quantity of oxygen and moisture contained in each cubic foot of air, probably the low temperature, with a

total change in the daily habits of life, have assisted in the beneficial results. The diminution in the quantity of air, and consequently of oxygen, taken in at each breath is to a certain extent counterbalanced by an increased frequency and depth of the respirations, and a greater capacity of the chest. In this country, alterations in the barometric pressure are chiefly valuable as indicating an approaching change in the wind, and as well as of the amount of moisture in the air; hence the instrument is often called "the weather glass." A sudden diminution in the atmospheric pressure is likely to be attended with an escape of ground air from the soil, and therefore to cause injury to health, especially amongst the occupants of basement rooms, unless the whole interior of the building be covered with concrete.

Temperature.—Experience has shown that man can bear greater variations of temperature than any other animal, as in the Arctic regions a temperature of 70 degrees Fahrenheit, or more than 100 degrees below freezing-point, can be safely borne; that he can not only live but work, and remain in good health in these regions, provided that he be supplied with suitable clothing and plenty of proper food. On the other hand, man has existed and taken exercise in the interior of Australia, when the thermometer showed a temperature of 120 degrees Fahrenheit, or nearly 90 degrees above freezing-point, so that he can live and be in fairly good health within a range of nearly 200 degrees Fahrenheit.

The effects of a high temperature vary very much according to the amount of moisture in the air, as when the air is nearly saturated in hot climates, or even in summer in our own, more or less languor and malaise are felt, with great indisposition to bodily labour. With a dry air these are not so noticeable. The cause is evident; in the former case but little evaporation occurs from the skin, and the normal amount of moisture is not given off from the lungs, so that the body is not cooled down to such an extent as by dry air. Sunstroke is probably the result, not only of the direct action of the sun's rays, but partly from diminished cooling of the blood by want of evaporation from the lungs and skin.

The effects of temperature on man does not depend so much on the mean for the day, month, or year, as on the extremes, as when the days are hot and the nights comparatively cool, the energy of the system becomes partially restored, so that a residence near the sea, or in the vicinity of high mountains, in hot climates is, other things being equal, less enervating than in the plains, as the night air is generally cooler. It is commonly believed that hot climates are *necessarily* injurious to Europeans, by causing frequent liver derangements and diseases, dysentery, cholera, and fevers. This, however, is, to a certain extent, a mistake, as the recent medical statistical returns of our army in India show that in the new barracks, with more careful supervision as regards diet and clothing, the sickness and death-rates are much reduced. Planters and others, who ride about a good deal, as a rule keep in fairly good health; but the children of Europeans certainly degenerate, and after two or three generations die out, unless they intermarry with natives, and make frequent visits to colder climates. This fact shows that hot climates, probably by interfering with the due performance of the various processes concerned in the formation and destruction of the bodily tissues, eventually sap the foundations of life amongst Europeans; but how far this result has been caused by bad habits as regards food, exercise, and self-indulgence, I cannot say. Rapid changes of temperature in this country are often very injurious to the young and old, causing diarrhœa and derangements of the liver when great heat occurs, and inflammatory diseases of the lungs, colds, &c., when the air becomes suddenly colder, even in summer.

The *Direct* influence of rain on man is not very marked in this country, except by giving moisture to the air by evaporation from the ground and from vegetable life, and by altering the level of ground water. This is a subject almost overlooked by the public, and it is therefore as well that it should be known that when ground water has a level, persistently less than five feet from the surface of the soil, the locality is usually unhealthy, and should not, if possible, be selected for a residence. Fluctuations in the level of ground water, especially if great and sudden, generally cause ill-health amongst the residents. Thus, Dr. Buchanan in his Reports to the Privy Council in 1866-67, showed that consumption (using the word in its most extended sense) is more prevalent in damp than on dry soils, and numerous reports of medical officers of health, and others, which have been published since then, show that an effective drainage of the land, and consequent carrying away of the ground water, has been followed by a diminution of these diseases.

Varying amounts of moisture in the air materially affect the health and comfort of man. In this country, however, it is not only the absolute but the relative proportions of aerial moisture which materially influence mankind. The quantity of aqueous vapour that a cubic foot of air can hold in suspension, when it is saturated, varies very much with the temperature. Thus at 40 degrees Fahr. it will hold 2·86 grains of water; at 50 degrees, 4·10 grains; at 60 degrees, 5·77 grains; at 70 degrees, 8·01 grains; and at 90 degrees as much as 14·85 grains. If saturation be represented by 100, more rapid evaporation from the skin will take place at 70 degrees, and 75 per cent. of saturation, than at 60 degrees when saturated, although the absolute quantity of moisture in the air is greater at the first-named temperature than at the latter. As regards the lungs, however, the case is different, as the air breathed out is, if the respirations be regular and fairly deep, completely saturated with moisture at the temperature of the body. In cold climates the amount of moisture and of the effete matters given off from the lungs in the expired air, is much greater than in hot climates, and the body is also cooled by the evaporation of water in the form of aqueous vapour. Moist air is a better conductor of heat than dry air, which accounts for much of the discomfort felt in winter when a thaw takes place as compared with the feeling of elasticity when the air is dry. In cold weather, therefore, moist air cools down the skin and lungs more rapidly than dry air, and colds consequently result. London fogs are injurious, not only on account of the various vapours given off by the combustion of coal, but in consequence of the air being in winter generally saturated with moisture at a low temperature. The injuriousness of fogs and low temperatures will be presently dwelt upon at greater length.

Variations in the pressure and temperature of the atmosphere exert a considerable influence on the circulation of air contained in the soil, which is called ground air. As all the interstices of the ground are filled with air or water, the more porous the soil, the greater is the bulk of air. The quantity of air contained in soil varies very much according to the material of which the soil is composed, as it is evident that in a gravelly or sandy soil it must be greater than when the ground consists of loam or clay. The estimates vary from 3 to 30 per cent., but the latter is probably too high. If, therefore, a cesspool leak into the ground, the offensive effluvia, if in large quantities, will escape into the soil, and are given off at the surface of the ground, or are drawn into a house by the fire; but, if small, they are rendered inocuous by oxidation. The distance to which injurious gases and suspended or dissolved organic matters may travel through a porous soil is sometimes considerable, as I have known it pass for 130 feet along a disused drain, and above 30 feet through loose soil.

Winds exercise a great effect on health both directly and indirectly. Directly, by promoting evaporation from the skin, and abstracting heat from the body in proportion to their dryness and rapidity of motion. Their indirect action is more important as the temperature and and pressure of the air depend to a great extent in their direction. Thus winds from the north in this country are usually concomitant with a high barometer and dry weather; in summer with a pleasant feeling, but in winter with much cold. South-west winds are the most frequent here of any, as about 24 per cent. of the winds come from this quarter against 16½ from the west, 11½ from the east, and the same from the north-east; 10½ from the south, 8 from the north, and a smaller number from the other quarters. South-west winds are also those which are most frequently accompanied by rain, as about 30 per cent. of the rainy days are coincident with south-west winds. Another set of observations give precisely the same order, but a considerable difference in their prevalence, viz. south-west 31 per cent., west 14½, and north-east 11½ per cent. Easterly winds are the most unpleasant, as well as the most injurious to man of all that occur in this country.

I now propose discussing very briefly the known relations between meteorological phenomena and disease. I say the known relations, because it is evident that there are many unknown relations of which at present we have had the merest glimpse. For instance, small-pox, while of an ordinary type, and producing only a comparatively small proportion of deaths to those attacked, will sometimes suddenly assume an epidemic form, and spread with great rapidity at a time of year and under the meteorological conditions when it usually declines in fre-

quency. There are, however, in this country known relations between the temperature and, I may say, almost all diseases. As far back as 1847 I began a series of elaborate investigations on the mortality from scarlet fever at different periods of the year, and the relations between this disease and the heat, moisture, and electricity of the air. I then showed that a mean monthly temperature below 44°·6 F. was adverse to the spread of this disease, that the greatest relative decrease took place when the mean temperature was below 40°, and that the greatest number of deaths occurred in the months having a mean temperature of between 45° and 57° F. Diseases of the lungs, excluding consumption, are fatal in proportion to the lowness of the temperature and the presence of excess of moisture and fog. Thus, in January 1882 the mean weekly temperature fell from 43°·9 F. in the second week to 36°·2 in the third, with fog and mist. The number of deaths registered in London during the third week, which may be taken as corresponding with the meteorological conditions of the second week, was 1700, and in the next week 1971. Unusual cold, with frequent fogs and little sunshine, continued for four weeks, the weekly number of deaths rising from 1700 to 1971, 2023, 2632, and 2188. The deaths from acute diseases of the lungs in these weeks were respectively 279, 481, 566, 881, and 689, showing that a large proportion of the excessive mortality was caused by these diseases. At the end of November and in December of the same year there was a rapid fall of temperature, when the number of deaths from acute diseases of the lungs rose from 297 to 358, 350, 387, 541, 553, and 389 in the respective weeks. From November 29 to December 9 the sun was seen only on two days for 4½ hours, and from December 9 to the 18th also on two other days for less than 4 hours, making the total amount of sunshine 8·1 hours only in 20 days. In January and February the excess of weekly mortality from all diseases reached the large number of 504 deaths; in December it was less, the fogs not having been so dense, but the excess equalled 246 deaths per week.

The relations between a high summer temperature and excessive mortality from diarrhœa have long been well known, but the immediate cause of the disease as an epidemic is not known. Summer diarrhœa prevails to a greater extent in certain localities, notably in Leicester (and has done so for years); and the cause has been carefully sought for, but has not been found out. Recent researches, however, point to a kind of bacillus as the immediate cause, as it has been found in the air of water-closets, in the traps under the pans, and in the discharges from infants and young children. In order to indicate more readily how intimately the mortality from diarrhœa depends on temperature, I now lay before you a table showing the mean temperature for ten weeks in summer, of seven cold and hot summers, the temperature of Thames water, and the death-rates of infants under one year per million population of London:—

London. Deaths under 1 Year, in July, August, and part of September, from Diarrhœa per 1,000,000 Population Living at all Ages, arranged in the Order of Mortality

Years	Mean temperature, 10 weeks	Temperature of Thames water	Age 0-1 year. Deaths from diarrhœa per 1,000,000 population living at all ages
1860 ...	58°·1 ...	60°·6 ...	151
1862 ...	59°·0 ...	62°·0 ...	189
1879 ...	58°·7 ...	60°·7 ...	228
1877 ...	61°·2 ...	63°·3 ...	347
1874 ...	61°·7 ...	63°·8 ...	447
1878 ...	63°·7 ...	64°·1 ...	576
1876 ...	64°·4 ...	64°·9 ...	642

As may be seen, the deaths of infants under 1 year of age from diarrhœa per 1,000,000 population was only 151; whilst the mean summer temperature was only 58°·1 F. against 189 in 1862, when the mean temperature was 59°·0. In 1879, when the mean temperature was 58°·7, the deaths from diarrhœa rose to 228 per million, but a few days were unusually hot. In 1877 the mean temperature of the air was 61°·2, of the Thames water 63°·3, and the mortality of infants from diarrhœa 347 per million population. In 1874, when the mean temperature of the air was 61°·7, the mortality rose to 447 per million; and in the hot summers of 1878 and 1876, when the mean air temperatures were 64°·1 and 64°·9 respectively, the death-rates of infants were 576 and 642 per million population. The relations, therefore, between a high summer temperature and the mortality from diarrhœa in infants are very intimate. I have selected the mortality amongst infants in preference to that at all ages, as the deaths occur more quickly, and because young children suffer in greater proportion than other persons.

The proportionate number of deaths at *all ages* from diarrhœa corresponds pretty closely with those of infants. To prove this, I made calculations for three years, and ascertained that only 3·9 per cent. of all the deaths from this disease were registered in the weeks having a temperature of less than 50°; 11·9 per cent. in the weeks having a temperature between 50° and 60°, whilst in the comparatively few weeks in which the temperature exceeded 60° F., as many as 84·2 per cent. of the total number of deaths was registered. In the sixteen years, 1840-56, for which many years ago I made a special inquiry, only 18·9 per cent. of all the deaths from diarrhœa occurred in winter and spring, against 81·1 per cent. in summer and autumn. In the twenty years, 1860-79, there were seven years in which the summer temperature was in defect when the mortality per 100,000 inhabitants of London was 200; whilst in ten summers, during which the temperature was in excess by 2° or less, the mortality was 317 per 100,000. The mean temperature was largely in excess, that is to say, more than 2° plus in three of these summers, when the mortality reached 339 per 100,000 inhabitants. These figures show that great care should be taken in hot weather to prevent diarrhœa, especially amongst young children; by frequent washing with soap and water to ensure cleanliness, and proper action of the skin; by great attention to the food, especially of infants fed from the bottle; free ventilation of living rooms, and especially of bedrooms; and by protection, as far as possible, being afforded from a hot sun, as well as by avoiding excessive exercise. All animal and vegetable matter should be removed from the vicinity of dwelling-houses as quickly as possible (indeed these should be burnt instead of being put in the dust-bin), the drains should be frequently disinfected and well flushed out, especially when the mean daily temperature of the air is above 60° F.

Time will not admit of more than a mere mention of the relations between meteorological phenomena and the mortality from many other diseases and affections, such as apoplexy from heat, sunstroke, liver diseases, yellow fever, cholera, whooping-cough, measles, &c., especially as the state of our knowledge on the subject is so very limited. A comparison between the mortality from several diseases in this and other countries shows that certain of these do not prevail under closely corresponding conditions. Thus the curves of mortality from whooping-cough, typhoid fever, and scarlet fever, do not correspond with the curves of temperature in both London and New York, and the same may be said of diarrhœa in India. It is therefore evident that some other cause or causes than a varying temperature must be concerned in the production of an increased death-rate from these diseases. The subject is of great importance, and I do not despair of our obtaining some day a knowledge of the agents through which meteorological phenomena act in the production of increased and decreased death-rates from certain diseases, and the means by which, to a certain extent, these injurious effects on man be prevented.

Mr. R. H. Scott, F.R.S., read a paper on "The Equinoctial Gales—do they occur in the British Isles?" Most scientific meteorologists, Mr. Scott stated, are disposed to give up, almost in despair, the idea of eradicating from the popular mind the belief in the influence of the moon on the weather. There is, however, another belief, not quite so widely spread, but still very generally accepted, which attributes to the equinoxes a peculiarly stormy character. Over and over again have I heard the remark that it would be well for those proposing to take a voyage to wait until the equinoctial gales were over. It has struck me, therefore, that as we have had for several years past a regular system of storm warnings, it might be of interest to ascertain if the record of these warnings, and of the storms with which they were connected, exhibited any maximum of storm frequency about the equinoxes.

The period I have taken has been that of the fourteen years beginning with the spring of 1870, and I have commenced with the spring in order to include the past winter, that of 1883-4. With the year 1870, the systematic checking of storm warnings was commenced on the demand of the late Colonel Sykes. The results were published as "Parliamentary Papers" for the first seven years, and subsequently the returns have been regularly prepared in the Meteorological Office, though only the summary of results has appeared in the Annual Reports. As these returns give not only the storms for which warnings were issued,

but also those for which none were sent out, they afford a ready index to the storms which have been felt on the coasts.

Only such storms have been selected as have been really severe, such as have attained force 9 of the Beaufort scale at more than two stations, with a velocity exceeding 50 miles an hour recorded by an anemograph for more than a single hour. I have also not discriminated between the directions from which the strongest winds were felt.

The results of these records show that gales are of no greater frequency at the equinoxes than at any other time.

The diagrams show that the storms are all but exclusively confined to the winter half-year, if we take that to include part of the autumn and spring.

The diagrams show that there is no strongly-marked maximum at either equinox, but they do exhibit indications of periodicity which are very interesting.

Leaving the summer alone, as not worth notice, the frequency rises from nine and eight in the periods preceding the autumn equinox to ten at that epoch. The curve then rises rapidly, the value doubling itself and trebling itself in the two succeeding intervals. We then find a falling off at the time of the Martinmas summer in the first half of November, and a second maximum in the end of that month—the period indicated by Sir John Herschel long ago, in an article in *Good Words* for January 1864, as that succeeding what he called "The Great November Wave," a phenomenon which does not receive as much attention now as formerly. The first part of December is comparatively quiet, but after that the frequency rises to its absolute maximum at the latter half of January, from which period the curve descends gradually, with one decided check in February, to the same value which it had in August, and which it attains at the end of April. The check in February reminds us of the well-known tradition of the "halcyon" days at the end of winter. The frequency at the spring equinoctial period is nearly double what it is at the corresponding interval at the autumn equinox, being 19 as compared with 10. In one particular, however, the phenomena agree—the equinoxes are periods of sudden change in storm frequency. In the autumn this rises from 10 to 20 as soon as the equinox is passed; in the spring it falls from 27 to 19 as the equinox arrives. Accordingly, persons who wait till the equinox is passed in autumn improve their chances of falling in with a storm, for the diagram shows no signs of a lull once a heavy storm has occurred. In the spring it would apparently be wise to wait till April was well advanced, if you wished to get calm weather in the Bay of Biscay.

If we now look to see what evidence of recurrence of storms for particular short periods is discoverable in our data, we find that the day most frequently so distinguished is January 1, on which a storm was recorded six times in the fourteen years. This is very remarkable, as December 31 only shows one, and January 2 only two storms. Five days—November 10 and 20, January 18 and 19, and February 26—show five each, and no less than sixteen days show four. The stormiest two-day interval is that of January 18 and 19, which, as just explained, exhibits five storms each. The most disturbed three-day period is that of January 24 to 26, where we find four storms on each day. The date of the Battle of Trafalgar, October 21, is marked by two fours, on the 21st and 22nd, but the end of October is not so disturbed as the end of January.

The diagram also shows that almost every month in the year is occasionally nearly free from storms. October, November, December, and January have only one apiece, but in different years. March is the only month which has at least two storms, thus justifying its epithet, "March many-weathers."

Mr. Scott also read a paper on Cumulative Temperature, of which the following are the leading points:—

On the walls of the Meteorological Annexe will be found a series of diagrams, exhibiting from various districts in the United Kingdom, in a graphical form, the March of Temperature, Rainfall, and Bright Sunshine, from the beginning of the present year, and also for the entire year 1881, which is reproduced for purposes of comparison.

The object of these curves is to show clearly some of the most important factors in the growth of crops.

It is proved, almost beyond a doubt, that each plant, say each individual cereal, requires a definite amount of heat to bring it to maturity. Thus, maize requires more than wheat, and wheat again more than barley or oats.

Now various investigators, and notably Boussingault and Prof. Alphonse de Candolle, of Geneva, have devoted much attention to this subject, and the latter writer, in his "Géographie Botanique," has come to the conclusion that a certain total amount of temperature above a definite base line is necessary for plant growth, and that this amount, or, as he calls it, this "sum of temperature," varies for each crop.

He found that plants, as a rule, did not begin to give indications of active vegetation until the temperature rose above 6° C. This temperature, 6° C., or, in round numbers, 42° F., that is ten degrees above the freezing point, is taken as the base for all the diagrams. Although Prof. de Candolle propounded his views some years ago, as recently as the year 1874, at the Agricultural Conference at Vienna, meteorologists were quite at sea as to how these sums of temperature were to be calculated.

The credit of solving this problem belongs to Lieut.-General Richard Strachey, the Chairman of the Meteorological Council. In the first place he proposes to adopt a certain unit of temperature to supply a standard for calculation, the unit being one degree continued for the unit of time, either one hour or one day, as the case may be. Such a unit may be conveniently called an hour degree, or day degree. The unit of time adopted for the calculations to which I am about to refer is a day, and the unit of what may be termed the effective temperature is therefore *a day degree*. A day degree therefore signifies 1° F. of excess or defect of temperature above or below 42° F. continued for twenty-four hours, or any other number of degrees for an inversely proportional number of hours.

Now the first idea I want you to take in about these day degrees is that when we speak generally of the mean or average temperature for a day, or month, or year, we imply that the resulting temperature is the same as would be observed if the thermometer indicated this mean temperature throughout the entire period for which the mean is taken. Thus, if we were dealing with daily means, an average daily temperature of 62° F., which is an ordinary temperature for a warm summer's day, would mean twenty day degrees of temperature for that day, starting from the assumed base line of 42° F., which has already been mentioned.

The first step therefore towards determining this effective temperature in day degrees resolves itself into determining as speedily and simply as possible the average temperature for the period under consideration.

We have, fortunately, to our hands, a very simple mode of arriving at the mean temperature with accuracy sufficient for our purposes. Almost all observers record the maximum and minimum temperatures once in the twenty-four hours. It is found that the half sum of these readings, the mean between them, is nearly but not exactly the average for the day. It must, of course, be understood that the instruments must be read regularly and at the same hour every day.

The next points which require attention are: whether the maximum and minimum are both above 42°, which occurs in summer, or both below that point, which occurs in winter; or, finally, whether one is above, and the other below. In the first case all the accumulated temperature is to the good; it is all on the positive side. In the second case it is all on the negative side. The third case is the only one which presents difficulty, for when the extreme temperatures are on either side of the line of 42°, one portion of the effective temperature for the day is positive, and the other negative.

Now, General Strachey carried out a long series of calculations, based on the observed hourly temperatures at Kew Observatory, and at other stations in the United Kingdom, in order to ascertain the magnitude of the co-efficient by which the difference between either of these extreme temperatures and the base temperature (42° F.) should be multiplied in order to obtain the values of the temperatures in excess or defect of 42° F. expressed in day-degrees, and he found that this, *for a weekly period*, was 0·4.

Accordingly we get the following rules:—

If the mean of the day is above 42° F., we multiply the difference between the minimum and 42° F. by 0·4 (four-tenths), and call this *the negative effective temperature*.

To find the positive effective temperature we subtract from the difference between the mean for the day and 42°, the negative effective temperature just determined.

If the mean of the day is below 42° F. the proceeding is similar; but we first ascertain the positive effective temperature, and subtract that from the difference between 42° F. and the mean, thus obtaining the negative effective temperature.

The method of determining the effective temperature, which may briefly be called the accumulated temperature, is fully explained in a paper by General Strachey, which will appear in the forthcoming volume of the "Quarterly Weather Report," that for 1878. Meanwhile it is extremely interesting to examine the diagrams in the Annexe somewhat minutely, and to observe how the total accumulated temperature, say, up to July 1, is made up in very different ways in the two years, 1881 and 1884, there exhibited.

The year 1881 was very cold in the winter, and its accumulated temperature was made up in the spring and early summer. In the present year we had practically no frost, but then we had unusually cold weather at Easter and at the end of May.

The practical application of the data thus obtained as standards of comparison for the growth and ripening of various agricultural products must of course be left to the agriculturists, and it will be interesting to learn how far a correspondence between the character of the several crops and the accumulated temperature of the year can be established.

The measure of temperature afforded by this system of computation appears to be as well suited to supply a standard of comparison of climates for hygienic purposes as for agriculture, and the diagrams indicate in a forcible manner the characteristic differences of climate, in respect of temperature, of the portions our islands to which they refer.

Mr. William Marriott read a paper on "Some Occasional Winds and their Influence on Health." After referring briefly to the causes of winds, Mr. Marriott spoke of the East wind, the Mistral, the Sirocco, and other well-known occasional winds. Of the East wind, Mr. Marriott said it was the most dreaded in this country. It is usually dry, cold, and very penetrating, and is well described in the old saying—

"When the wind is in the East
'Tis neither good for man nor beast."

Dr. Arthur Mitchell, in a "Note on the Weather of 1867, and on some effects of East winds," says, "Such winds blowing over a moist surface, like that, for instance, of the human body, tend to reduce the temperature of that surface to the temperature of evaporation, which in this case is much below that of the air itself. In licking up the moisture — that is, in causing its evaporation — a large amount of heat is rendered latent. This heat must be taken from something, and, in point of fact, our bodies are, and must be, almost its entire source. A cold and dry wind, therefore, cools the surface of our bodies, not simply by enveloping them in a cool medium, and warming itself by conduction at their expense. It does this of course; but, being dry as well as cold, it does it with less activity than it would if moist and cold—damp air being a better conductor than dry air. It is chiefly, however, by the other mode that dry cold winds abstract heat from our bodies,—that is, by using their heat in the conversion of moisture into vapour. The heat so used becomes latent, and is for the time being lost. It does not raise the temperature of the air in immediate contact with the body. On the contrary, that air itself, low as its temperature may be, gives up some of its heat to become latent in the vaporised moisture, and probably gives up more than it gains from our bodies by conduction, so that the temperature of the film of air actually in contact with our bodies may be, and probably is, a little lower than the temperature of the bulk. The quantity of heat which our bodies lose in this way is far from insignificant, and the loss cannot be sustained without involving extensive and important physiological actions, and without influencing the state of health. In feeble and delicate constitutions, the resources of nature prove insufficient to meet the demand made on them, and a condition of disease then ensues."—(*Journal* of the Scottish Meteorological Society, vol. ii. p. 80.)

SCIENTIFIC SERIALS

Proceedings of the Linnean Society of New South Wales, vol. viii. part iv. contains:—Occasional notes on plants indigenous in the neighbourhood of Sydney, by E. Haviland.—Temperature of the body of *Echidna hystrix*, by N. de Miklouho-Maclay.—Plagiostomata of the Pacific, part 2, by N. de Miklouho-Maclay and W. Macleay, F.L.S.—Notes on some reptiles of the Herbert River, by W. Macleay, F.L.S.—Notes on some customs of the aborigines of the Albert district, by C. S. Wilkinson, F.G.S., F.L.S.—On the brain of Grey's whale, by W. A. Haswell, M.A., B.Sc.—On a new genus of fish from Port Jackson, by W. Macleay, F.L.S.—Fishes from the South Sea Islands, by Charles De Vis, M.A.—Some results of trawl-fishing outside Port Jackson, by W. Macleay, F.L.S.—The "Barometro Araucano" from the Chiloe Islands, by N. de Miklouho-Maclay.—Far southern localities of New South Wales plants, by Baron Sir F. von Müller, K.C.M.G., F.R.S.—Description of Australian Micro-lepidoptera, part 10, by E. Meyrick, B.A.—Notes on the geology of the southern portion of the Clarence River basin, by Prof. Stephens, M.A.—Dimensions of some gigantic land-tortoises, by J. C. Cox, M.D., F.L.S.

THE *Zeitschrift für wissenschaftliche Zoologie*, vol. xl. part 1, contains:—P. M. Fischer, upon the structure of *Opisthotrema cochleare*, nov. genus et spec.: a contribution to the anatomy of the Trematoda.—F. Blochmann, remarks upon some Flagellates.—A. Korotneff, the budding of Anchinia.—L. Döderlein, studies of Japanese Lithistidæ.—J. Brock, the male of *Sepioloidea lineolata*, d'Orb. (*Sepiola lineolata*, Quoy and Gaim), with general remarks upon the family of Sepioladæ.—A. Gruber, upon the nucleus and nuclear-fission in the Protozoa.—O. E. Imhof, results of a study of the pelagic fauna of the Swiss fresh-water lakes and tarns.

Part 2 contains:—A. Kölliker, the embryonic germinal layers and tissues (with a postscript).—C. R. Hoffmann, contribution to the history of the development of reptiles.—P. Langerhans, the worm-fauna of Madeira.—F. Ahlborn, (1) upon the origin and exit of the cerebral nerves in Petromyzon; (2) upon the segmentation of the body in Vertebrates; (3) upon the importance of the pineal gland (conarium, epiphysis cerebri).—C. Emery, study of *Luciola italica*, L.

THE *Morphologisches Jahrbuch*, vol. ix. part 3, contains the following:—G. Ruge, contributions to the study of the hæmal system in man.—J. E. V. Boas, a contribution to the morphology of the nails, claws, and hoofs of the Mammalia.—M. Davidoff, on the variations of the plexus lumbosacralis of *Salamandra maculosa*.—O. Bütschli, remarks upon the gastræa theory.—C. Gegenbaur, on the accessory tongue (*Plica fimbriata*) of man and other mammals.

Vol. ix. part 4 contains:—M. Sagemehl, contributions to the comparative anatomy of fishes, ii., some remarks upon the membranes of the brain in bony fishes.—P. Lesshaft, upon the muscles and fasciæ of the female perineum.—H. Klaatsch, contributions to a more exact knowledge of the Campanularia.—G. Baur, the carpus of the Artiodactyles: a morphogenetic study.—G. Gegenbaur, contributions to the anatomy of the mammary organs in Echidna.

SOCIETIES AND ACADEMIES

EDINBURGH

Mathematical Society, July 11.—Dr. R. M. Ferguson in the chair.—Prof. Chrystal contributed three papers on the application of the multiplication of matrices to prove a theorem in spherical geometry, on the discrimination of conics enveloped by rays joining the corresponding points of two projective ranges, and on the partition of numbers; in connection with the second of these he indicated a solution he had received in a note from Signor Cremona of Rome.—Dr. Alexander Macfarlane gave illustrations of a common error in geological calculations; and Mr. A. Y. Fraser explained two solutions (by himself and Mr. R. E. Allardice) of a problem of arrangements entitled La Tour d'Hanoi, which appeared in the *Journal des Débats* for December 27, 1883.

PARIS

Academy of Sciences, July 28.—M. Rolland, President, in the chair.—On the rule of Newton as demonstrated by Sylvester; a sequel to the two previous communications, by M. de Jonquières. Here two cases of indeterminants are dealt with: (1) That in which several consecutive terms are wanting in the equation, the absence of one or more non-consecutive terms giving rise to no uncertainty; (2) that in which one or more of the quadratic functions intervening in the operation are identically nul.—A study of the deviations of the pendulum at Fort Loreto, Puebla, Mexico, two illustrations, by M. Bouquet de la Grye. These observations were conducted by means of a multiplying seismograph set up in connection with the expedition sent out to observe the transit of Venus. Their object was

to ascertain how far the oscillations of the ground and the phenomenon of tides may be determined by the vibrations of the pendulum in volcanic and mountainous regions.—Report of the Commissioners, MM. Gosselin, Pasteur, Marey, Bert, and others on various recent communications received in connection with the present outbreak of cholera in the South of France. The Commission has examined altogether 240 communications, mostly from Spain, and either suggesting "infallible nostrums," or such remedies as are already in practice. Others recommend hypodermic injections of the nitrate of pilocarpine, arsenic, copper, phenic acid, salicylic acid, vapour of hyponitric acid, intra-venous injections of pure water, or mixed with chloride of calcium or other salts. All these methods have been tried, mostly with indifferent results, although phenic acid and the intra-venous injections seem to call for further consideration. But, speaking generally, the Commission regrets to have to report that none of the communications contain any really useful suggestions.—On a new application of electricity to the treatment of fibrous tumours of the womb, by M. G. Apontoli.—Researches on wheaten and other flours; distribution of the acid and saccharine elements in the various products of the corn-mill, by M. Balland.—Note on the analytical calculating machine invented by Charles Babbage, by General F. L. Menabrea. The author gives a full description of the machine left incompleted by the inventor. He also gives an unpublished letter of Mr. Babbage, dated August 28, 1843, and certifying that the anonymous English translation of Signor Menabrea's original account of the machine, which appeared with some brilliant accompanying explanations in the third volume of the *Scientific Memoirs*, was by Lady Ada Lovelace, only daughter of Lord Byron.—Note on the exact number of the variations gained or lost in the multiplication of the polynome $f(x)$ by the binome $x^h \pm a$, by M. D. André.—Note on the temperature and critical pressure of the atmosphere. Relation between atmospheric temperature and the pressure of evaporation, by M. K. Olzewski.—Description of a new method of directly measuring absolute magnetic intensities, by M. A. Leduc. This method, which is an application of M. Lippmann's discovery, is extremely simple and expeditious. It enables magnetic intensities to be measured in absolute unities, and is now being applied by the author to the study of a magnetic field.—Note on the combustion of explosive gases in various states of dilution, by M. A. Witz.—Note on the quantitative analysis of nitric acid by precipitation in the state of nitrate of cinchonamine. Application of this process to the quantitative analysis of the nitrates contained in natural waters and in plants, by M. Arnaud.—Note on the triacetic ether of a butylic glycerine, by M. L. Prunier.—Note on a new method of making a quantitative analysis of the dry extract of wines, by M. E. H. Amagat.—Anatomical and physiological description of *Convoluta Schultzii*, a curious animal of relatively high organisation, but in which the association with chlorophyll elements has produced some interesting physiological phenomena, by M. A. Barthélemy. Although deprived of eyes even in the rudimentary state, these worms appear to possess a sort of visual sensation. The act of breathing by absorption of carbonic acid through the cuticle also presents a striking analogy to that of submerged aquatic plants.—Fourth contribution to the history of the formation of coal, isolated carboniferous blocks, from Commentry, by M. B. Renault.—Note on the microscopic organism associated with the zooglæic tuberculo-is, by MM. L. Malassez and W. Vignal.—Note on a hitherto unobserved portion of the sting of melliferous insects, and on the mechanism employed by them in expelling the venom, by M. G. Carlet.—Memoir on the geology of the Kepp district, Tunisia, one illustration, by M. P. Marès. The author determines in this district a regular superposition of the Upper Cretaceous, Eocene, and Miocene formations, a detailed study of which promises to be of great interest.—Note on the relations existing between the crystalline systems of various substances, by M. E. Mallard.

Berlin

Physical Society, June 27.—Dr. König described a subjective optical perception of which he had repeatedly become conscious in the morning on waking from sleep and while his eyes were yet shut. On a blue-gray background he saw regular closely adjoining hexagons, like the cells of a beehive, the contours of which appeared black, while the upper sides and the outwardly adjoining sides of the hexagons had a yellow appearance interiorly, an effect produced perhaps by way of contrast to the bluish background. In the interior of each hexagon, but not exactly in the centre, and just as little uniformly in the different fields, a black point was visible. The radius of each figure was about the length of the diameter of the moon's image. In endeavouring to explain this phenomenon Dr. König thought first of the epithelial cells of the eye, which formed a similar mosaic behind the retina, and calculated the visual angle under which such a phenomenon was produced. From this calculation it appeared that these hexagons were considerably less than the subjective ones, as many as twelve epithelial cells being needed to tally with the field of the subjective figure. No other explanation of the phenomenon had yet been come upon by Dr. König.—Prof. Neesen gave a short survey of the methods that had hitherto been proposed with a view to regulating the electric current in its technical application. No method, it appeared, had yet been introduced into practice, and for the present the question turned only about proposals on points of principle. These were divisible into such as sought to regulate the energy by changing the resistance, and into such, on the other hand, as attempted this object by changing the electromotive force. The change in resistance was effected at first by means of the hand, and later in different ways automatically. The change of electromotive force in the case of dynamic machines was sought in part by regulation of the propelling steam-engine, in part by change of the magnet, in part by means of a second counteracting engine, in part by changing longitudinally the wire pulleys, and in part by opposed windings of the rolling wires. Thirdly, and lastly, it was proposed as a means towards regulating the electric current, that when the dynamic machine delivered more electricity than was used, the surplus should be diverted to the supply of an accumulator where, when the machine yielded too feeble a current, the supplementary energy required could be drawn. Prof. Neesen gave a more detailed account of some of these proposals, and concluded in favour of the last or third method, that, namely, of the transference and storage of surplus energy in an accumulator, as the most advisable of all the plans proposed from a practical point of view.

CONTENTS

	Page
Electric Lighting	333
Our Book Shelf:—	
Merriman's "Text-Book on the Method of Least Squares"	334
Harris's "Propositions in Geometry"	334
Letters to the Editor:—	
"Gas-Burners, Old and New."—"Owen Merriman"	335
The "Cotton-Spinner."—Dr. F. Jeffery Bell	335
Krakatoa.—R. D. M. Verbeck	335
The Meteorology of Ben Nevis. By Alexander Buchan	336
The Forestry Exhibition	337
Practical Taxidermy	338
Notes on the Canadian North-West. By Gerrard A. Kinahan	340
Native American Literature and Ethnology. By A. H. Keane	341
Notes	343
Our Astronomical Column:—	
The New Comet	346
Periodical Comets in 1885	346
A Variable-Star in Aquarius	346
Ptolemy's 30th of Centaurus	346
Observations on a Green Sun and Associated Phenomena. By Prof. C. Michie Smith	347
Education, Science, and Art	349
The Marine Biological Association	350
The Meteorological Conference	351
Scientific Serials	355
Societies and Academies	355

THURSDAY, AUGUST 14, 1884

THE REPORT ON TECHNICAL INSTRUCTION

THE Report of the Royal Commissioners on Technical Instruction is now before the public. These two volumes, together with the short interim Report on Apprenticeship Schools in France, which was issued two years ago, extend over a wide range of matter. The Commissioners' account of their travels abroad and at home is narrated in vol. i., which concludes with their various recommendations. Vol. ii. contains a Report on Agricultural Education, by Mr. Jenkins, and another on Technical Education in America, by Mr. Wm. Mather. In the remaining volumes will be found a Report by Mr. Wardle on Silk Industries, and a scheme by Prof. Sullivan for Technical Education in Ireland, and a variety of Statistics and Programmes are also promised.

The immense mass of detail thus gathered together in this voluminous and interesting blue-book renders it a matter of some difficulty to give anything like an adequate review of the labours of the Commission. In the present article we shall confine our attention to that part of the Report which deals with technical schools in foreign countries, reserving for a second notice that part of the Report which relates to Great Britain.

The Commissioners preface their account of Continental Technical Instruction with some concise introductory notices of the general conditions of Primary and Secondary Education in various nations. Their remarks on the gradation of schools, on the use of school museums, and on the prominence given to drawing are worthy of attention. After these notices the Commissioners deal with artisans' evening technical schools, artisans' apprenticeship schools, intermediate technical schools for foremen, trade and professional schools for women, and the higher technical instruction for employers and managers. Concerning the first of these matters the Commissioners remark on the value of the numerous continuation-schools (Fortbildungschulen) which exist in nearly all towns of Germany and Switzerland. It appears that in Bavaria, Baden, and elsewhere, pupils leaving the primary schools at the age of 13 are compelled by law to continue their studies in the evening schools until the age of 16: a truly wise rule, calculated to sustain the benefits of school training at a period when such training is too often prematurely cut short. It also appears that although in no country abroad is there any organisation for systematic evening instruction at all comparable to that under the control of our Science and Art Department, the teaching, at least in many foreign towns, is conducted by professors of higher standing than, and of superior attainments to, the ordinary English "science-teacher" who, it must be confessed, is too often sadly deficient in training. On the subject of artisan apprenticeship schools the Commissioners do not add much to the information given two years ago in their preliminary report, so far as France is concerned; but, in relation to some of the German schools, as, for example, the clock-making and wood-carving schools at Furtwangen and other districts of the Black Forest, there is much interesting information. In Wurtemburg there are no such schools, as the authorities prefer to attempt to give sound education by means of evening and Sunday schools, without interfering with the conditions of daily labour.

In regard to Intermediate Technical Schools for foremen and others much is being done abroad, both in the special departments of weaving, mining, and industrial art, and in more general schools. In France particularly this is the case. The great schools of this type at Lyons, Rheims, and Paris are practically unique. There is nothing approaching them in this country except perhaps the Allan Glen's Institution in Glasgow. These schools and the secondary technical schools of Germany are elaborately described. The Higher Trade Institute of Chemnitz, and the four "Industrie-Schulen" of Munich, Augsburg, Nüremberg, and Kaiserslautern are of this class, intermediate between the Real-Schulen and the Polytechnics. No classics are taught in these schools. Throughout Austria, Germany, France, and Holland there are also special schools for mining and for the building trades. The Commissioners devote many pages to the weaving schools, which, like those of Chemnitz, Crefeld, and Mulhouse, are to be found doing work of utmost importance to the continental industries. The spirit with which municipalities and manufacturers support these schools is truly remarkable. Employers are constantly looking out for students who have attended the technical classes. The manufacturers feel it imperative to extend their work in order that in troublous times they may have more than one string to their bow. Thus in Crefeld, where silk goods are the staple manufacture, much attention is given in the weaving school to the weaving of jute, wool, and cotton. The people cheerfully tax themselves to pay for efficient management. They recognise that the day has gone by when money can be made without effort: "to exist they must move on." Heavily taxed as the German people are by the burden of enormous civil and military expenditure, they yet believe that it is cheapest in the long run to educate the "human machine" to the highest pitch of perfection.

It is, however, with the higher technical instruction, with the great Polytechnic colleges of Germany, and with the École Centrale and École Polytechnique of Paris that the interest of the Commissioners' Report culminates. The German Polytechnics form a group of institutions of which the type is absolutely wanting in this country. These institutions, though in many respects resembling the German universities, differ absolutely from them, not merely in being technical and practical, but in having fixed curricula of study, and regular systems of examination. The eleven schools of this type (eight of which are in Germany proper, one at Zürich, one at Delft, one at Moscow) have been built at a cost of not less than three millions sterling, and are maintained at an annual cost of over 200,000*l*. This amounts to a State expenditure of about 100*l*. per annum for each student in attendance. This may be contrasted with the case of the two leading English Universities of Cambridge and Oxford. These and their colleges are believed to have a total annual income from endowments of 500,000*l*., and as there are about 5000 men in total attending the two Universities, this also is at the rate of 100*l*. per annum per student. There is, however, room in the Polytechnic for three times the number of students

actually in attendance. A few figures respecting some of these schools will show how these institutions stand in public opinion. The Munich Technical High School cost 157,000*l.*, the apparatus alone being worth 36,000*l.*, and the annual expenses amounting to 20,000*l.* The Zürich Polytechnic spends 20,000*l.* annually, 13,800*l.* being derived from Federal taxes, and 3794*l.* only from fees. There are forty-five professors on the lecturing staff. 50,000*l.* have just been spent on laboratory extension. The Stuttgart Polytechnic has a State subvention of 12,000*l.*, that of Dresden 12,200*l.* The Hanover Polytechnic cost 350,000*l.*; its collection of models (chiefly engineering), 36,000*l.*, and 1250*l.* is spent every year in adding to the collection. Some idea of the preparation made for teaching engineering students may be gathered from the fact that there are stated to be in this one school no fewer than 673 tables for drawing. The Berlin Polytechnic, now nearly completed, has cost 450,000*l.*; that of Moscow 496,000*l.* The chemical laboratory of the Polytechnic of Aachen alone cost 45,000*l.* The Bernouillianum of Berne cost that little town more than 1*l.* per inhabitant! At such a price do our neighbours provide for the higher technical training. In France, too, the technical schools are maintained at great cost. In the École Polytechnique, salaries alone amount to 22,000*l.* per annum. A new addition to the laboratories is costing 96,000*l.* All this is found by the Government. On the other hand the École Centrale, which spends 17,836*l.* per annum, is self-supporting, the fees being very high.

From this enormous expenditure of money on Higher Technical Education, tangible results cannot but accrue. Many such are mentioned in the pages of the Commissioners' Report. They adduce examples of improvements in machinery which are the result to a large extent of students' training. They point out how in Continental chemical works and dye works there is a thoroughly trained chemist at the head of each separate department. They indorse the opinion of Prof. von Helmholtz as to the absolute economy of employing as heads of departments persons conversant with the theory of their work, and able by virtue of their scientific knowledge to anticipate results and to make quantitative calculations. They remark that in physics, as also in chemistry, the knowledge of the principles of the science and of the methods of research is the more important part of the equipment of the technical student. They ascribe the general diffusion of high scientific knowledge in Germany to the multiplication of the Polytechnics, and to the small cost of a higher or University education. Amongst the opinions, which they quote, of authoritative speakers, there is one of particular appositeness from the mouth of Prof. Quincke. He holds that it is an error to suppose that any Polytechnic course of instruction can *by itself* teach a student to erect an engine, work a blast-furnace, or manufacture sulphuric acid: he holds that lectures and laboratory work are obviously insufficient to prepare the student for carrying on work where actual practical experience is needed; but that, in contradistinction, the object of the Polytechnic School is *to facilitate the transition from pure science to practice.* The functions of the Polytechnic have probably never before been so well defined. It may be an open question what kind of training is the best to qualify a man to be manager of an industrial concern. But there can be no question whatever of the consensus of opinion on the Continent as to the value of the Polytechnic training. It may not, nay, cannot, supplant the experience of the workshop: but it gives something that no amount of mere workshop experience can give—something which, were it suitably introduced into industrial Britain, would supply the greatest industrial want of our time.

BRITISH MINING

British Mining, a Treatise on the History, Discovery, Practical Development, and Future Prospects of Metalliferous Mines in the United Kingdom. By Robert Hunt, F.R.S. 4to. Pp. xx. 944, 231 Woodcuts and 2 Folding Plates. (London: Crosby Lockwood and Co., 1884.)

THE title shows that the author's object is to describe the past and present condition of British metal mines, and to venture some prophecies as to their future. It requires a bold heart to attempt a work of this kind; but, as explained in the preface, Mr. Hunt's long connection with mines and his official position as Keeper of Mining Records have given him excellent opportunities for gathering information.

The work is divided into four books. Book I. gives a long historical sketch of British metal mining from the time of the Phœnicians downwards. With reference to St. Michael's Mount being their trading station, the author indorses the old Cornish tradition and disagrees (p. 845) with Prof. Rhys, who has suggested that the Isle of Thanet was the *Iktis* of Diodorus. From detached memoirs and reports much information has been collated concerning mining work carried on by the Romans for lead, iron, copper, and gold.

In Chapter III., upon mining to the eighteenth century, Mr. Hunt fixes very exactly the date of the introduction of gunpowder for blasting in Cornish mines. Chapters IV., V., and VI., relating to the mining of tin, copper, lead, silver, iron, and zinc to the end of the eighteenth century, are full of valuable facts, and both here and in Chapter III. we notice many interesting statements concerning the special privileges of miners and the charters granted to them.

Book II., occupying one-third of the volume, is devoted to the formation of metalliferous deposits. The rocks and mineral veins of the principal mining districts are described, and long quotations are made from sundry writers. Mr. Hunt then sets forth the hypotheses of the best-known authors concerning the origin of lodes, and very wisely does not bind himself to any particular theory; he admits that mineral veins have been formed by deposition in fissures from lateral infiltration, from surface-water carrying down soluble salts they have dissolved out in their passage, and lastly, from ascending mineral springs. He further considers that many of the conditions observed are due to electro-chemical influences.

In the last chapter of this book the author brings forward instances of remarkable tin, lead, and copper mines in Cornwall, Wales, Ireland, and the North of England.

Book III., which is of the same length as the preceding one, is a treatise on practical mining. Rock-boring by machinery very properly comes in for a large share of attention, but some other departments of mining are

treated rather cursorily. In speaking of the *man-engine* for raising and lowering men, Mr. Hunt points out that the reason why this valuable invention is so little used is "the unfortunate system under which the mines of Cornwall and Devon are worked—a system which does not encourage the holder of shares to take any interest in the mines themselves, his interest being confined to the market value of the shares which he holds." This remark unhappily applicable to other districts.

In Chapter IV., on ore-dressing, after an historical sketch, the principles of the mechanical preparation of ores for the smelter and the various kinds of machines now in use are described with the aid of numerous illustrations.

Chapter V., upon the discovery and extraction of iron ores from veins and other deposits, is disappointing, on account of its meagreness compared with the space devoted to less important metals, and the Cleveland ore should scarcely have been dismissed in a dozen lines.

Book IV. relates to the future prospects of British mining. To persons interested in mines, whether as owners, shareholders, workmen, or merchants furnishing them with supplies, this book will no doubt seem the most important in the volume. Mr. Hunt is not sanguine about better prices for tin, and he says that "it is improbable that our native copper mines can be expected to prove profitable for some time to come"; in the case of lead he evidently is not more hopeful, and though the prospects as regards zinc are brighter, still we are unable to supply our own wants. In spite of the productiveness of our iron mines, we have to import more than three million tons of iron ore annually.

The fourth chapter of this book contains numerous useful suggestions for working mines, and is well worthy of consideration by miners and shareholders in mines. With reference to profitable mining, Mr. Hunt says (p. 863):—"The question is frequently asked, Is British mining a remunerative pursuit? Various replies might doubtless be given in accordance with any particular set of views and opinions held on the subject, but mines promoted by mere speculation can scarcely be expected to become profitable, inasmuch as they are too frequently grounded upon a misrepresentation of facts, while the capital connected with them is often largely diverted to the pockets of individuals whose main purpose is immediate gain. Further, the management or conduct of affairs is often leavened with ignorance and incompetency; the acquisition of personal gain, at the cost of unsuspecting shareholders, being unfortunately sometimes the rule of action." No one who knows anything about mining can fail to indorse these remarks.

In Chapter V., which contains the general summary and conclusion, Mr. Hunt says that "the exhaustion of our mineral wealth is now going onward at a rapidly increasing rate," and the question arises whether we can meet the demands of trade from British mines or not. According to the author, our tin ore is practically inexhaustible, but for copper, lead, zinc, and silver we must depend greatly upon foreign and colonial mines; of iron ore we have enough for some years, though certain foreign ores are of importance to us.

The situation is summed up as follows:—"Without great improvements in the principles of mining it will not be possible to work, at a profit, many of our deeper and more extensive mines."

The last two pages of the work, before the appendix, contain several important maxims which deserve the careful study of all persons engaged in mines, such as the necessity of supplying pure air *at any cost*, of raising and lowering the men by machinery, and providing for them in the event of accident or disease. The concluding words very properly strike at the rascality which has done much to wreck British metal mining. "Beyond these, to enable the adventurers in our Home Mines to compete satisfactorily in the metal markets with the proprietors of colonial and foreign mines, and to realise a profit on the sale of their minerals, it is absolutely necessary to study the strictest economy, and to establish—beyond the risk of any failure—the highest principles of honesty in every department, directly or indirectly, connected with British Mining."

The size of Mr. Hunt's volume is apt to alarm the reader, and the publishers would probably have done better by issuing the work in separate books. It strikes us, too that undue prominence is given to tin, to the detriment of the more important metal iron. From the "Mineral Statistics" for 1883, we see that the iron ore raised had a value of about 5¼ millions sterling, whereas the value of all the other metalliferous ores put together was only 1½ million. However, in spite of this favour shown to tin and of occasional inaccuracies, Mr. Hunt's *magnum opus* is very praiseworthy, as it contains a vast store of useful information, and the antiquary, the miner, and the capitalist are greatly indebted to him for having taken the trouble to chronicle so many valuable facts relating to such an important branch of British industry as Metal Mining.

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 International Geological Congress

WILL you allow me to announce in your columns that, in consequence of the outbreak of cholera in the South of Europe, the International Geological Congress is postponed to September 1885. JOHN MCKENNY HUGHES

Woodwardian Museum, Cambridge, August 12

The Volcanic Dust Phenomena

I WOULD draw the attention of such of your readers as may be travelling in Switzerland or other mountainous countries to the circumstance that in the clear atmosphere of the mountains the great corona or circle round the sun, as well as the semicircle seen opposite the sun before and after sunset continue to be markedly conspicuous; and the higher one ascends the more striking these phenomena are. I saw both the phenomena especially remarkable on the Gornergrat, altitude 10,289 feet, on the 21st and 22nd of last month; and even as low as 4000 feet they are decidedly more striking than at sea-level. It appears, therefore, that the bulk of the volcanic dust, if such it be, that still remains continues at a great elevation, and the prediction made last autumn that it might remain for years in the atmosphere, seems likely to be fulfilled.

The explanation of the strange sunsets given by "F. A. R. R." in NATURE (p. 155), seems a good one, except as regards the green appearance of the moon and stars; I must confess I am

not convinced that this was anything but a subjective phenomenon. It is true I saw it myself when there was little if any redness perceptible in the sky; but the probability is that one's eyes had become so dazzled by, and used to, the intense redness previously existing, that one was rendered incapable of seeing a moderate degree of red, and the complementary colour was produced in uncoloured objects. Besides, gas-lights sometimes partook of this colour. As regards the sun, I agree with "F. A. R. R." in the impression that when it was moderately near the horizon it was whiter than usual all last winter and spring, and perhaps to the present time.

Sunderland, August 6 T. W. BACKHOUSE

Upon the Occurrence of Bacteria and Minute Algæ on the Surface of Paper Money

THE recent researches of Paul Reinsch of Erlangen have shown the occurrence of different schizomycetes and of two new minute algæ (*Chroococcus monetarum*, *Pleurococcus monetarum*, Paul Reinsch) on the surfaces of the coins of many nations, living in the thin incrustations of organic detritus (composed especially of starch grains, fibres, &c.) deposited upon their surfaces in the course of long circulation. This extremely thin incrustation renders the coins very suitable for this micro-vegetation, but the same phenomenon is also exhibited in the case of paper money, and indeed by notes of clean and, to the unassisted vision of a quite unaltered appearance.

Having scraped off some of these minute incrustations with a scalpel and needle and divided them into fragments in recently boiled distilled water, with lenses of high powers (1/10th inch of Messrs. Beck) there were distinctly seen various schizomycetes, &c.

I have investigated the Hungarian recent and older (from the year 1848-49) bank and State notes, also Russian 1-rouble notes, and have found upon all of them—even upon the cleanest—schizomycetes, &c.

On the surface of all the paper money is always to be found the bacterium of putrefaction (*Bacterium termo*, Dujardin).

In the thin incrustations of paper-money the occurrence of starch grains, especially that of wheat-starch, linen, and cotton fibres, animal hairs, &c., are easily to be demonstrated, and upon the 1-forint[1] State-notes in such deposits the common saccharomyces are also to be found. Various micrococci, leptotriches (many with club-shaped swelled-up ends), and bacilli are also very frequent plants in these deposits on paper-money.

The two new species of algæ described by Paul Reinsch are very rare on the paper-money. The green pleurococcus cells I have observed in some cases on 1- and 5-forint State-notes and the bluish-green minute chroococcus on the edges of the 5-forint State notes.

The vegetation of the paper-money is, as a result of my researches, composed of the following minute plants:—

1. *Micrococcus* (various forms).
2. *Bacterium termo*.
3. *Bacillus* (various forms).
4. *Leptothrix* (various forms).
5. *Saccharomyces cerevisiæ*.
6. *Chroococcus monetarum*.
7. *Pleurococcus monetarum*.

From a hygienic point of view, also, the investigations of the commonest necessary household objects may not be superfluous, and I would especially call attention to these forms as occurring on the means of instruction, viz. the handbooks, &c., used by our young scholars.

JULES SCHAARSCHMIDT,
Privat docent of Cryptogamic Botany and Anatomy of Plants, Assistant at the Botanic Institute and Gardens, Royal Hungarian University, Kolosvár

Fireballs

THE following account I have received from a lady at Brühl near Cologne, July 26:—"8.22. A large fireball of scarlet fire almost as large as a harvest moon just sailed along and upwards, at a varying but mostly very rapid rate, until, at a great height, it remained for some minutes almost or quite stationary; then after some uncertain movements rose again, and rising, became smaller, until it finally disappeared. . . . Every one who saw it seemed petrified with amazement." This is of interest from the long time that the ball was visible, and its being seen by several people. I described some time ago some fireballs which I saw slowly moving at a distance during a storm in Egypt, which were then put down as illusory results of a flash (NATURE, vol. xxiv. p. 284), but now many similar cases have been lately reported. A large fireball, described as about a foot in diameter, was seen a few years ago near here; it struck a pavement, went over a low wall, moved across a wide lawn, and finally vanished in a wet ditch.

While living lately at San (Tanis), thirty-two miles south-west of Port Said, there occurred a most remarkable thunderstorm on May 12, lasting from 1.15 till 4 p.m. The rainfall in two hours was over 1½ inches; the hailstones (which covered half the area of the ground) were mostly 3/10ths to 4/10ths inch in diameter, and some 7/10ths, of concentric structure with jagged edges. Whenever I could hear anything above the battering of the hail on my iron roof there was always thunder going on; and as soon as the rain ceased I went out of doors, where for half an hour longer I can positively assert that there was not an instant of silence. This thunder was not in loud, reverberating peals, but was a continuous rushing, gusty, swishing sound; the noise rising and falling just like a gusty, tearing, high wind, without any crashes or explosive bursts, and with very little bumping or knocking sounds. It only lightened once or twice during that half hour, and there was but a faint breeze of wind. To the best of my belief the thunder was similar during the whole time of the storm, though with more explosive sounds and more lightning in the early part. It is impossible to refer such a storm to the ordinary instantaneous, sharp discharges with echoes, as the sound had no character of a reverberation; it appears to be due to a continuous discharge like that from a point. The storm was quite local, only extending a few miles. Since returning to England I have also heard thunder which was apparently not from an instantaneous discharge, as it began lightly and waxed louder for two or three seconds, until a loud crash of the main discharge took place.

The whole question of slow or peculiar discharges and of fireballs needs clearing up by careful observation; it is useless to ignore it or refer it to illusion, merely because we have not imitated it artificially or made a theory on the subject.

Bromley, Kent W. M. FLINDERS PETRIE

Museums

IN an excellent article on "Practical Taxidermy" in NATURE of August 7, reference is made to the Museum at Leicester as approaching to the ideal of what museums should be. While fully agreeing with the opinions attributed in that article to Mr. Bowdler Sharpe, and admitting that the Leicester Museum has at last taken one step towards the ideal which was worked out for it some years ago, I feel bound to point out to such other museums as are waking up to the necessity of a radical revolution, that perfection is a long way off yet; that there is ample room for each to do better than its predecessor; that Leicester has not even carried out the general principles laid down by Mr. Bowdler Sharpe; and that these general principles may be developed in various directions.

They should consider what a provincial museum can do to the best advantage, for the world, for local students, and for the unlearned public; and by what methods of arrangement, of public exhibition and of private access, its highest functions can be most completely brought out.

Of the three educational objects for which rates can be levied by Town Councils, viz. museums, free libraries, and art galleries, the popular taste is rather tending just now towards the free libraries and the art galleries. There is a disposition to regard museums as mere hobbies for the few, and to devote the lion's share of the rate to literature and art. This is perhaps only a swing of the pendulum, but it is justified to a large extent by the condition of nearly every provincial museum at the present time.

Science is taught in most museums as reading, writing, and arithmetic were taught in the old-dame schools—in a clumsy, thoughtless, perfunctory manner, which wasted half the time and interested nobody. Mr. Mundella, with the Education Act in his hands, has made a revolution in the schools; if Mr. Bowdler Sharpe will get his ideas developed in museums with equal success, he will supplement the schools in a most valuable and important direction.

[1] 1-forint (to German Gulden) = 2*d*.

His first principle, that the primary object of every county museum should be to make as perfect a collection as possible of the natural productions of that county, exhibited in the most attractive form, is undoubtedly correct, and has been definitely sanctioned by a large body of competent authorities. This is just what can be done by each provincial museum better than by any other institution in the world, and it is just what is especially wanted by scientists, by students, and by the public. But this unfortunately has not been made the primary object either at Leicester, Nottingham, or Derby.

Mr. Sharpe's second principle, that each museum should possess also a typical series of foreign specimens for comparison with the local ones is equally correct. Science depends upon the appreciation of similarities and differences. The faculty of careful observation and comparison is of such fundamental value in all education and might be so effectively cultivated in museums that these institutions will in the future be found essential adjuncts to the schools. But here all existing museums are particularly weak. Opportunities for comparison are not sought out. The collections are not arranged with any special view to making comparisons easy and obvious. If, for instance, the local birds are in one room, and the foreign types in another, comparison is made as difficult as possible. Even if they are on opposite sides of one gallery, and the divisions of the orders made exactly to correspond, it is still difficult. They must be brought so near together that the eye can match them as it would match two patterns. This can be accomplished, and in an artistic and very interesting manner. It is to be hoped that the museum of the future will work out Mr. Bowdler Sharpe's principles much more completely than has yet been done.

Birstal Hill, Leicester F. T. MOTT

Measuring Heat

DURING the past twelve months I have been endeavouring to construct some form of calorimeter which should aid me in the identification of minerals, and which should, to that end, combine accuracy with ease of manipulation. The avoidance of thermometry seemed highly desirable, and a *differential* method suggested itself.

One gramme of the mineral undergoing investigation, and one gramme of pure silver, are heated in the same steam chamber and simultaneously transferred into the muffles of two Favre and Silbermann's calorimeters, made of uniform size and placed side by side, similarly shielded from external sources of error during experiment. The specific heats are compared by the index movements of the calorimeters, the index tubes being either simply calibrated or empirically graduated.

Both calorimeters are here exposed to the same external sources of error. The amount of heat lost by radiation, however, will, for each calorimeter, depend on the duration of the experiment and the rise of temperature experienced. Now the heat received is communicated to the walls of the calorimeters by convection currents, ascending from the muffles, in the first instance, very much more slowly by conduction. It appeared, then, that an *internal* non-conducting shield of a porous nature lining the walls and retarding convection currents might reduce such loss very considerably. Experiment confirmed this supposition. An apparatus I have had constructed on this principle by Yeates of Dublin is now nearly ready for experiment.

J. JOLY

Engineering School, Trinity College, Dublin,
August 5

Circular Rainbow seen from Hill-top

THIS is not such an unusual phenomenon. It depends of course on the position of the observer as regards the sun, and his "coin of vantage," viz. having a space below him. I have seen it several times in my life, and remember a beautiful illustration of it given by Mr. Bains, the artist who accompanied the traveller Chapman to the Victoria Falls on the Zambese. His painting was, and probably is, in the Library at Cape Town. He is represented as standing on a projecting rock overlooking the Falls, or perhaps I should say looking up the crevice into which the water falls, and in the centre of a glorious double circular rainbow. I have heard the picture much criticised and its accuracy doubted, but having had actual experience of such a sight, I always maintained its correctness.

I saw lately another "bow," which struck me as very remarkable—perhaps because I never saw one like it before. My house stands on a hill-top; below me at some distance is a piece of low ground, covered by the tide at high water. The sun was low behind me, and the "bow" was formed on a mist coming up from the sea and swamp. It was, however, so *flat* that it at once arrested my attention, and I called the members of my family to see a "flat rainbow"! All agreed they had never seen one like it. It was quite near us, as was proved by its intervening between certain objects; but I subsequently detected one part a long way to the left of me, showing it was, of course, a true "bow," but of an enormous size.

British Consulate, Noumea, June 17 E. L. LAYARD

THE MIGRATION OF SALMON

DURING the last ten years some exceedingly interesting researches have been effected by German, Finnish, Swedish, and Norwegian ichthyologists as to the migration of salmon on their respective coasts. Thus, by careful researches, some Swedish and Finnish *savants* have proved that the salmon, which in the summer are caught in the rivers of the upper gulf of the Baltic, have at another season, most probably in the winter, paid a visit to the shores and rivers of Northern Germany. This has been conclusively proved by salmon caught in the Swedish and Finnish rivers having German-made hooks in their gills and stomach. From this it is therefore apparent that, in the Baltic, salmon are in the habit of quitting the rivers of Northern Sweden and Finland in the autumn in order to visit the shores of Northern Germany during the winter, and return to their haunts in the spring. That the fish should be capable of performing the enormous journey across the Baltic—from the upper gulf to the Pomeranian coast—and back every year may indeed seem incredible, but that it is impossible is fully disproved by the experiments with salmon and trout effected by the late Mr. Frank Buckland on the coasts of Scotland and England in the same direction.

In March 1872 Profs. Virchow and Hansen were commissioned by the German Fishery Association to "mark" some of the salmon which had been hatched artificially near Hameln, in order to ascertain whether they were in the habit of returning to the river. The fish then in the hatching reservoirs were one year old, and mostly seven centimetres in length, although some were twice the size. Having tried cutting off various parts of the fins, it was found that it was most suitable for the object in view and the health of the fish to cut the so-called "fat" fin right away, particularly as the fish would retain this mark even when full grown.

On March 23 and 24, 1872, a thousand salmon marked in this manner were let out into the Weser. The marking was effected by taking the fish in the left hand, and then cutting the fin away with a pair of scissors, whereby the fish were perfectly uninjured. The little fat fin, which is mostly found on Salmonidæ only, contains no nerves of any importance, and has no particular function, so that its removal does not impair the fish in the least.

Ever since that year the fishermen between Bremen and Hameln have been on the look out for the marked fish, but not until a month ago a fish was caught, weighing 30 lbs., at Osterdeich, just above Bremen. The fat fin, which, on the fish one metre long, ought to have been six centimetres, was entirely absent; and, when the well-healed cut was felt, the hard membrane indicated that an operation had at one time or another been performed at this spot. The fish, which was marked as a grilse in 1872, was then thirteen years old—an age which in every respect corresponds with the age fixed by the fishermen. According to general observation, it has been demonstrated that the salmon in the Weser is, when one year old, from five to twelve centimetres long. In the second year it has been proved that the salmon go into the sea, and when they re-enter the river at four years of

age they weigh from eight to twelve pounds, and in the fifth year from twelve to fifteen pounds. From that age upwards the weight increases rapidly.

The results of the artificial hatching in the Weser are exceedingly promising. Thus the salmon fisheries at Hameln have been doubled in consequence during the last ten years, the tax at present paid to this town alone by the salmon fisheries being more than a thousand pounds.

In Norway, too, efforts have been made in the same direction during the last few years. Thus in 1883 the Storthing granted a sum of money for this purpose, and with this amount the Chief Inspector of Fisheries, Herr A. Landmark, has effected the marking of several hundreds of salmon and trout, chiefly on the west coast of Norway, during last autumn and winter. The marking here is effected by means of a tiny bit of platinum, 7 mm. long, and 4 mm. broad, being thus about the size of the nail on the little finger, which is attached by a very fine platinum wire to the fat fin of the big fish and the tail of the smaller ones. The piece has a number stamped on it, which corresponds with one in a "log" giving all the particulars as to the date the fish was marked, its weight, size, &c.

In order to encourage fishermen to be on the look-out for these marked fish, the inspector offers a reward of two shillings and sixpence for each mark forwarded to him, if accompanied with precise information as to the spot and date when it was taken, the length and breadth of the fish, and its weight.

As these researches will tend greatly to ascertain the habits and migrations of *Salmonidæ*, the result will be watched with interest.

THE TRINITY HOUSE EXPERIMENTS ON LIGHTHOUSE ILLUMINANTS

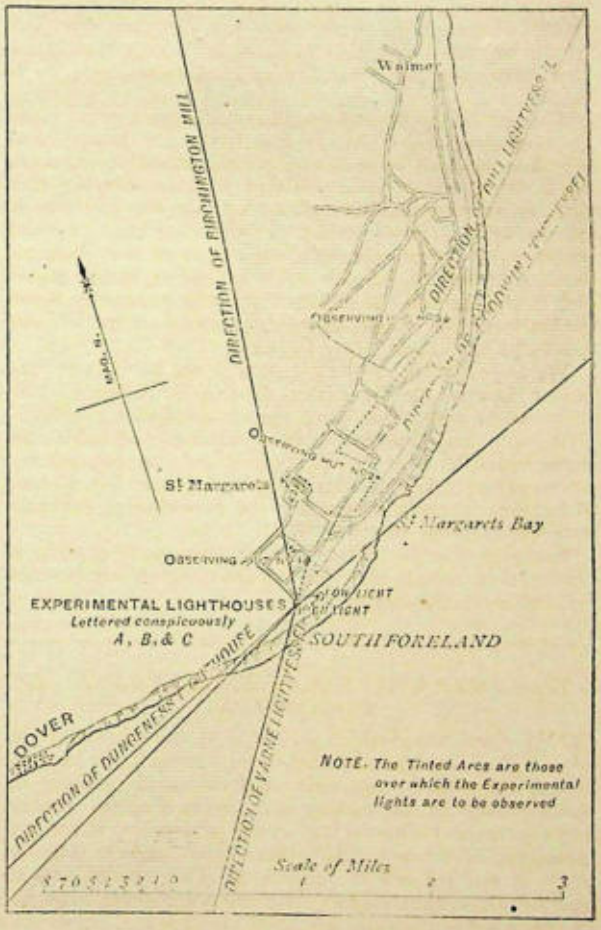
THE great advances made during the past few years in the science of illumination have rendered it desirable, or rather absolutely necessary, that experiments should be undertaken with a view to the determination of the advantages and disadvantages attending the use of different illuminants in lighthouses. With this view the Corporation of Trinity House have commenced a series of experiments at the South Foreland.

There are at present on the South Foreland two lighthouses, known as the high light and low light, and both of these are illuminated by electricity. Near these, three experimental lighthouses have been erected for use with the electric light, with gas and with oil respectively. The electric apparatus consists of three arc lamps and three magneto-electric machines made by Baron de Meritens. The lamps are placed one above the other in the tower. The carbons being used are "compound carbons," made up of many small rods of carbon of square section, coated with copper, and Siemens's "core-carbons," made of gas-carbon, with a central rod of graphite. When worked up to their full power, each lamp is estimated to be capable of giving a light equal to 30,000 candles.

The second tower is fitted up with Mr. Wigham's gas-burners. To supply the burners a small gasworks, fitted with retorts, purifiers, and a gasholder capable of holding about 5000 cubic feet, have been erected near by. The tower contains four burners, one above the other, each burner consisting of concentric rings of jets. The total number of jets on each burner is 108, making a total on the four burners of 432 jets; but the outer rings may be removed when less light is required: so that each burner may be used with 28, 48, 68, 88, or 108 jets. A talc chimney above the flame produces the necessary draught; no glass or talc is placed over the most luminous portion of the flame.

The intensity of the light when all the jets on all four burners are used is stated by the inventor to be equal to 12,000 candles. The third tower is for the present devoted to the oil and gas-burners invented by Sir James Douglass. The oil is supplied from a tank to the burners under a slight pressure. One oil-burner has six concentric wicks, and has a power of 720 candles; a second has seven wicks and a power of 1000 candles. There are three burners in the tower, placed one above the other. Each tower is provided with lenses both for revolving and for fixed lights. The highest power of the gas tower is a quadriform light, of the other towers a triform light. Besides the illuminants already mentioned, there are gas-burners from the Sugg and from the Siemens Companies, which will be tested in the lighthouse towers.

For observing the lights and testing them, a line of



Local Map for Observations on Land.

observation has been measured out in the direction of Deal, and three huts have been erected at a distance of ½ mile, 1¼ mile, and 2½ miles respectively from the towers. These huts are fitted up as photometric observatories. The lights are focussed on one of the huts, and they are then measured in all conditions of weather by means of the pentane unit of light devised by Mr. Vernon Harcourt. When the weather is too thick to allow of direct comparison with the unit, the lights are compared one with another by means of a polariscope-photometer, in which the ordinary image of one light is brought to equality by means of a Nicol prism with the extraordinary image of another light. In ordinary weather a ray from the lighthouse tower enters a hole in a shutter and falls

on a portion of a paper disk : a contiguous portion of the disk is illuminated by the pentane candle fixed on one side of the opening in the shutter. The disk can be moved on a trolley to and fro until equality of illumination is reached, when its distance from the candle is measured. This measure and the known distance of the observatory from the lighthouse give the necessary data for determining the illuminating power of the light. By these measurements, taken at different distances in various states of the atmosphere, the penetrative power of the several illuminants will be determined. For instance, in very clear weather the electric light may give twenty times the light of the oil light; a slight haze comes on and the electric light is found to be only ten times as bright. It has suffered in a greater ratio than the other. A mist blows by the towers, and the superiority of the electric light becomes less and less marked: before the lights are finally obscured the superiority has vanished. It need hardly be stated that this question of penetration is the most important point the Trinity House are called on to settle.

The principle of superposition of lights also raises an interesting point. When two lights are placed close together they can be seen at a greater distance than one light. Up to what point will this increase of range continue on multiplying the lights—without altering the intrinsic brightness of each? It may be that in thick weather the eye can detect a large area of low illumination better than a smaller area of higher illumination; and it may be that the electric light with its smaller lenses suffers from this reason in comparison with the oil and gas lights with their larger lenses.

We hope that the experiments will not be discontinued before these points have been thoroughly sifted, as they only can be satisfactorily, on the actual working scale.

We may add that the electric machines and cables are being tested by Prof. Grylls Adams, and the photometric observations taken by Mr. Harold Dixon. Mr. Vernon Harcourt is appointed to watch the experiments generally and report to the Board of Trade.

We give a plan of the district showing the point of observation, which includes the coast-guard stations and light-ships in the vicinity.

THE INTERNATIONAL CONFERENCE ON EDUCATION

THE Conference which was held at the Health Exhibition last week has achieved a remarkable success. It was attended by upwards of a thousand persons, including many of the leading teachers in English, Scotch, and continental schools, University professors, statesmen, managers of schools, and others interested in different ways in the subject of education. The interest was so well sustained that all four sections were more crowded on the last day than the first, and very general regret was expressed that the Conference should close so soon. Two circumstances mainly contributed to this result. The president, Lord Reay, by his tact and courtesy, his knowledge of foreign languages, and his cosmopolitan experience was singularly qualified, both to obtain from different continental States their most fitting representatives, and to give to these representatives when they arrived appropriate tasks and a worthy welcome. And Lord Reay was helped in the task of organising the Conference by a small but efficient committee, by whom during several previous months the work of selecting the readers of papers had been sedulously pursued. Unless pains had been taken in relation to each subject of discussion to secure that it should be initiated by a person who spoke upon it with some authority, and special knowledge, the result would have been far less satisfactory.

The Conference sat in four sections, which were at work simultaneously during five days. The first of these was devoted mainly to the consideration of questions relating to elementary education. The best and most fruitful subjects of discussion here were the Kindergarten, physical training, and the right way of inspecting, examining, or otherwise testing the work of pupils. Frobel's principles, which have done so much to transform the system of training very young children in England, in Belgium, and in France, were expounded with much fulness of knowledge and felicity of illustration by some of Frobel's own countrymen and disciples, as well as by ladies who have in England qualified themselves by special sympathy and knowledge to become his exponents. Closely akin to this subject were the topics of gymnastic and physical training, the better construction of schools and school apparatus, and the indirect effect of pictorial or other decorations in improving the taste and cultivating the imagination, and of increasing the scholars' interest in their work. The Swedish and other systems of bodily exercise, and the means of sense training by music and by object lessons were well discussed. On the general subject of the organisation of elementary education, which was debated in a crowded audience under the presidency of the Vice-President of the Council, the results were somewhat disappointing. Some of the teachers took the opportunity of the presence of their official chief to urge the demand with which the public have been long familiar, for grants of public money on easier conditions, and for the abandonment of the principle of payment by results. But no other practical method of distributing the public money was suggested, and it was generally felt that the Vice-President had an easy victory over those who sought to attack the principles of the recently-modified Code. A more important subject was raised in the animated debate on the inspection and examination of schools, which was rendered more apposite at the moment by the appearance of the recommendations of the Select Committee of the House of Commons, recommending that there should be in England a Minister of Public Instruction, and that he should have *inter alia* the duty of inspecting and annually reporting on the endowed secondary schools. I was perceived that this was a step of considerable moment and significance. Under the Act of 1869 endowed schools have been re-organised, and their governing bodies and schemes of study re-constituted. But neither the Commissioners who administer that Act, nor the public, know anything of the way in which those schemes are carried out, nor of the actual performances of the schools from year to year. There was among the larger number of earnest speakers on this point, a very general agreement on two points: first that some such public supervision over the reformed foundations was absolutely necessary, in order to keep them efficient; and secondly, that as there would be in this case no grant to administer, there would not be, as in elementary schools, any need to formulate conditions as to instruction, but simply to inquire in every case what the endowed school professed to do, and to see how far it had realised its own ideal. It is rather for the purpose of knowing what the schools are doing, than for that of imposing upon them by authority any theory or official ideal that State supervision seems to be demanded in regard to endowed schools.

In the second of the sections the principal topics of discussion were connected with scientific, technical, and artistic instruction. The fact that the Conference held its sittings in the new and beautiful buildings recently erected for the City and Guilds of London Technical Institute, naturally excited special interest, and awakened discussion as to the place which the physical sciences ought to hold in general education, as well as the special uses to which the Institute might be put in connection with the improvement of handicrafts and skilled trade. Mr. Magnus, Prof. Armstrong, Mr. Sparkes, and other

authorities whose names are associated with the improved teaching of science or of art in this country, were enabled to compare notes with professors of similar subjects from France and the United States, and some useful results were arrived at. In one special department of this Section, the agriculturists, under the presidency of Lord Fortescue and Sir Thomas Acland, held several long and animated discussions on the better teaching of agricultural science, on farm schools, and on the right education of boys intended to be farmers. In another department the subject of school museums was brought forward in an interesting paper by Dr. Jex-Blake of Rugby, and divers subsidiary aids to school instruction, such as field excursions, organised visits to factories, museums, and other places of interest, were suggested or described. Some of the more skilled and earnest of the elementary teachers, who, by their own personal influence, have secured the co-operation of their scholars in the formation of school museums illustrative of the flora, fauna, history, or industry of particular districts, gave interesting accounts of their plans and of the practical results which attended them; and from France and Belgium, and particularly from Liverpool, remarkable testimony was produced as to the success which had attended school savings' banks, and the influence they had exercised on the children and their parents.

The third section was mainly concerned with Universities and their relation to secondary instruction on the one hand, and to the liberal professions on the other. Profs. Morley, Fleeming Jenkin, and Seeley discoursed severally on those parts of the University curriculum with which their own names are most prominently associated, while the legal and theological aspects of the University question were discussed by Sir C. Bowen and Prof. Lorimer, by Cardinal Manning and Dr. Wace. The chief interest of this section, however, lay in that department in which the proper relation between the teaching and the examining functions of a University were examined by Sir George Young and others. The status of the present University of London was regarded by many speakers as unsatisfactory, notwithstanding the searching and effective character of its examinations, and the stimulating influence which its regulations have had upon the education of students in all parts of the country. A strong wish was expressed by many speakers, that the greatest city in the world should possess a teaching University, rather than a mere examining Board; and that some means should be found of co-ordinating all the higher agencies now at work in the metropolis in such a way as to constitute a London University of a new and nobler type. The duties of the Universities to our Indian Empire were well urged upon the Conference by Prof. Monier Williams; and the whole subject of the relations of the Universities to the education of women was debated in a crowded room and with great animation and interest, *apropos* of a paper by Mrs. Henry Sidgwick, whose own valuable services at Newnham have given her a special claim to speak with authority on such a topic.

The fourth section had a somewhat miscellaneous programme, but may be briefly described as concerned with problems connected with secondary and intermediate education. The first of these problems was the training of teachers, and the best means of securing for secondary schools a supply of teachers, qualified in respect to their knowledge of the theory and practice of their art, not less satisfactorily than the trained and certificated teachers of the elementary schools are, relatively to the humbler work which they have to do. Mr. Quick, Mr. Storr, Professors Laurie and Meiklejohn, and others who have made this a special subject of investigation, were enabled to throw much light on the recent efforts of the Universities to provide instruction in the art and philosophy of teaching, and to give professional certificates to persons qualified to receive them. It was manifest, however, from this discussion, that the one great hindrance in the way of such progress was the practical disbelief among the head-masters in the value of special professional training. Were it once understood that over and above the possession of a good University degree a head-master in search of an assistant would require, or would even *ceteris paribus* prefer that the candidate should show a knowledge of the principles of teaching or the literature of his profession, the arrangements of the Universities for imparting such knowledge would soon produce good fruit. At present, however, the teacher's diplomas issued by the Universities of Cambridge and London appear to possess but little market value in the public schools. It was shown, however, that in girls' schools of the highest class the work of professional training was much more keenly appreciated; and that among the foremost women engaged in the teaching profession, the strongest interest had been taken not only in the proposals of the Universities, but also in the Bishopsgate Training College, the Lectures of the College of Preceptors, and other public measures for ensuring specific instruction in the art and mystery of their craft for the skilled teachers of the future. One of the warmest, and at the same time one of the ablest debates in the Conference concerned the possible future relations of the State to secondary and higher education. Mr. Lyulph Stanley contended strongly for some public provision for the establishment of good secondary schools where they are deficient, and sketched out a plan which had evidently been thought out with some care, for the creation of such schools by means of rates, and for the supervision of such schools by local bodies having the public confidence. Canon Daniel, on the other hand, contended with much ability in favour of absolute freedom for local and religious bodies in the matter of secondary instruction, and against any attempt on the part of the State to initiate or control it. He pointed out, with considerable force, the remarkable success of the Girls' Public Day Schools Company, and remarked on the rapid growth of other agencies of a similar kind for supplying good middle-class schools, and for adapting the supply to the religious, social, and educational wants of different classes of the community.

Perhaps, on the whole, the most striking feature of the Conference, in the eyes of the numerous foreigners who were present and took part in the proceedings, was the remarkable interest evinced in the improved education of women; the variety of new fields now opening to their intelligence, activity, and public usefulness, and the number of ladies who took an active and effective share in the various discussions. Another point of special interest was the international character of the whole Conference, and the warm welcome with which the experience of experts from France, Belgium, Switzerland, Germany, and the United States, was received in all the sections. There has probably never been in the history of education in this country a gathering which afforded such an excellent opportunity for the interchange of opinions and suggestions between English and foreign teachers. And the executive of the Exhibition may well be congratulated on having added to their other successes the completion of a work of pre-eminent and far-reaching usefulness—a Conference which, for the ability of those who took part in it, for the high tone and courtesy of its discussions, and for the fruitfulness of its practical suggestions, has left an enduring and most pleasing impression on all who took part in it.

Among the subsidiary features of the Conference not the least useful were the visits organised by the Committee to some of the more characteristic and important of English schools. The most successful of these visits was that paid to the new buildings of St. Paul's School at West Kensington, which, though not yet occupied by the scholars, is now nearly complete in all its appointments. The party, nearly fifty in number, consisted largely of

foreign teachers from various countries. They were conducted over Mr. Waterhouse's costly and beautiful building by the Clerk of the Works and by a member of the governing body, and evinced much interest in observing all the latest improvements in school construction and fittings, and in inspecting the library, laboratories, lecture-rooms, and the ample appliances for physical training.

It is understood that the results of the Conference, the text of the papers, and a summary of the discussions will shortly appear in four or five volumes.

THE VOYAGE OF THE "VETTOR PISANI"

KNOWING how much NATURE is read by all the naturalists of the world, I send these few lines, which I hope will be of some interest.

The Italian R.N. corvette *Vettor Pisani* left Italy in April 1882 for a voyage round the world with the ordinary commission of a man-of-war. The Minister of Marine, wishing to obtain scientific results, gave orders to form, when possible, a marine zoological collection, and to carry on surveying, deep-sea soundings, and abyssal thermometrical measurements. The officers of the ship received their different scientific charges, and Prof. Dohrn, director of the Zoological Station at Naples, gave to the writer the necessary instructions for collecting and preserving sea animals.

At the end of 1882 the *Vettor Pisani* visited the Straits of Magellan, the Patagonian Channels, and Chonos and Chiloe Islands; we surveyed the Darwin Channel, and following Dr. Cuningham's work (who visited these places on board H.M.S. *Nassau*), we made a numerous collection of sea animals by dredging and fishing along the coasts.

While fishing for a big shark in the Gulf of Panama during the stay of our ship in Taboga Island one day in February, with a dead calm, we saw several great sharks some miles from our anchorage. In a short time several boats with natives went to sea, accompanied by two of the *Vettor Pisani's* boats.

Having wounded one of these animals in the lateral part of the belly, we held him with lines fixed to the spears; he then began to describe a very narrow curve, and irritated by the cries of the people that were in the boats, ran off with a moderate velocity. To the first boat, which held the lines just mentioned, the other boats were fastened, and it was a rather strange emotion to feel ourselves towed by the monster for more than three hours with a velocity that proved to be two miles per hour. One of the boats was filled with water. At last the animal was tired by the great loss of blood, and the boats assembled to haul in the lines and tow the shark on shore.

With much difficulty the nine boats towed the animal alongside the *Vettor Pisani* to have him hoisted on board, but it was impossible on account of his colossal dimensions. But, as it was high water we went towards a sand beach with the animal, and we had him safely stranded at night.

With much care were inspected the mouth, the nostrils, the ears, and all the body, but no parasite was found. The eyes were taken out and prepared for histological study. The set of teeth was all covered by a membrane that surrounded internally the lips; the teeth are very little and almost in a rudimental state. The mouth, instead of opening in the inferior part of the head, as in common sharks, was at the extremity of the head; the jaws having the same bend.

Cutting the animal on one side of the backbone we met (1) a compact layer of white fat 20 centimetres deep; (2) the cartilaginous ribs covered with blood vessels; (3) a stratum of flabby, stringy, white muscle, 60 centimetres high, apparently in adipose degeneracy; (4) the stomach.

By each side of the backbone he had three chamferings, or flutings, that were distinguished by inflected interstices. The colour of the back was brown with yellow spots that became close and small towards the head so as to be like marble spots. The length of the shark was 8·90 m. from the mouth to the *pinna caudalis* extremity, the greatest circumference 6·50 m., and 2·50 m. the main diameter (the outline of the two projections is made for giving other dimensions).

The natives call the species *Tintoreva*, and the most aged of the village had only once before fished such an animal, but smaller. While the animal was on board we saw several *Remora* about a foot long drop from his mouth; it was proved that these fish lived fixed to the palate, and one of them was pulled off and kept in the zoological collection of the ship.

The *Vettor Pisani* has up to the present visited Gibraltar, Cape Verde Islands, Pernambuco, Rio Janeiro, Monte Video, Valparaiso, many ports of Peru, Guayaquil, Panama, Galapagos Islands, and all the collections were up to this sent to the Zoological Station at Naples to be studied by the naturalists. By this time the ship left Callao for Honolulu, Manila, Hong Kong, and, as the *Challenger* had not crossed the Pacific Ocean in these directions, we made several soundings and deep-sea thermometrical measurements from Callao to Honolulu. Soundings are made with a steel wire (Thomson system) and a sounding-rod invented by J. Palumbo, captain of the ship. The thermometer employed is a Negretti and Zambra deep-sea thermometer, improved by Captain Maguaghi (director of the Italian R.N. Hydrographic Office).

With the thermometer wire has always been sent down a tow-net which opens and closes automatically, also invented by Captain Palumbo. This tow-net has brought up some little animals that I think are unknown.

Honolulu, July 1 G. CHIERCHIA

The shark captured by the *Vettor Pisani* in the Gulf of Panama is *Rhinodon typicus*, probably the most gigantic fish in existence. Mr. Swinburne Ward, formerly Commissioner of the Seychelles, has informed me that it attains to a length of 50 feet or more, which statement was afterwards confirmed by Prof. E. P. Wright. Originally described by Sir A. Smith from a single specimen which was killed in the neighbourhood of Cape Town, this species proved to be of not uncommon occurrence in the Seychelle Archipelago, where it is known by the name of "Chagrin." Quite recently Mr. Haly reported the capture of a specimen on the coast of Ceylon. Like other large sharks (*Carcharodon rondeletii*, *Selache maxima*, &c.), Rhinodon has a wide geographical range, and the fact of its occurrence on the Pacific Coast of America, previously indicated by two sources, appears now to be fully established. T. Gill in 1865 described a large shark known in the Gulf of California by the name of "Tiburon ballenas" or whale-shark, as a distinct genus—*Micristodus punctatus*—which, in my opinion, is the same fish. And finally, Prof. W. Nation examined in 1878 a specimen captured at Callao. Of this specimen we possess in the British Museum a portion of the dental plate. The teeth differ in no respect from those of a Seychelles Chagrin; they are conical, sharply pointed, recurved, with the base of attachment swollen. Making no more than due allowance for such variations in the descriptions by different observers, as are unavoidable in accounts of huge creatures examined by some in a fresh, by others in a preserved state, we find the principal characteristics identical in all these accounts, viz. the form of the body, head, and snout, relative measurements, position of mouth, nostrils and eyes, dentition, peculiar ridges on the side of the trunk and tail, coloration, &c. I have only to add that this

shark is stated to be of mild disposition and quite harmless. Indeed, the minute size of its teeth has led to the belief in the Seychelles that it is a herbivorous fish, which, however, is not probable.

ALBERT GÜNTHER

Natural History Museum, July 30

PYROMETERS

THE accurate measurement of very high temperatures is a matter of great importance, especially with regard to metallurgical operations; but it is also one of great difficulty. Until recent years the only methods suggested were to measure the expansion of a given fluid or gas, as in the air pyrometer; or to measure the contraction of a cone of hard, burnt clay, as in the Wedgwood pyrometer. Neither of these systems were at all reliable or satisfactory. Lately, however, other principles have been introduced with considerable success, and the matter is of so much interest not only to the practical manufacturer but also to the physicist, that a sketch of the chief systems now in use will probably be acceptable. He will thus be enabled to select the instrument best suited for the particular purpose he may have in view.

The first real improvement in this direction, as in so many others, is due to the genius of Sir William Siemens. His first attempt was a calorimetric pyrometer, in which a mass of copper at the temperature required to be known is thrown into the water of a calorimeter, and the heat it has absorbed thus determined. This method, however, is not very reliable, and was superseded by his well-known electric pyrometer. This rests on the principle that the electric resistance of metal conductors increases with the temperature. In the case of platinum, the metal chosen for the purpose, this increase up to 1500° C. is very nearly in the exact proportion of the rise of temperature. The principle is applied in the following manner:—A cylinder of fireclay slides in a metal tube, and has two platinum wires 1ooth of an inch in diameter wound round it in separate grooves. Their ends are connected at the top to two conductors, which pass down inside the tube and end in a fireclay plug at the bottom. The other ends of the wires are connected with a small platinum coil, which is kept at a constant resistance. A third conductor starting from the top of the tube passes down through it and comes out at the face of the metal plug. The tube is inserted in the medium whose temperature is to be found, and the electric resistance of the coil is measured by a differential voltameter. From this it is easy to deduce the temperature to which the platinum has been raised. This pyrometer is probably the most widely used at the present time.

Tremeschini's pyrometer is based on a different principle, viz. on the expansion of a thin plate of platinum, which is heated by a mass of metal previously raised to the temperature of the medium. The exact arrangements are difficult to describe without the aid of drawings, but the result is to measure the difference of temperature between the medium to be tested and the atmosphere at the position of the instrument. The whole apparatus is simple, compact, and easy to manage, and its indications appear to be correct at least up to 800° C.

The Trampler pyrometer is based upon the difference in the coefficients of dilatation for iron and graphite, that of the latter being about two-thirds that of the former. There is an iron tube containing a stick of hard graphite. This is placed in the medium to be examined, and both lengthen under the heat, but the iron the most of the two. At the top of the stick of graphite is a metal cap carrying a knife-edge, on which rests a bent lever pressed down upon it by a light spring. A fine chain attached to the long arm of this lever is wound upon a small pulley; a larger pulley on the same axis has wound upon it a second chain, which actuates a third pulley on the axis of the indicating needle. In this way the relative dilatation of the graphite is sufficiently magnified to be easily visible.

A somewhat similar instrument is the Gauntlett pyrometer, which is largely used in the north of England. Here the instrument is partly of iron, partly of fireclay, and the difference in the expansion of the two materials is caused to act by a system of springs upon a needle revolving upon a dial.

The Ducomet pyrometer is on a very different principle, and only applicable to rough determinations. It consists of a series of rings made of alloys which have slightly different melting-points. These are strung upon a rod, which is pushed into the medium to be measured, and are pressed together by a spiral spring. As soon as any one of the rings begins to soften under the heat, it is squeezed together by the pressure, and, as it melts, it is completely squeezed out and disappears. The rod is then made to rise by the thickness of the melted ring, and a simple apparatus shows at any moment the number of rings which have melted, and therefore the temperature which has been attained. This instrument cannot be used to follow variations of temperature, but indicates clearly the moment when a particular temperature is attained. It is of course entirely dependent on the accuracy with which the melting-points of the various alloys have been fixed.

Yet another principle is involved in the instrument called the Thalpotasimeter, which may be used either with ether, water, or mercury. It is based on the principle that the pressure of any saturated vapour corresponds to its temperature. The instrument consists of a tube of metal partly filled with liquid, which is exposed to the medium which is to be measured. A metallic pressure gauge is connected with the tube, and indicates the pressure existing within it at any moment. By graduating the face of the gauge when the instrument is at known temperatures, the temperature can be read off directly from the position of the needle. From 100° to 220° F. ether is the liquid used, from thence to 680° it is water, and above the latter temperature mercury is employed.

Another class of pyrometers having great promise in the future is based on what may be called the "water-current" principle. Here the temperature is determined by noting the amount of heat communicated to a known current of water circulating in the medium to be observed. The idea, which was due to M. de Saintignon, has been carried out in its most improved form by M. Boulier. Here the pyrometer itself consists of a set of tubes one inside the other, and all inclosed for safety in a large tube of fireclay. The central tube or pipe brings in the water from a tank above, where it is maintained at a constant level. The water descends to the bottom of the instrument and opens into the end of another small tube called the explorer (*explorateur*). This tube projects from the fireclay casing into the medium to be examined, and can be pushed in or out as required. After circulating through this tube the water rises again in the annular space between the central pipe and the second pipe. The similar space between the second pipe and the third pipe is always filled by another and much larger current of water which keeps the interior cool. The result is that no loss of heat is possible in the instrument, and the water in the central tube merely takes up just so much heat as is conducted into it through the metal of the explorer. This heat it brings back through a short indiarubber pipe to a casing containing a thermometer. This thermometer is immersed in the returning current of water and records its temperature. It is graduated by immersing the instrument in known and constant temperatures, and thus the graduations on the thermometer give at once the temperature, not of the current of water, but of the medium from which it has received its heat.

In order to render the instrument perfectly reliable, all that is necessary is that the current of water should be always perfectly uniform, and this is easily attained by fixing the size of the outlet once for all, and also the level of water in the tank. So arranged, the pyrometer works with great regularity, indicating the least variations of temperature, requiring no sort of attention, and never suffering injury under the most intense heat; in fact the tube, when withdrawn from the furnace, is found to be merely warm. If there is any risk of the instrument getting broken from fall of materials or other causes it may be fitted with an ingenious self-acting apparatus shutting off the supply. For this purpose the water which has passed the thermometer is made to fall into a funnel hung on the longer arm of a balanced lever. With an ordinary flow the water stands at a certain height in the funnel, and, while this is so, the lever remains balanced; but if from any accident the flow is diminished, the level of the water in the funnel descends, the other arm of the lever falls, and in doing so releases two springs, one of which in flying up rings a bell, and the other by detaching a counterweight closes a cock and stops the supply of water altogether.

It will be seen that these instruments are not adapted for shifting about from place to place in order to observe different temperatures, but rather for following the variations of temperature at one and the same place. For many purposes this is of great importance. They have been used with great success in porcelain furnaces, both at the famous manufactories at Sèvres and at another porcelain works in Limoges. From both these establishments very favourable reports as to their working have been received.

W. R. BROWNE

THE AGRICULTURAL INSTITUTE OF BEAUVAIS

WE have already referred to the interesting collection exhibited in the Technical School at the Health Exhibition by the Brothers of the Christian Schools. One of the most instructive of their specimen museums is that from their Agricultural Institute at Beauvais.

This Institute was founded in 1855, the late Prince Consort being one of its first patrons. Recently the Agronomical Society of France have extended to it an encouraging hand.

Candidates for admission to the school must be at least sixteen years of age, and must give evidence, either by certificates obtained or by a preliminary examination, of their having successfully studied the recognised branches of a good modern education. The course of instruction extends over a period of three years, and is intended to prepare young men to manage and develop estates and direct all farming operations. Special provision is made, in the third year, for those who wish to qualify themselves for agricultural professorships. The syllabus of subjects is framed by a Board appointed by the prefect of the *département*, and consists of the Director and Professors of the Institute, of the Professor of Agriculture, and the Veterinary Surgeon of the *département*, as also of three other members.

The subjects for the first year are: French language, book-keeping and commercial subjects, elementary algebra and geometry, the fundamental principles of agriculture, rural law and engineering, general zoology, arboriculture, horticulture, physics, chemistry, and linear drawing.

In the second year the students follow more advanced courses of agriculture, zoology, botany, entomology, geology, surveying, levelling, physics, general and analytical chemistry, rural law and engineering, linear drawing, arboriculture, and horticulture.

The instruction for the last year comprises agriculture, arboriculture, horticulture, analytical chemistry, botany, geology, entomology, applied mathematics and mechanics, and architectural drawing.

Science teaching, to be of any use, must be practical; the authorities of the Agricultural Institute, fully convinced of this, attach great importance to laboratory and field work. In the physical laboratory, the work is exclusively of a demonstrational kind, the students not being required to test the accuracy of their knowledge or their familiarity with instruments by the actual and precise measurement of physical constants. Nor do such measurements appear necessary for the object in view. It is, of course, quite different with chemistry, where skill in quantitative analysis is of the highest value to any one who intends to direct the agricultural interests of a district. The students are consequently trained with much care in those branches of analytical chemistry which bear directly upon the science of agriculture. The study of botany, geology, and entomology is encouraged and stimulated by frequent excursions to the neighbouring country, the specimens brought back being compared, classified, and minutely described in appropriate language.

The school has also a model farm of 325 acres, in which the principal operations of farming are extensively carried on. The students visit this farm at stated hours every week; they are familiarised with the chief implements and agricultural appliances, and are required to take part in all the regular work that may be going on.

The Professors have set aside a number of acres for experimenting upon the conditions most favourable to the growth of the principal cereals. These comparative studies are carried out with the assistance of the students mainly for the purpose of showing them how to practically initiate a scientific investigation of an agricultural nature. The results of these studies are fully described in the *Annales de l'Institut agricole*, a yearly publication of considerable merit. A valuable synopsis of the results obtained by the Director of the School, Brother Eugene, will be found in the Educational Section of the International Health Exhibition, Room 5.

From a recent report, we find that there have been, this year, under cultivation no less than sixty-five kinds of wheat, twenty of oats, ten of barley, eight of rye, besides fields of potatoes, beetroot, cabbage, &c. There are also pasture lands for sheep and cows, and a well-stocked poultry yard.

At the end of each year the students are put through a practical examination, when they are expected to give satisfactory evidence of their competency to deal with the general working of the farm. It is also required by the programme of the Institute that the students shall visit exhibitions of an agricultural character which may be held in the vicinity, and attend with their Professors certain markets and sales of live stock.

The attention of the students is maintained and quickened by requiring them to write, with considerable care, notes of all their courses, as well as detailed reports of what they may have seen in their visits or met with in their excursions. Several volumes of these reports, notes, and theses, together with typical herbaria, specimens of grain and seeds, may be seen in the Exhibition, Room 5.

Besides superintending the museum and giving instruction in the laboratories, the Brothers teach drawing, physics, chemistry, botany, geology, zoology, &c., leaving such subjects as rural jurisprudence and engineering, agriculture, and the like to other eminent professors.

IS SALPA AN EXAMPLE OF ALTERNATION OF GENERATIONS?

THE chances against the accidental discovery of a great natural law are so great that we cannot feel surprise that naturalists are slow to believe that Salpa,

the animal in which Chamisso discovered alternation of generations, is not an example of alternation.

The historical associations which render the life-history of Salpa so interesting to the naturalist have induced me to restate briefly my reasons for believing that the solitary Salpa is a female and the chain Salpa a male; since a recent contributor to NATURE ("Recent Morphological Speculations," by R. N. G., in NATURE, May 15, p. 67) rejects my observations for reasons which a little examination will show to be inconclusive.

The author characterises my opinion as "Brooks' theory," but it is neither a theory, nor was I the first to describe the phenomenon in question. Embryological observations by Kowalevsky must be received by all

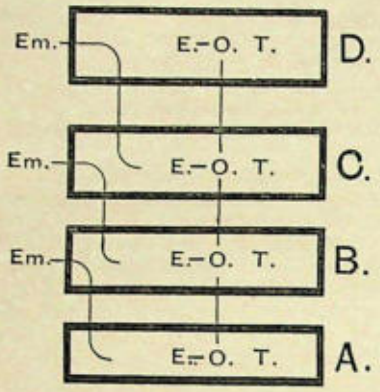


Fig. 1

naturalists with the greatest respect, and I therefore call the attention of R. N. G. to the fact that this great observer published, while my first paper was in the press, the following account of the life-history of Salpa (see *Arch. f. Mik. Anat.* xi. 604):—"Bei den Salpen giebt es bekanntlich zwei Generationen, in der einen entwickelt sich der aus vielen eikeimen bestehende Eierstock, welcher in den Stolo hineingeht, und sich hier zu je einem Eie vertheilt, sodann die einzelnen Knospen resp. Kettensalpen in welchen weiter aus diesem Eie ein Embryo entsteht, wieder mit einem aus mehreren Eikeimen bestehende Eierstock."

No one will question the statement that the animal in whose body an ovum is produced is the mother of the

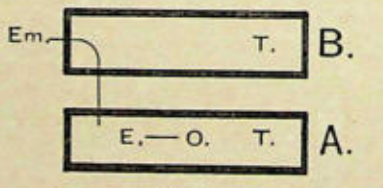


Fig. 2

embryo to which this ovum gives rise, and if the egg which is fertilised in the body of the chain Salpa is developed, as Kowalevsky and I have stated, in the body of the solitary Salpa, the latter is certainly a female, and as no one has ever observed the production by a chain Salpa of more than one embryo, either from an egg or by budding, there is no true alternation of generations.

This view is in no sense a "morphological speculation," nor should it be spoken of as "Brooks' theory." It is either an observed fact or an erroneous statement, and its untruth can be proved only by observation.

R. N. G. lays much stress upon the life-history of Pyrosoma, a closely related but less modified form, and regards it as an "indirect negation" of my statement that the solitary Salpa is a female, and the chain Salpa a male. Our knowledge of Pyrosoma and of other Tunicates certainly leads us to believe that Salpa is the descendant of a hermaphrodite ancestor, but it proves nothing more.

The fact that nearly all the Arthropods are bisexual does not disprove the hermaphroditism of Balanus. It simply shows that Balanus is the modified descendant of bisexual ancestors.

While the life-history of Pyrosoma cannot be quoted to disprove the statement that the solitary Salpa has an ovary, it can help us to understand the way in which the present life-history of Salpa has been acquired, and thus show that my own view is not very anomalous after all.

As the phenomena are very complex, I have attempted to exhibit the leading features by diagrams, and Fig. 1 shows the points of greatest importance in the life-history of Pyrosoma.

The egg gives rise, by a process which does not here concern us, to several sexual animals, one of which is represented by A in Fig. 1. It has a testis, T, and an ovary, O, which consists in part of "generative blastema," and, in part, of ova in various stages of growth. It is, therefore, a hermaphrodite. One of the ova, E, is very much larger than any of the others. This hermaphrodite,

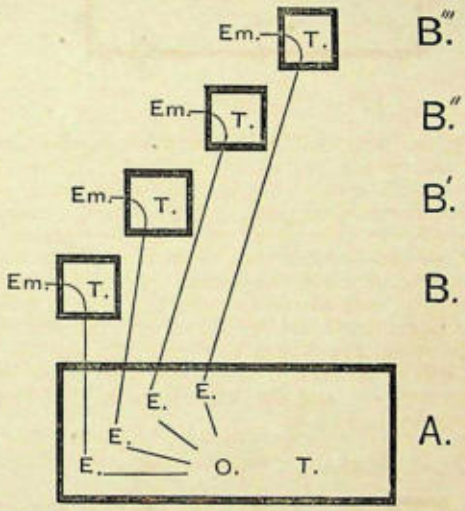


Fig. 3

A, produces a second, B, by budding, and during this process part of the "generative blastema" from the ovary of A passes into the body of B, and forms its ovary, O, which here produces one fully developed ovum, E, and a number of small ones. As B has a testis, T, it is a hermaphrodite like A.

The single mature ovum, E, of A, also passes into the body of B, where it is fertilised and gives rise to an embryo, EM, which undergoes development within, and finally escapes from, the body of B, although A is its mother, because the egg which has produced it was formed in the ovary of A before the body of B was formed by budding.

B then gives rise by budding to C, and the single mature egg of B passes into the body of C, where it is fertilised, and gives rise to an embryo.

Part of the "generative blastema" of B's ovary passes into the body of the bud C, and becomes an ovary, O, which again gives rise to one mature ovum, E; and C produces another bud, D, and discharges into it one ripe ovum and part of the ovary in the same way, and so on indefinitely. As C and D have testes like A and B, they are all hermaphrodite.

After the bud B has become independent of A, another ovum is matured in A's ovary, another hermaphrodite bud

is produced, and so on indefinitely, and each hermaphrodite bud produces in succession an indefinite series of similar buds.

Now let us imagine a limit to this indefinite series of buds, and examine its effect.

Suppose that, while B retains its power to produce in succession an indefinite series of C's, the C's lose this power. As the function of the ovary of C is to provide the "generative blastema" for the ovaries of the series of D's, and to mature the eggs E, which are to be fertilised and developed within the bodies of the D's, it is plain that with the loss by the C's of the power to reproduce by

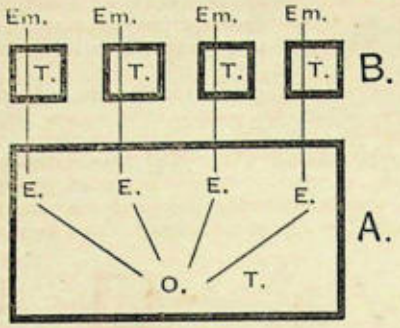


Fig. 4

budding, the ovary will be left without function, and we should therefore expect it to disappear. C would then become simply a male, but it would while young contain a single unfertilised egg, EM, derived from the ovary of B.

If the power to bud were lost by the first generation of buds, B, we should have the condition of things which is shown in Fig. 2, where the hermaphrodite A produces a male bud, B, and discharges the egg E into its body, there to be fertilised and developed into the embryo EM. A has, however, the power to repeat this process indefinitely, and to produce in succession a series of buds of the generation B, and the life-history is therefore now exactly shown in Fig. 3.

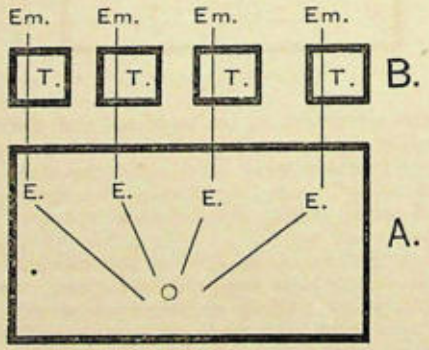


Fig. 5

Now suppose that, instead of appearing in succession, a number of buds of the generation B are formed at the same time, we shall then have the phenomena shown in Fig. 4, where a number of eggs, E, E, E, E, are matured simultaneously in the ovary, O, of the hermaphrodite A, and are discharged while still unfertilised into the bodies of the male buds, B, B, B, B, there to give rise to the embryos, EM, EM, EM, EM.

This is very nearly what we have in Salpa, where very many chain Salpæ are produced at one time. As these have no power to reproduce by budding, they have lost their ovaries, although each of them, when it is born, contains, like the buds of Pyrosoma, a single unfertilised egg, derived, according to my observations and those of Kowalevsky, and according to the analogy of Pyrosoma, from the ovary of the solitary Salpa A, Fig. 5.

The solitary Salpa is therefore a true female, and as it has lost the testis which, according to the analogy of Pyrosoma, its ancestors must have possessed, it is a true female and not a hermaphrodite.

We therefore have in place of the indefinite series of hermaphrodite buds of Pyrosoma, a single generation of male buds, each of which receives, like the buds of Pyrosoma, a single mature ovum from the ovary of its gemmiparous ancestor.

While the series of stages which are here described may not correspond exactly to the actual phylogeny of Salpa, it certainly shows that our knowledge of Pyrosoma cannot be quoted as an "indirect negation" of my view; for it shows that the analogy of Pyrosoma would lead us to look to the ovary of the solitary Salpa for the origin of the egg which is fertilised and developed within the body of the chain Salpa.

All observers agree that the so-called "ovary" of the chain Salpa consists of a single egg, which is fertilised while the animal which carries it is very young and almost embryonic, and all agree that normally no more eggs are produced by the chain Salpa. A "rudiment of an ovary, which only consists of one fully developed ovum", is certainly not an *ovary* at all, but an *ovum*, for the origin of which we must search elsewhere, and Kowalevsky's observation as well as my own show that it originates in the ovary of the solitary Salpa.

As all observers agree that the chain Salpa has a testis, and that it normally contains only one egg, it is certainly a male; and as all observers agree that the solitary Salpa has no testis, while Kowalevsky and I agree that it has an ovary, we must regard it as a female, and we therefore have, instead of an instance of alternation, a very remarkable example of sexual difference.

There seems to be only one way to escape this conclusion;—that is, by denying that the structure which Kowalevsky and I have described as an ovary is an ovary at all.

Salensky is an advocate of this view, and claims that my so-called ovary is simply a mass of embryonic cells destined to give rise to the branchial sacs, as well as the ovaries of the chain Salpæ, but I have shown in a recent paper in the *Zoologischer Anzeiger* that the branchial sacs of the chain Salpa originate from quite a different part of the stolon, and that the ovary contains cells which are in no sense embryonic or unspecialised, since they have all the characteristics of ova. In a paper which is now ready for publication, I shall give photographs of sections which prove this point beyond question.

R. N. G. gives, as another reason for rejecting my view, the fact that Salensky has found a second ovary in a chain Salpa.

This is clearly exceptional, for all observers agree that no such second ovary normally occurs, nor has Salensky given conclusive proof that the cells which he observed were ova at all, as he has not observed their development. Out of many thousand sections which I have examined, I have found three chain Salpæ which had received two ova from the ovary of the solitary Salpa instead of one, and if Salpa is descended from a form like Pyrosoma, it is quite possible that a chain Salpa may occasionally receive with its ovum part of the ovary, and that this may give rise to other ova, but the discovery of such an abnormal Salpa would not prove that the normal chain Salpa is hermaphrodite, even if it could be shown that these eggs completed their development and became embryos.

In conclusion, I wish to point out to R. N. G. that, inasmuch as the writer who attempts to generalise from the observed phenomena of science for the benefit of the public should use every precaution to insure accuracy in

the statement of facts, he will do well to examine his authority for his statements that I have called the *solitary* Salpa a *nurse;* that I have described a Cunina in which the "hydroid produces medusæ by gemmation;" and that I believe "that the solitary Salpa is hermaphrodite."

Baltimore, July 14 W. K. BROOKS

COLONIAL AND FOREIGN REPORTS

THE annual reports of colonial botanical gardens, Government plantations, museums, &c., form at the present day no inconsiderable item of the literature of scientific progress in different parts of the world which constantly crowd an editor's table. These records become, year after year, of increasing importance as well as of increasing bulk, and it is right that their contents should be better known, so that they may become useful, and this can only be done by a wide distribution of the reports themselves, and attention drawn to them by other publications.

Taking a few of these reports, which have recently come to hand, in the order of their issue, we first find one from Wellington, New Zealand, under the following title, "Eighteenth Annual Report on the Colonial Museum and Laboratory," together with the "Fourteenth Annual Report on the Colonial Botanic Garden, 1882-83." This Report treats of various branches of science, and, as might be expected, geology has its full share. In the observatory the principal work is said to have been the observation of the transit of Venus, Dr. Hector's account of his observation, which, he says, was written out within an hour after the transit, being given as an appendix. Under the head of Botanic Garden, after describing some successful experiments in planting wattles (species of *Acacia*), Dr. Hector refers to experiments in the cultivation of *Sorghum*, which, however, are said not to have been continued in the garden, but in the northern part of the colony, the results were very favourable, proving that quite as large a percentage of crystallisable sugar can be obtained in New Zealand as in America. "Recent improvements," it is said, "have been made in the machinery, and by the use of a vacuum evaporating pan all the causes of the former miscarriage in the production of the sugar appear to have been removed, so that there is every prospect of the growth of the *Sorghum* becoming an important industry in the north of New Zealand." A most interesting and important feature of the year is said to be the sudden expansion of the cultivation of hops in the colony. In Nelson it is shown that the cultivation has been most successful, and in the neighbourhood of Wellington the hop also grows well. The plants are subject more or less to attacks from the red spider and what is known as the plant louse, but they have not yet committed any great damage.

Mr. Morris's "Annual Report of the Public Gardens and Plantations for the year ended September 30, 1883," shows that the usual operations of the department have been fully maintained, while the "chief scientific work of the year has been connected with the collection and determination of numerous native plants of the island which have been added to the Department Herbarium, and the large addition of others to the growing collections." Referring to the attacks by insects on the sugar cane, Mr. Morris points out that the spasmodic or intermittent character of the attack is in accordance with their general habit in all parts of the world; "but," he says, "it is well for us to note their appearance and disappearance with great care, in order that we may thereby be prepared for their attacks, and reduce the amount of damage they do to our crops to a minimum."

The indiscriminate destruction of small birds in the island has attracted some attention, and measures have been suggested whereby it may be checked or perhaps stopped.

The mungoose, which has been imported from India to destroy rats on sugar estates, is stated to be increasing very rapidly, not only on sugar estates, but on the highest mountains along the shore, and even amidst swamps and lagoons. The sugar planters have greatly benefited by its introduction, rat-eaten canes being now scarcely known. The negro settlers and persons not connected with sugar estates complain of its ravages amongst their poultry, fruit, and vegetables. Mr. Morris says, however, that poultry is still fairly plentiful in country districts, and from his experience of the mungoose in confinement, the creature is not likely to eat either sugar cane, banana, or field vegetables, except under the influence of extreme hunger, which would not occur so long as there are rats, mice, lizards, and other small animals to feed on. "The mungoose is, however," Mr. Morris says, "disturbing greatly the distribution of animal life in the island; and the harmless yellow and other snakes, lizards, ground-hatching birds, the interesting cony, and many members of our indigenous fauna, are likely to become extinct at no distant period."

Under the head of cultivation and distribution of economic plants Mr. Morris reports progress in many new products. It is not encouraging, however, to find that the cultivation of ginger in Jamaica appears to be dying out, due "to the smaller yield of plants cultivated so persistently on the same land, to the uncertain nature of the crop, no less than the difficulty experienced in many districts in curing it properly." Jamaica ginger has hitherto held a prominent position in the market as to quality, and it is a pity that its reputation should become a thing of the past.

The next report before us is that of Dr. Schomburgk, and treats of the "Progress and condition of the Botanic Garden and Government plantations" at Adelaide, South Australia. A similar work seems to be going on here as at most other colonial gardens at the present time, namely, the distribution of native, and the acclimatisation of foreign plants, chiefly of economic value. The Gardens seem to be very popular, as well as the Museum of Economic Botany, which is a comparatively new institution to Adelaide. Two appendices are added to Dr. Schomburgk's report, one consisting of a "Catalogue of Plants added during 1883 to those under cultivation in the Botanic Garden," arranged according to their natural orders, and the other a "List of Palmæ, Bromeliaceæ, Filices, and Lycopodiaceæ, cultivated in the Botanic Garden." The report is illustrated by eight views in the Gardens.

A Report of the Committee of Management for 1883 of the Technological Industrial and Sanitary Museum of New South Wales shows that a great deal of progress has been made in extending the utility of the Museum during the year. The Museum, which seems to have been opened so recently as December last, bids fair to become of very great service to the colony. One paragraph in the Report says, "Special endeavours are being made to collect the raw products and samples illustrative of the industries and manufactures of the Australian colonies, and the Committee have already secured a considerable number of native vegetable and mineral products and a comprehensive series of specimens of wool."

The "Annual Report of the Royal Botanic Garden, Calcutta, for the year 1883-84," and that of the Government Cinchona Plantations in Bengal for the same period, are, as usual, very creditable to Dr. King as superintendent. Dr. King's reports are always concise and interesting records of admirable work both at the Botanic Garden and at the cinchona plantations, and those before us show that in the former a good deal of consideration has been paid during the year to the extension of plants of real commercial value, such, for instance, as paper materials, including the sabai grass (*Pollinia eriopoda*, Hance). and the

paper mulberry (*Broussonetia papyrifera*, Vent), also fibrous plants, including the Rhea, or China grass (*Boehmeria nivea*, W. and A.). Much progress has been made in arranging the specimens in the new building which has been providedf or the herbarium, and numerous contributions have been received both to the herbarium and to the gardens. In the Report on the cinchona plantations Dr. King gives details of the year's crop, of the expenditure for the year, and of the progress of the several forms or varieties. At the factory the total out-turns for the year was 8714 lbs. of febrifuge, 250 lbs. of which were of the new crystalline preparation, which closely resembles the ordinary febrifuge, but, on examination, the grains are seen to be small crystals; it differs, however, in constitution from the old febrifuge, inasmuch as it contains none of the amorphous alkaloid which is the ingredient in that preparation which causes the nausea which sometimes follows its administration. The efficiency of the staff both in the Calcutta Gardens and at the cinchona plantations is indicated by the testimony which Dr. King, with his usual frankness and consideration, bears to the ability of his subordinates.

From the Botanic Garden, Hong Kong, Mr. Charles Ford, the Superintendent of the Botanical and Afforestation Department, reports, under date April 30, 1884, of the department under his charge. A good many plants both of commercial and horticultural interest have been grown with more or less success, including the carob tree (*Ceratonia Siliqua*) of Southern Europe, the Chinese tea oil tree (*Camellia drupifera*), the Chinese varnish tree (*Aleurites vernicia*), and many others. A very interesting account of a visit to the Lo-fau-shan Mountains and a list of the plants collected is given in this Report.

NOTES

HER MAJESTY'S GOVERNMENT, on the recommendation of the Lords of the Committee of Council on Education, have given their adhesion to the International Geodetic Association, and have nominated the undermentioned gentlemen as delegates of the United Kingdom to the Association, viz.:—The Director-General of the Ordnance Survey (for the time being), Col. A. R. Clarke, R.E., F.R.S., the Astronomer-Royal, the Hydrographer of the Navy (for the time being), General J. T. Walker, R.E., C.B., F.R.S.

Two academic honours have recently, *Science* states, been conferred in the United States upon scientific men, which are worthy of note because more rare and costly than such distinctions usually are. At New Haven, on the day before commencement, a bronze statue of Prof. Silliman, for more than fifty years a teacher of chemistry, mineralogy, and geology in Yale College, and the founder of the *American Journal of Science and Arts*, was placed on its pedestal near the new chapel. The other honour is that of a medal struck at the U.S. Mint in Philadelphia, at the request of the colleagues and friends of Prof. Sylvester, to commemorate his residence in Baltimore during a period of seven years, marked, among other things, by the establishment of the *American Journal of Mathematics*. The medal, in size and general aspect, is not unlike that which was struck in commemoration of the life of Agassiz. On one side is an accurate and spirited portrait of the mathematician, with the name Sylvester; on the reverse a Latin inscription commemorates the fact that he was for seven years Professor of Mathematics in the Johns Hopkins University—from 1876 to 1883. The original medal in gold was sent to Prof. Sylvester, in his new home in the University of Oxford; a duplicate in silver was retained in Baltimore, and a few impressions in bronze have been distributed among his scientific friends and correspondents.

Science, in referring to the recent researches of Koch, states that work of value upon the subject of micro-organisms is not done in this country (the United States), nor will it be until some such encouragement is offered to investigators as is the case in France and Germany. This kind of research requires the rare combination of many forms of training, added to a critical, analytical, and judicial mind. These we can have; but until the facilities for the work are offered, until the necessity for personal sacrifice and self-denial is done away with, we can hope for no better work in the future than has been done in the past; in other words, what is first needed in order to place our own investigations upon an equality with those of the two countries mentioned above, is a thoroughly-equipped, fully-endowed laboratory, with a strong corps of well-trained and salaried officials. These remarks might very well have been written concerning our own country, and the official mission of Dr. Klein to India is a tardy recognition by our Government of the necessity of State intervention if scientific research is to be pursued with any hope of speedy and substantial practical results. The true way to encourage such inquiries (*Science* truly says) lies in the establishment of a Commission composed of men thoroughly trained and qualified for the work, and then to treat it as the German Government has treated its Cholera Commission, that is, to give it full powers and funds to allow the prosecution of its labours to the end.

THE death is announced at the age of seventy-five years of Sir Erasmus Wilson, the eminent surgeon.

THE death is also announced of Mr. John Aitken, J.P., of Urmston, well known as a geologist in the northern counties. Deceased was born in 1820. He was early distinguished for his application to scientific matters, and he twice filled the office of President of the Manchester Geological Society. He wrote for the Society's papers a number of articles relating chiefly to the geology of Clitheroe, Bacup, and Holcombe, and he also contributed to the *Geological Magazine* and the *American Journal of Science*. He furnished for Newbiggin's "History of the Forest of Rossendale" the geological section relating to that district.

SIR JOHN LUBBOCK has been compelled, for personal reasons, to abandon his intention of attending the meeting of the British Association at Montreal.

A COMMITTEE was appointed in 1882 at the Montreal meeting of the American Association for the Advancement of Science, "to confer with committees of foreign associations for the advancement of science with reference to an international convention of scientific associations." The committee consists of Dr. T. Sterry Hunt, Mr. Alexander Agassiz, and Prof. Simon Newcomb. If the British Association responds, as has been suggested, by also appointing a committee, the official channels for the interchange of opinion between the two national bodies will be suitably established on both sides. We (*Science*) are unable to make any authorised statement as to what the American committee has done or proposes, but its membership justifies the conviction that it is capable of efficient action, wisely planned. We shall await their report with interest.

THE Committee appointed by the Government at M. Pasteur's request to verify his experiments in the treatment of hydrophobia has just presented its first report. M. Bouley is president, his colleagues being MM. Beclard, Paul Bert, Tisserand, Villemin, and Vulpian. The Committee states that M. Pasteur's experiments have been entirely borne out. Inoculation with the attenuated virus of hydrophobia gives a dog immunity from the disease, just as similar treatment preserves a sheep from *charbon*. All the twenty-three dogs submitted by M. Pasteur as having been thus inoculated have resisted the strongest virus on inoculation, whereas the majority of the nineteen non-inoculated dogs have suc-

cumbed. Of the latter, six were bitten by mad dogs, three of them becoming mad, eight were subjected to intra-venous inoculation, all becoming mad, and five to inoculation by trepanning, all becoming mad. The result is decisive; but the Committee will now inoculate a large number of fresh dogs, and will compare these with an equal number of dogs not inoculated. It will likewise investigate the question whether after a dog has been bitten inoculation with the attenuated virus will prevent any consequences from the bite. M. Pasteur will lay before the International Health Congress at Copenhagen results which, as the Committee remarks, "are so honourable for French science, and give it a fresh claim on the gratitude of mankind."

A CORRESPONDENT living about two hundred yards from the river at West Chelsea complains that mosquitos first appeared sparingly in the middle of July, but are now almost nightly visitors. There is too much reason to fear, he states, that they are thoroughly acclimatised in this part.—Mosquitos and gnats are synonymous terms. Whenever the heat is greater than usual we constantly receive notices similar to the above. Possibly it renders the gnats more vicious, and at the same time the object of their attacks more irritable. Gnats (mosquitos) inhabit water (not sea-water) in their early stages, and from this reason it is practically impossible to import them, unless intentionally. The conditions at West Chelsea at the present moment are particularly favourable to the welfare of gnats (see article "Mosquito" in the new edition of the "Encyclopædia Britannica").

THE eighth International Medical Congress, of which the King of Denmark has consented to be the patron, was opened on Sunday in the Grand Hall of National Industry, Copenhagen, in the presence of the King and Queen of Denmark, the King and Queen of the Hellenes, the Crown Prince and Crown Princess of Denmark, and the rest of the Royal Family, the Danish Ministers, the Corps Diplomatique, the official authorities, civil and military, and delegates from Great Britain and Ireland, Germany, France, Russia, Austria, Holland, Belgium, Greece, Switzerland, Japan, New York, Columbia, Kentucky, and California. Addresses were delivered by the President, Prof. Panum, the Secretary, Dr. Lange, Sir James Paget, Prof. Virchow, and Prof. Pasteur. The assembly consisted of about 1500 members.

EARTHQUAKES have been frequent and widespread during the past few days. The inhabitants of the towns and villages along the whole range of the Alban hills were alarmed at two a.m. on August 7 by a sharp shock of earthquake, followed by another at a quarter past three. The direction taken by the wave was through Velletri, Nemi, Ariccia, Albano, Castel Gandolfo, and Rocca di Papa and Frascati. The shocks were most severely felt at Rocca di Papa, but no damage was done beyond the felling of two chimneys at Ariccia. At half-past three a severe shock, quickly followed by another, was distinctly felt at Rome, and that which shook the Alban hills extended also as far as Porto d'Anzio, on the coast.

AN earthquake shock shook the most solid buildings in New York at two o'clock on Sunday afternoon, and produced a sensation like that on board a steamer under way. At Brooklyn the residents were frightened into running out of their houses. The earthquake suddenly moved along the Alleghany Mountains and their eastern slopes, from Virginia to Vermont, in a direction from south-west towards north-east, extending over the entire country from the mountains to the ocean. The most southerly city in which the shocks were noticed was Washington, and the most northerly Brattleborough, Vermont. Two distinct shocks, each of about two seconds' duration, with an interval of about four seconds, were generally felt, while in New York and further eastwards a slight third shock was experienced a few minutes afterwards. The earthquake was observed at nine minutes past two o'clock in the afternoon at Philadelphia, and somewhat later to the eastward of this city. It was most severe in New York City, Connecticut, and Boston. The vibration was slighter elsewhere.

SLIGHT earthquake shocks, recurring at short intervals, have recently been felt at Massowah.

PROF. MILNE, of Tokio, Japan, writing to the *Times* on the subject of the Essex earthquake, concludes as follows:—"Before earth movements can be generally understood, it is necessary that they should be observed as other natural phenomena are observed. A reason that has been expressed against the establishment of seismometers in British observatories is that in Britain earthquakes are a rare occurrence. Such a reason appears to arise from an imperfect acquaintance with the phenomena to be observed. Earth-tremors, which are minute earthquakes, may be observed in Britain every day. Messrs. George and Horace Darwin have shown that such movements are of common occurrence in Cambridge. Then there are the slow earthquakes or earth-pulsations, like those which I have from time to time observed in Tokio. Whether these exist in Britain cannot be known until they are sought for. That they existed on the outer rim of the area where the Essex earthquake was felt is tolerably certain. It is also certain that shortly after great earthquakes—as, for instance, some which have shaken South America—pulse-like motions have been observed in the bubbles of astronomical levels at places as distant as St. Petersburg. When we consider that we are observing meteorological changes with which earth-tremors have a close relationship, that we observe the tides, magnetic and electric changes in our earth and the escape of gas in our mines, with all of which earth movements may be closely associated, when we possess so many earthquake-shaken colonies, and send our Navy and mercantile marine to all the earthquake countries of the world, it would certainly not be an unreasonable undertaking for us to investigate the ill-understood phenomena which continually occur beneath our feet. We study our oceans, our atmosphere, the sky above us, and, I may add, the ice at our poles, while the changes in the earth on which we live are almost neglected."

MESSRS. COTTEAU AND KORTHALS, members of the French Mission sent by the Minister of Public Instruction to explore the Krakatoa volcano, write from Batavia on June 2 that the object of the expedition has been fully realised. Soon after their arrival at Batavia on May 14, the Dutch Colonial Government placed at their disposal a small steamer, on board of which they started for the Sunda Strait on the 21st. Along the west coast a well-marked line, running at an elevation of from fifty to eighty feet above sea-level, indicated the limit reached by the terrible wave that spread disaster far and wide towards the end of August 1883. The plantations had been swept away, and all the houses of this populous district, together with the town of Anjer, had completely disappeared. On the 23rd the steamer cast anchor at the head of Lampong Bay on the south coast of Sumatra, whence a visit was paid to the Telok-Betong district. Here the extensive and thickly-settled coastlands had assumed the aspect of a desolate swamp, relieved here and there by a few bamboo huts recently set up. Nearly three miles inland lay the steamer *Berouw*, which had been borne on the crest of the wave into the forest, where it now forms a sort of bridge across a small stream. On the 25th the formerly fertile and densely-peopled islands of Sibuku and Sibesi were successively visited and found to be entirely covered by a deposit of dry mud several yards thick and furrowed by deep crevasses. Of the inhabitants, all had perished to a man. Continuing the trip on the 26th to Krakatoa itself, the mission was surprised to note the complete disappearance of the three islands of Steers, Calmeyer, and the islet east of Verlaten, which had risen above the

surface at the time of the eruption, but which are now covered by 12 or 14 feet of water. Approached from the north Krakatoa seemed wrapped in a whitish smoke, vapours apparently issuing from fissures on this side, and settling on the summit, which is at present 2730 feet high. It was at this point that the great convulsion took place on August 26-27, when about half the island was blown into the air. A closer examination showed that what had been taken for fissures were simply ravines, and the vapours were clouds of dust stirred up by stones incessantly rolling down the steep slope of the mountain. This was accompanied by a continuous noise like the rattling of distant musketry, while stones of a certain size were seen whirling in the air, then falling and ricochetting down to the sea. Notwithstanding the evident danger, the boats of the expedition succeeded in approaching the foot of the volcano and collecting specimens of the rocks at several points. The same afternoon they reached the island of Verlaten, formerly one mass of verdure, now uniformly covered with a layer of solidified ashes about 100 feet thick. The deep crevasses, widened by the erosion of tropical rains, give the aspect of a glacier to this island, which has been doubled in extent by the deposits from the last eruption. Returning next day to Krakatoa the members of the expedition found a safe landing place, where it was possible to study the nature of the rocks and other matter ejected by the volcano. No trace was found of animal or vegetable life, with the exception of a solitary little spider, and the solidified bed of mud and ashes was estimated in some places to have attained a thickness of from 200 to 260 feet. A black rock rising a few yards above the surface about a mile and a quarter from the present shore, represents a last fragment of the portion of the island engulfed during the eruption. After touching at Lang Island, which presented much the same appearance as its neighbour Verlaten, the expedition concluded its survey of the Strait, landing on the 28th at Merak at the north-west extremity of Java. Merak had shared the fate of Anjer, and the coast-line in this district had been considerably modified. The expedition returned to Batavia on the 29th, after determining two new facts—the disappearance of the islands upheaving during the eruption, and the total cessation for the present of all volcanic activity at Krakatoa.

On Saturday, August 9, M. Renard, Captain of Engineers, and M. Krebs, Captain of Infantry, made an experiment with the directing balloon which they are constructing at the expense of the French Government in the aëronautical works of Chalet Meudon. The balloon, which is about 60 metres in length and 10 metres in diameter, carries a long platform of about 40 metres in length and 3 metres in breadth. At one of its extremities sit the aëronauts in a car. The aërial helix and a gramme magneto-electric machine are placed at the other. The voltaic elements and ballast are disposed on the platform. The wind not being strong, the aëronauts ascended and tried first the effect of their rudder, which is a sail of about 10 metres square. The results were very satisfactory indeed, and the steering of the balloon remarkably quick and easy. The balloon was drifted by the wind from Chalet Meudon to Petit Bicetre, above the Meudon woods. Then the aëronauts, wishing to return home, adjusted the rudder and the experiment succeeded wonderfully; in five minutes the distance, which is about two miles, was run. The balloon landed just before the doorway of its wooden house. This experiment will be tried again in a few days for a longer distance. The system practised by the French officers is a slight modification of the one used by Gaston Tissandier and described in NATURE. The French officers were originally adherents of the helix moving round an axis traversing the balloon, but the result of the experiments published by Tissandier seems to have modified their opinion.

M. F. Lhoste, Secretary of the Académie d'Aérostation Météorologique de France, who started in a balloon from Boulogne on Thursday last, descended at Romney, fifteen miles from Folkestone, at half-past eight o'clock the same evening. M. Lhoste left Boulogne at seven p.m. He encountered three distinct currents of air, one of which carried him in the direction of the North Sea. The descent was effected without difficulty.

Already a prospectus has been issued of the International Exhibition of Inventions and of Musical Instruments, to be opened in May 1885, in the buildings now standing in the gardens of the Royal Horticultural Society at South Kensington. The Exhibition will have all the advantages of royal patronage and support. Her Majesty the Queen becomes patron, and the Prince of Wales assumes once more the duties of president. The Executive Council, appointed by the royal president, having for chairman Sir Frederick Bramwell, F.R.S., vice-president of the Institute of Civil Engineers, and for vice-chairman the Marquis of Hamilton, is composed of Sir Frederick Abel, C.B., Mr. I. Lowthian Bell, F.R.S., president of the Institution of Mechanical Engineers, Mr. Birkbeck, M.P. (honorary treasurer), Colonel Sir Francis Bolton, Sir Philip Cunliffe-Owen, C.B., C.I.E., Prof. Dewar, F.R.S., Mr. Joseph Dickenson, Sir George Grove, D.C.L., Mr. E. W. Hamilton, Mr. Henry E. Jones, M.Inst.C.E., Mr. W. H. Preece, F.R.S., Sir E. J. Reed, M.P., F.R.S., Prof. Chandler Roberts, F.R.S., Mr. John Robinson, Mr. Warington W. Smyth, F.R.S., Dr. Stainer, and Mr. R. E. Webster, Q.C., with Mr. Edward Cunliffe-Owen as secretary. Mr. J. R. Somers Vine will be the City and official agent. The idea upon which the Exhibition is planned is not to bring together a mere collection of models of inventions, but rather to illustrate the progress which has been made in the practical applications of science during the past twenty years. In order to carry out this intention the Council will, as far as possible, confine the exhibits to processes and appliances, products being admitted only where they are themselves novel or where their introduction is required to make the purpose or advantages of that which is new in any process more interesting and intelligible. It is not proposed to allot space for manufactured goods unaccompanied by any illustrations of the process of manufacture. Generally it may be said that, as far as is practicable, inventions will be shown by models, with, in the case of models of entire machines, actual specimens of the portions improved under the exhibitor's patent, and when the invention relates to parts only the whole machine will not be admitted unless indeed the improvement effected cannot be sufficiently shown without the exhibition of the entire apparatus. The limitations of space which make these restrictions necessary, also compel the Council to decline, unless in exceptional circumstances, to receive objects which have already been shown in the Smoke Abatement Exhibition, 1881, in the Fisheries Exhibition, 1883, or in the present Health and Education Exhibition, and it is thought that the annual shows of the Royal Agricultural and kindred Societies have served so well to exhibit inventions bearing upon agriculture that it will suffice to present a few typical examples (and these models or diagrams) of each class of improvements effected during recent years.

The U.S. National Academy of Sciences recently received a gift of 8000 dollars from the widow of the late Dr. J. Lawrence Smith. The deed of trust has now been executed, and provides that the interest of the fund shall be used in striking a gold medal of the value of 200 dollars, to be called the "Lawrence Smith Medal," and to be awarded by the Academy, not oftener than once in two years, "to any person in the United States of America, or elsewhere, who shall make an original investigation of meteoric bodies, the results of which shall be made known to the public, such result being, in the opinion of the National Academy of Sciences, of sufficient importance and benefit to science to merit such recognition."

Any sums which may accumulate from the interest of the fund, above what is required for the purposes specified, is to be used "in aid of investigation of meteoric bodies, to be made and carried on by a citizen or citizens of the United States of America."

THERE being a notable difference between the determinations of specific weight of the normal hydrate of sulphuric acid, H_2SO_4, which have been made by Marignac in 1853 and 1870, and later on by MM. Schertel, Kohlrausch, Lunge, and Naeff, Prof. Mendeléeff, aided by M. Pavloff, has recently determined it again with all possible accuracy, and communicated the results of his determinations to the Russian Chemical Society (*Journal*, vol. xvi. fasc. 5). The hydrate was crystallised four times, the operations being made in a perfectly dry atmosphere of carbonic acid. Out of 6 kilogrammes, a remainder of only 300 grammes was received. The thus prepared hydrate melted at 10°·1 to 10°·6, and an accurate titration of it gave the following figures: 81·71, 81·52, and 81·58, that is, on the average, 81·6 per cent. of SO_3, the theoretic percentage deduced from the chemical formula being 81·64. The specific weight of the hydrate has been determined with great accuracy, and the average result, with all necessary corrections, was 1·83295 at 19°·02. The reduction to 15°, as compared with water at 4°, being made with Marignac's data for dilatation, the final result will be 1·8371, which figure differs only by 0·0001 from that of Marignac, and widely differs from those of Kohlrausch, Lunge, and Naeff.

WHEN submitting the Baku naphtha to fractional distillation, carried on at each 2°, Prof. Mendeléeff had shown that the specific weight of the products of distillation, while rising on the whole together with temperature, decreases however three times, namely, between 55° and 62°, between 80° and 90°, and between 105° and 110°. He shows now, in a recent communication to the Russian Chemical Society (*Journal*, vol. xvi. fasc. 5), that this is not a peculiar feature of the Baku naphtha, but that the same decrease of specific weights is displayed also by American naphtha, if this last be submitted to fractional distillation at each 2°, and that the phenomenon is produced at nearly the same temperatures. The products that boil below 60° were insufficiently represented in Prof. Mendeléeff's samples; but from 60° (where the specific weight, reduced to 17°, like all following, was 0·6642) until 124° (where it was 0·7322), there are two decreases of specific weight. Thus, at 80° it was 0·7347, but only 0·7069 at 92°, that is, the same as at 75°. After that it increases until 104°, where it reaches 0·7543; but it soon decreases for a second time, and at 115° to 117° it reaches 0·7270, that is, the same figure as it had between 85° and 98°. Beyond 117° it continues to rise. Both kinds of naphtha—Caucasian and American—however different their origin, thus display the same phenomena at nearly the same temperatures; the corresponding specific weights, however, are not the same; the portion at 80° has, in the Baku naphtha, a specific weight of 0·7486, and only 0·7347 in the American; and at 100° the respective densities are 0·7607 and 0·7380. The amounts of substance distilled at each temperature are also different. The researches will be continued in Prof. Mendeléeff's laboratory.

WE have been requested to state that at the meeting of the Essex Field Club, referred to in last week's NATURE (p. 343), the natural history and archæological conductor who addressed the Club on the "salting mounds" and other subjects was Mr. Henry Laver, F.L.S., of Colchester.

THE additions to the Zoological Society's Gardens during the past week include a Bonnet Monkey (*Macacus sinicus* δ) from India, presented by Mr. T. S. T. Tregellas; a Striped Hyæna (*Hyæna striata*) from North Africa, presented by Sir John H. Drummond Hay, K.C.B., C.M.Z.S.; three Greater Sulphur-crested Cockatoos (*Cacatua galerita*), three Leadbeater's Cockatoos (*Cacatua leadbeateri*), a White-backed Piping Crow (*Gymnorhina leuconota*) from Australia, a Red-sided Eclectus (*Eclectus pectoralis*) from New Guinea, a Blue and Yellow Macaw (*Ara ararauna*) from South America, six Amherst Pheasants (*Thaumalea amherstiæ*) from China, eight Himalayan Monauls (*Lophophorus impeyanus*) from the Himalayas, two Javan Peafowls (*Pavo spicifer* δ δ) from Java, presented by Mr. Charles Clifton, F.Z.S.; a Rough-legged Buzzard (*Archibuteo lagopus*), British, presented by Sir R. Payne Gallwey, Bart.; a Cockateel (*Calopsitta novæ-hollandiæ*), a Rose-Hill Parrakeet (*Platycercus eximius*) from Australia, presented by Mr. J. W. Dixon; a Green Turtle (*Chelone viridis*) from the West Indies, presented by Mr. A. E. Painter, F.Z.S.; a Loggerhead Turtle (*Thalassochelys caouana*) from the Atlantic Ocean, presented by the Surrey Commercial Docks Company; a Leopard Tortoise (*Testudo pardalis*) from South Africa, presented by Mr. William Lane; a Slow-worm (*Anguis fragilis*) from Norfolk, presented by Mr. T. E. Gunn; a Bonnet Monkey (*Macacus sinicus*) from India, a Blue-fronted Amazon (*Chrysotis æstiva*) from Brazil, a Grey Parrot (*Psittacus erithacus*) from West Africa, an Alligator Terrapin (*Chelydra serpentina*) from North America, deposited; two Jardine's Parrots (*Poicocephalus gulielmi*) from West Africa, two —— Conures (*Conurus perlatus*) from the Lower Amazons, an Electric Eel (*Gymnotus electricus*) from British Guiana, purchased; a Mule Deer (*Cariacus macrotis*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

THE NEXT MINIMUM OF MIRA CETI.—In the ephemeris of variable stars for 1884 in the *Vierteljahrsschrift*, the next minimum of Mira is fixed to 1884 October 24, a date which does not appear to result from Argelander's formula of sines, as it is given in Schönfeld's Catalogue of 1875, viz.:—

$$\text{Epoch Min.} = 1866 \text{ August } 8^{\circ}0 + 331^{d}\cdot3363 \cdot E$$
$$+ 10^{d}\cdot48 \sin\left(\frac{360^{\circ}}{11} \cdot E + 282^{\circ}\ 45'\right)$$
$$+ 18^{d}\cdot16 \sin\left(\frac{45^{\circ}}{11} \cdot E + 31^{\circ}\ 15\right)$$
$$+ 33^{d}\cdot90 \sin\left(\frac{45^{\circ}}{22} \cdot E + 70^{\circ}\ 5\right)$$
$$+ 65^{d}\cdot31 \sin\left(\frac{15^{\circ}}{11} \cdot E + 179^{\circ}\ 48\right)$$

For the present year E = 20, and hence substituting logarithms the four perturbations become—

$$+ [1\cdot02036] \sin(217^{\circ}\cdot29) = -\ 6^{d}\cdot35$$
$$+ [1\cdot25912] \sin(113^{\circ}\cdot07) = +\ 16^{d}\cdot71$$
$$+ [1\cdot53020] \sin(110^{\circ}\cdot99) = +\ 31^{d}\cdot65$$
$$+ [1\cdot81498] \sin(207^{\circ}\cdot07) = -\ 29^{d}\cdot72$$

The Julian date of the initial minimum is 2402822, and we have—

		2402822·0
331·3363 . E	... ...	6626·73
Sum of perturbations	... ...	+ 12·29
Julian date of next minimum	... ...	2409461·0

Which it will be seen from the *Nautical Almanac* (p. 486) corresponds to 1884 October 11. In 1882 by a very precise determination of the time of minimum, Schmidt found that it occurred on December 16, which is 18 days earlier than the date given by Argelander's formula, and the previous maximum had also been earlier by about 19 days. If this correction still applies the next minimum might be expected to fall about September 23, or a month earlier than the *Vierteljahrsschrift* has it. Still there is the possibility that Prof. Schönfeld may have applied corrections to the formula.

The present year's minimum may be therefore advantageously observed. In that phase Mira descends to about the brightness of the well-known star following it, not far from the parallel, or to about 8·5 m.

Another of the more interesting variables, χ Cygni, may be expected at a maximum about November 15, and R Leporis, "the crimson star," at a minimum on January 5.

THE DOUBLE-STAR 99 HERCULIS.—Mr. S. W. Burnham, in his last Catalogue of double-star measures, refers to a statement by M. Flammarion to the effect that the change in the position of the companion of 99 Herculis (one of Alvan Clark's discoveries) very nearly corresponds to the proper motion of the large star. But although the alteration in position between Dawes' measures in 1859 and Mr. Burnham's in 1880, may be fairly represented by rectilinear motion, it will hardly appear, when the best value we can assign at present for the proper motion of 99 Herculis is introduced, that it accounts for the observed change in the position of the companion. If we compare Bradley for 1755 with the Greenwich Catalogue for 1864, employing the accurate formulæ, we find :—

Secular proper motion in right ascension ... $-11''.34$
,, ,, ,, declination ... $+6''.90$

Mädler assigned for the respective proper motions $-10''.4$, and $+7''.0$.

Taking for comparison the following measures of 99 Herculis,

	Position		Distance	
	°		″	
1859·63 ..	347·2	...	1·705	... Dawes
1880·18 ...	29·9	...	0·91	... Burnham

we find on bringing up Dawes' measures to Burnham's epoch, with the proper motions of the principal star given above, the angle of position becomes 81°·5, and the distance 1″·65, showing a great difference from the result of the American astronomer. It seems at least probable, as he remarks, that it will prove to be a physical pair.

THE WATER SUPPLY CONFERENCE

THE Water Supply Conference of the Society of Arts, held at the National Health Exhibition, in the unavoidable absence of the President, H.R.H. the Prince of Wales, was opened by Sir Frederick Abel, C.B., F.R.S., chairman of the Council, who alluded in his introductory address, to these Congresses having been originated by His Royal Highness, who hoped a comprehensive scheme might be elaborated that would provide not only for the urban populations, but for the rural communities. He alluded to the good and useful work done by the Congress held in 1878, and in 1879, and reviewed the present position of the water-question in this country.

The papers read at the Conference were placed under three heads, viz. :—"*sources of supply*," "*quality of water*, with methods of filtration and softening," and "methods of *distribution*, with modes of giving pressure, house fittings, discovery and prevention of waste." Under all heads valuable papers were contributed, and the Society may again be congratulated on bringing together a jury of experts capable not only of showing us the weak points in our existing water-supply, but the methods by which these defects may be remedied. This was done to a large extent by the previous Conference, but the dangers then pointed out have been hardly appreciated, owing to the years of the Conference being followed by a remarkable succession of wet seasons. Now that a hot summer is succeeding a dry winter, the gravity of the situation is forcing itself upon public attention, and the importance of husbanding our water resources is found to be a matter of vital necessity, the neglecting of which has already facilitated the spread of English cholera, in certain districts, and will be a constant element of danger, should Asiatic cholera appear on this side of the English Channel.

Rainfall being the source of all water supply, it may be well to first notice the paper contributed by Mr. G. T. Symons, F.R.S., who, just a quarter of a century ago, instituted the first general series of rainfall observations ever made in this country, and who, since that time has been gradually increasing their number, until there are now nearly 3000 observers, no less than 2433 stations having furnished perfect records of rainfall last year. Worthy of all praise as is this remarkable voluntary staff of observers, not only giving their services, but actually contributing 99 per cent. of the cost of publishing the observations made, it is obvious, looking to the direct bearing such observations have on engineering, agricultural, and sanitary questions, bearing on the health and welfare of our population, that the scope of the inquiry should be enlarged so as to increase its sphere of usefulness, and that it should be placed under a Government department with a grant from Parliament, and the inquiry be no longer crippled for want of funds as regards possible and necessary extensions, though ten years ago the British Association for the Advancement of Science, feeling it their duty to initiate, rather than support, investigations of national importance, withdrew the vote with which they had aided the work for many years, it is due to Mr. Symons to point out that he has not merely maintained the standard of excellence found in his annual volumes of that period, but has increased their size and usefulness. In his paper Mr. Symons urges as a question of general policy the necessity of the formation of an hydraulic office, the early duty of a Government being "to see that all parts are completely supplied with the chief necessary of life. Englishmen," he says, "have a dread of centralisation, but in many ways they pay a long price for their dread. At present, it is not often that any town can even state before Parliament its views as to the effect upon it of what its next neighbour may be obtaining powers to do," and which, when passed by Parliamentary Committees become law, and "law for all time to come;" he truly adds that "no one can foresee what will be the total population of the country a century hence. No one can tell where the bulk of the people will reside, nor what will be the need for water in various parts of the country," and he justly urges that special water rights, "now asked to be created, should be subject to revision, *without compensation*, after the lapse of 100 years."

Mr. E. Bailey-Denton, in his paper on "The Water Supply of Villages and Rural Districts," points out that though a state department exists charged with sanitary matters, the condition of our rural districts as regards water supply "is a positive disgrace," and he considers the department should have their efforts specially directed to the protection of small communities, and states that those who form the "Local Boards" and "Boards of Guardians," having jurisdiction over such districts are elected under pledges to oppose all sanitary works that will increase the rates, and that even when men of knowledge and position are elected to such posts—outvoted by the majority they fall back to quietly agreeing with the *laissez faire* policy of their colleagues, and allow their constituents to continue to inhale and imbibe those germs of disease which float in the foul air that surrounds them, and are present in the only water provided for their use. Mr. Denton is evidently of the opinion that the writer has already advocated in these columns, that the Local Government Board should not only have the power to sanction local authorities providing pure water and efficient sanitary arrangements, but should themselves survey the country and seek out the districts where advantage is not taken of the law, as it even now exists, and to compel the authorities to remedy the abuses and shortcomings discovered.

In the present position of our knowledge it would be difficult, and often impossible, for an engineer to advise such a rural authority, suddenly called on to provide itself with an efficient water supply, even were the legal difficulties, and cost of parliamentary struggles obliterated. Thanks to Mr. Symons, we know something of the rainfall, but as Mr. Conder and others have pointed out, our knowledge of the discharge of our rivers is lamentably small. Daily gaugings have been taken of the Thames, but no systematic examination of the quantities run off by streams draining equal areas of rocks of varying degrees of permeability have been carried out, and the necessity of such observations being taken in all our streams cannot be too highly insisted on, and should be made a matter of State care. The few observations we have were chiefly made in the last century by Rennie, if we except the comparison of chalk and clay basins, made by Mr. C. Homersham, who showed the large quantity of water absorbed by the chalk, which never appears as streams. As regards underground waters, our knowledge is also not yet sufficiently definite to safely predicate the quantity of water a given unknown district will yield. A large body of information has been published by the Underground Water Committee of the British Association, during the past ten years, from which the direct relation of yield to rainfall, modified by degree of permeability is clearly made out, and details given of actual supplies obtained in enormous quantities, in certain districts, but what is still required, is a systematic examination of the height of water in wells and borings throughout the kingdom, and until the seasonal variation is clearly established, the minimum yield to be obtained in a given district, during a dry year, and still more after a succession of dry years cannot be ascertained, or calculations made be depended on with any safety. Information of this class is being steadily

accumulated in the Epsom, Croydon, and in some other districts by Mr. Baldwin Latham, C.E., who is ascertaining the seasonal variation in level of the underground waters, and the difference of cubic discharge of springs by self-recording apparatus. Valuable as are such observations for special districts for general use and public advantage, it is necessary that they should be extended to the whole country and be made by official observers for public use, and free access to the results.

In a paper on "Water from the Chalk," Mr. Joseph Lucas alluded to the work he has been doing during the past twelve years in measuring the height of the water in the wells over a large district in the Thames and Hampshire Basins, connecting together the points of observations by imaginary lines, or underground contours. He is able to map out with some degree of accuracy the height at which water stands in the rocks, the varying width, or proximity of the contours, indicating the varying decrease or increase of the steepness of the water gradients, *i.e.* the angle which the slope of the water plane makes with the sea-level, which, as shown by the Rev. J. Clutterbuck in 1841, varies in the chalk from 14 to 47 feet per mile. Mr. Lucas is of opinion that a comprehensive and uniform survey of the sources of water-supply, both surface and subterranean, should be carried out by the nation, and that maps should be constructed, "defining levels, areas, and quantities of water."

The Geological Survey have done much to prepare the way for such an examination as was pointed out by Mr. Edwin Chadwick, C.B. at a previous Congress, and it is encouraging to note that the first four papers read on "Sources of Supply" at the present Conference, were contributed by three present officers, and one former officer of that staff. Mr. Whitaker's paper commenced by pointing out that ordinary geological map, including the greater number as yet issued by the Geological Survey, are of little use in estimating the quantity of water obtainable from a given porous rock that may be represented on the map, and whose water-bearing capacity may be well known, owing to the thick covering of various beds of clay, sand, gravel, loam, and alluvial silt, together called by geologists drift, which obscures the solid geology, and where the beds consist of impermeable material entirely cut off the percolation of rainfall into the pervious rock beneath. Before, therefore, any estimate can be made with any degree of accuracy, of the quantity of water capable of being yielded by a given area of permeable rock, as represented on the ordinary geological map, it is necessary to have a Drift survey, showing the actual condition of the surface. Such maps are now being issued by the Geological Survey, the various rocks, being shown by their proper colour, in the areas, when they are not overlaid by any material, the surrounding districts being coloured to indicate the nature and character of the drift deposits overlying them, distinguishing the different clays and various gravels by distinct tints. For waterworks purposes, so elaborate a classification is not requisite, and in the interesting and valuable series of maps Mr. Whitaker laid before the Congress, the results of many years of work, he has adopted the following classification:—1, bare chalk; 2, chalk covered only by beds of a permeable kind; 3, chalk protected by beds of mixed or varying character; 4, chalk protected by impermeable beds. The result of Mr. Whitaker's investigations is to curtail the somewhat excessive estimates that may have been made in bygone years of the amount of chalk area available for the absorption of rain, but he states that the "chalk remains our chief water-bearing bed in the south-east of England; for though not always coming up to some of the sand-beds in permeability or porosity, it is pre-eminent over all other geological formations in thickness and extent of outcrop."

Mr. Topley contributed an interesting paper on a subject he has already done good and original work, "Water Supply in its Influence on the Distribution of the Population." He shows there "is a well marked and constant relation between the outcrop of porous strata and the parish or township boundaries, the longer axes of the parishes crossing the outcrops more or less at right angles." The arrangement of parish boundaries depends upon the sites of early settlements, which were entirely controlled by the outcrop of the water-bearing beds. Mr. Topley points out that with the river, London has at present no less than four different sources of supply of water, each giving a different quality, and he notes that no city in Europe is better situated for supplying itself from its own area, but it has become so vast that all sources have become insufficient. He notes that most of the other great capitals of Europe are also situated on basins capable of yielding deep well water, and instances Paris, Berlin, and Vienna.

Mr. De Rance, in a paper on "A Possible Increase of Underground Water Supply," endeavoured to show that the flow of intermittent springs might be increased, and the violence of floods diminished by the construction of "dumb wells," through impermeable beds to pervious beds below, draining what is now unproductive rainfall, passing in destructive floods to the sea, into permeable rocks which are now not storing water owing to their being covered by impermeable formations.

Mr. Edward Easton gives a useful *résumé*, gathered from his own practical experience, of well recognised principles which should govern the supply of water for domestic and other purposes, which, he justly observes, are too often neglected or forgotten. He appears to have a very decided predilection for soft water in preference to hard, and alludes to the value and cheapness of the lime-softening process of Prof. Clark; as regards filtration of supplies, in which it is found impossible to altogether prevent the chance of contamination, the filtering medium should include some deodorising agent, and he refers to the good results obtained in this direction at Wakefield by Spencer's magnetic carbide of iron, and at Antwerp by Prof. Bischof's spongy iron; in both cases the water was much contaminated, and was rendered perfectly wholesome. Referring to the dangerous practice of storing water in cisterns, he states that after an elaborate and exhaustive examination of the waters supplied by the London water companies, by Sir Frederick Abel, assisted by Dr. Dupré, Mr. G. H. Ogston, Prof. Voelcker, and the late able chemist to the Metropolitan Board, Mr. Keates, it was found that during the session of 1877-8, when two bills were introduced into Parliament at the instance of the Metropolitan Board of Works for purchasing the undertakings of the London water companies, and for providing a separate supply from the chalk for drinking purposes, that whilst the water in the main was in almost all cases excellent, the condition and position of the cisterns frequently rendered it utterly unfit for human consumption, a condition of affairs affording a most fruitful source of disease, and not alone confined to the dwellings of the poor, cisterns fixed on the roofs of the better class of houses being "rarely sufficiently covered, and often open to contamination from soot, dust, inroads of blackbeetles, and other abominations." Mr. Easton quotes Sir F. Bolton as to the importance of waste-pipes from cisterns being carried outside each house and the end left exposed to the air, instead of communicating, as now, with the drains, from which gases flow back into the cisterns, and are absorbed by the water; but it is to be hoped, with the steadily increasing expansion of the constant service in London, this frightful evil will cease to exist. According to Colonel Sir F. Bolton's return for the month of May, the quantity of water supplied to London amounts to 32 gallons per head per day, about 20 per cent. of which, say 6 gallons, it is estimated is used for other than domestic purposes, leaving 26 gallons per head as the quantity supposed to be absolutely consumed in the houses, while long practical experience has proved that the water really required is not half that quantity, and there can be little doubt that a system of supervision like that carried out at Liverpool would have similar results. The use of Deacon's meter has reduced the consumption of water from 33 to 22 gallons per head per day; this ingenious instrument enables waste of water to be localised, and the house or place detected where the flow-off is taking place.

Mr. Easton then shows the advantage to consumer and supplier of a constant service being given to each house by water, the quantity being regulated by the rateable value of the property, but returns to the keynote of all the speakers, that "it is useless to discuss the method and conditions of supply if the sources of water are not to be preserved to us," and adds, "it is quite certain that with the immense growth of the population of this kingdom, it will not be long before this preservation becomes a pressing necessity."

Mr. Easton repeats the proposition he made in his Presidential address to the Mechanical Section of the British Association at Dublin in 1878, which, expressing as it does a widespread feeling shared by all who have given attention to the subject, it may be well to quote at length. Mr. Easton considers that the question "of the management of rivers is of sufficient importance to make it worthy of being dealt with by new laws, to be framed in its exclusive behalf;" and that "a new department should be created—one not only endowed with powers analogous to those of the Local Government Board, but charged with the duty of collecting and digesting for use all the facts and knowledge necessary for a due comprehension and satisfactory dealing with every river-basin or watershed area in the United Kingdom

—a department which should be presided over, if not by a Cabinet Minister, at all events by a member of the Government who can be appealed to in Parliament."

Mr. J. Mansergh, C.E., states that "altitude and geological structure of a district on the two principal factors which determine what the source of water-supply must be in each district." He divides source of supply into (*a*) aboveground, and (*b*) underground. The former he subdivides, into—1. Water taken from heads of streams by pipes, just when it ceases to be underground water, as in the case of Lancaster. 2. Water obtained from natural lakes, as in the case of Glasgow. 3. Water collected from high lying moorland watershed areas, as at Manchester. 4. Water taken from a large river flowing past a town, as the Thames and Lea, near London. His second class (*b*) he does not subdivide, and includes all waters taken from all classes of stratification; he appears to take twelve degrees of hardness of Dr. Clark's scale as the maximum limit of safety for health, and regards a pure soft supply as preferable to a pure hard supply, using the word "pure" to mean absence from organic impurity. Speaking of towns which are compelled by position, and on the score of expense to be content with a water-supply derived from an adjacent river, he states that such sources "would be inadmissible but for the great rehabilitating process which nature silently carries on in a river, and to which chemists apply the term 'oxidation.'" In this wonderful process the polluting organic matters which the water contains are converted by the agency of oxygen into harmless inorganic salts, and the water again becomes fit for the use of man. He here refers to the burning controversy between the two schools of opinion on this matter, which have at their heads Dr. Frankland and Dr. Meymott Tidy respectively; the [illegible] admits that oxidation is effective in converting the most [illegible]tamination into a harmless condition, but does not admit [illegible]oys the organised germs, which he believes cause the virulent zymotic diseases, and which, being indestructible, may travel scores of miles in a running stream without being deprived of their fatal potency. Dr. Tidy, on the other hand, denies the existence of the germs, and affirms, after a run of a few miles, a river is fully oxygenated. Mr. Mansergh observes that, though Dr. Frankland's opponents appear to have the facts in their favour—as London, a city chiefly supplied from a polluted river, being one of the healthiest cities in the world—yet the "germ" theory is making steady advances under the investigations and researches of competent men.

Since the London water companies have come under the official supervision of Sir Francis Bolton, large sums of money have been spent in increasing the efficiency of the subsidence tanks, by greatly augmenting their capacity, in fact, their operations have converted them into storage reservoirs; from these the water is delivered into filter beds, the varieties in the construction of which, adopted by the different companies, are shown in the angle of the very interesting water pavilion erected in the Health Exhibition, under the auspices of Sir Francis Bolton, and which is full of interest to the student of the subject, and is decorated with some very artistic representations of the various waterworks on the banks of the Thames.

Any scheme of new legislation, and construction of a new department to carry out its provisions should, in the opinion of the writer, be made to include underground water supplies, the state of the law at the present time being exceedingly unsatisfactory, and the decisions of parliamentary committees being uncertain and contradictory. The law places underground water in the category of wild and free creatures, that he who can catch can hold, and just as one landowner can shoot a hare on his own property that has been bred on his neighbour's land, so can he [illegible] by sinking a well, the water that has been received on his [illegible]r's property, notwithstanding his neighbour may be [illegible]vendent upon it for water supply, and it may have been [illegible]e immemorial, and further than this, on the principle [illegible] you like with your own," he may actually pour [illegible]wn well, and destroy the value of the water in [illegible]hbour's land without hindrance and without [illegible] of the essayists at the congress referred to the [illegible]tice Pearson confirming this view.

[illegible]jons expressed in the papers read at this [illegible]ents made in the discussion upon them, [illegible] believed by those who have made the [illegible]udy, that the existing complex legisla- [illegible]l often antagonistic authorities in our [illegible] the greatestharm to the community, and can only be remedied by the constitution of an hydraulic department with absolute control over streams from their source to their outfall; that such department should at once make systematic arrangements for taking rain-gauge observations, the gauging of the whole of our streams, and the height and seasonal variation of the water stored in the rocks beneath the surface.

C. E. DE RANCE

THE CITY AND GUILDS OF LONDON INSTITUTE

FROM the Report on the Technological Examinations, 1884, we learn that a considerable increase is shown in the number of candidates at the recent examination, May 28, 1884, as compared with that of the previous year. In 1883, 2397 candidates were examined, of whom 1498 passed. In 1884, 3635 were examined, of whom 1829 passed. There is also shown a satisfactory increase in the number of centres at which the examinations have been held.

From the returns received at the office of the Institute in November last, it appears that 5874 persons were receiving instruction, with a view to these examinations, in the registered classes of the Institute. The number of students at the corresponding period of the previous year was 4052, this being 585 in excess of the number in 1882. Of the candidates who received instruction in the registered classes of the Institute, about one-half presented themselves for examination; of the remaining candidates who came up, some had received instruction in colleges the Professors in which do not accept payment on results, whilst others had supplemented their workshop practice by private study.

This year, as last year, Glasgow heads the list of centres from which the largest number of candidates have passed, the number being 139, as compared with 123 in 1883. Of the other centres, Manchester sent up 115 successful candidates, as against 76 in the previous year; Bolton 98, as against 117; Bradford 90, as against 51; Leeds 70, as against 64 (50 coming from the Yorkshire College, as against 43); Preston 59, as against 46.

In carpentry and joinery, which was added this year to the examination programme, 369 candidates were examined, of whom 125 passed. Nottingham sent up this year for the first time 19 candidates in lace manufacture, of whom 13 succeeded in satisfying the examiner.

Examinations were held this year in 43 subjects, as against 37 in 1883, the only subjects included in the programme in which no examinations were held being the Mechanical Preparation of Ores and Salt Manufacture.

Practical examinations were held this year for the first time in weaving and pattern designing, and in metal plate work, and owing to an alteration in the arrangements for the conduct of the Practical Examination in Mine Surveying, the results of the examination in this subject are also included in the accompanying tables.

Of the 23 candidates for honours who, besides undergoing a written examination in pattern designing and weaving, sent up specimens of their work, 13 succeeded in obtaining a certificate. In metal plate work, two candidates presented themselves for honours, but neither succeeded in obtaining the institute's certificate. In all subjects of examination, the honours certificate of the Institute is intended to be regarded as a diploma of proficiency, and is awarded in those cases only, in which the candidate shows a sound theoretical and practical knowledge of the subject.

The percentage of failures on the results of the examinations in all the subjects has increased from 37·5 in 1883 to 49·7 in 1884. This increase in the number of failures is due to many causes, which are referred to in the separate reports of the examiners, prominent among which is the want of skill in drawing, and of previous science teaching on the part of the candidates. In many subjects, too, there is still experienced the serious want of competent teachers, which it is hoped will to some extent be remedied when the Central Institution is in working order.

The large accession to the total number of candidates is due mainly to the increase in the number of candidates in cloth and cotton manufacture, in weaving and in mechanical engineering, and to the addition of the subject of carpentry and joinery to the programme. In 28 subjects there has been an increase in the number of candidates; in nine subjects, chiefly chemicals,

there has been a slight decrease, and in the remaining subjects the number has remained the same.

Table III. shows the proportion of candidates in each subject who have attended classes the teachers of which receive payment on results. By reference to this table it is seen that of the 1829 successful candidates, 1387 were taught in such classes, and of these, 176 have obtained certificates in honours.

Of the 1829 successful candidates, 1362 were examined this year for the first time. Of the remainder, 189, who had previously obtained an ordinary certificate, have this year gained an honours certificate; 98 have gained a higher place in the same grade; 180 have obtained a second class only in the same grade in which they previously passed, or have competed for a prize and failed to obtain it, and their names are consequently not included in the pass list. Last year, the number of candidates who passed the examination, but in the same class and grade as in the previous year, was 128.

A satisfactory feature of this year's examination is the increase, although small, in the proportion of candidates who, having already passed examinations under the Science and Art Department, are qualified to receive the Institute's full technological certificate. Although the returns of the candidates have not yet been verified, it may be assumed that at least 570 of the successful candidates will be entitled to the full certificate. The corresponding number last year was 420, and comparing these numbers with the total number of successful candidates, it will be seen that the percentage of those to whom full certificates will be awarded has increased from 28 per cent. last year to 31·2 per cent. this year.

In several subjects the full complement of prizes has not been awarded, the merits of the candidates not having justified the examiners in awarding them, whilst in other subjects additional prizes have been given. We see that 156 prizes have been granted, including 137 money prizes, 44 silver medals, and 112 bronze medals. Last year 143 prizes were granted, including 129 money prizes, 48 silver medals, and 95 bronze medals.

Looking at the general results of the examination, the large increase in the number of students under instruction and of the candidates who presented themselves for examination, may be considered satisfactory, as indicating the more general desire of artizans and of those engaged in manufacturing industry to take advantage of the opportunities now offered to them of receiving technical instruction. At the same time, the large proportion of failures consequent upon the accession of candidates, the majority of whom are already familiar with the practice of their trades, but possess a very imperfect knowledge of the application thereto of the principles of science, shows the need that still exists of improved and of more systematic technical instruction for those who are employed in factories and workshops.

Although the Royal Commissioners on Technical Instruction, the Report states, have spoken encouragingly of the facilities now offered to artizans of obtaining in evening classes good scientific and technical teaching, it would appear that the number of persons engaged in manufacturing industry, who avail themselves of the Science and Art Classes under the Department, is still comparatively small, and that the proportion of children who learn drawing in the public elementary schools is, as yet, inconsiderable. These causes doubtless prevent our artizans from deriving the full advantage of the Technical Classes now organised in different parts of the kingdom.

In considering the foregoing results, the inadequate supply of competent teachers in technology must also be taken into account.

SCIENTIFIC SERIALS

American Journal of Science, July.—Contributions to meteorology, twentieth paper: reduction of barometric observations to sea-level, by Prof. Elias Loomis. The results embodied in this paper have been determined by an extensive comparison of observations at five mountain stations, three in the United States and two in Europe. The reductions thus obtained were compared with those computed from the theories of Laplace and Plantamour, and exhibited very great discrepancies for all the stations, especially at the lowest pressures. The cause of these discrepancies is referred to the pressure coefficient in the Laplace formula, which appears to be too small.—Light of comparison stars for Vesta, by Edward C. Pickering. The light of the planet is here determined from comparison with the two stars, $DM_1 + 22^\circ$ 2163 and 2164, observed with the large meridian photometer of the Harvard College Observatory. The mean result thus obtained for the magnitude of Vesta is 6·64, as compared with 6·49 and 6·45 of previous observations at the same Observatory.—Mineral notes from the laboratory of the United States' Geological Survey, by F. W. Clarke and T. M. Chatard. The paper embodies a complete analysis of the jade or nephrite and pectolite implements in use amongst the Eskimo of Point Barrow, Alaska, and obtained from a region to the east, not yet visited by civilised man. Analyses are also given of Saussurite from Shasta County, California; of Allanite from Topsham, Maine; of Damourite from Stoneham, Maine; of Margarite from Gainesville, Georgia; of Halloysite from near Lake Mono, California; and several other rare minerals.—On the occurrence of alkalies in beryl, by Samuel L. Penfield. The results of numerous investigations show that alkalies are always present, undoubtedly replacing the beryllium, that water is also present, and cannot be disintegrated in the formula, and that the formula

$$Al_4Be_3H_2Si_{11}O_{31}$$

is the one best agreeing with the analyses.—The Niagara River and the Glacial Period, with map, by Prof. G. F. Wright. The author infers that the Niagara River itself has worn the whole of the Gorge, from Queenston to the falls, with perhaps some little help from pre-Glacial erosion above the whirlpool. The rate of erosion, calculated at about 3 feet a year, would make the time required not over 10,000 or 12,000 years.—Note on the discovery of primordial fossils in the town of Stuyvesant, Columbia County, New York, by S. W. Ford. The fossils obtained from the stratified rocks of this region show that they belong to the Lower Potsdam formations. Amongst the species obtained were *Palæophycus incipiens*, *Obolella crassa*, *Stenotheca* [illegible] *Hyolithes Americanus*, *H. impar*, *Hyolithellus micans*.—[illegible] on some apparently undescribed forms of freshwater [illegible] (ten illustrations), by Dr. Alfred C. Stokes. The species named and described are: *Loxodes thorax*, *Apgaria undulans*, *A. ovata*, *A. elongata*, *Ileonema dispar*, *Solenatus apocamptus*, *S. orbicularis*.—On the causes of variation of species, by Romyn Hitchcock. The author combats Dr. Carpenter's view, published in the Reports of the *Challenger* Expedition, that variation in the orbolites group is the expression of a not understood "progressive tendency along a definite line towards a higher specialised type of structure in the calcareous fabric." He contends that the highly complex form of shell developed by this simple sarcode organism is not due to any inherent tendency towards a definite plan, but to change of environment and other easily understood causes.—Remarks on the crustacea of the *Albatross* dredgings off Cape Hateras, and thence to the region of George's Banks in the year 1883, by Sidney J. Smith. The whole number of species of Decapoda determined from these dredgings was 72, of which 40 were taken below 500 fathoms, 29 below 1000, 13 below 2000, and 6 at a single haul in 2949 fathoms. Striking characteristics of the deep-sea specimens are their red or reddish colour and distinctly faceted eyes in the normal position, showing conclusively against the arguments of physicists that some rays of light must penetrate to depths of over 2000 fathoms.—Crystallised gold in prismatic forms, by Wm. P. Blake.—Mode of action of shell- and rock-boring molluscs, by Prof. F. H. Storer. The author argues that it is not a drilling or other mechanical action, but a distinctly chemical process, the solvent being probably free muriatic acid.—Memorials of the late George Engelmann and Oswald Heer, Associate Fellows of the American Academy, Botanical Section, by Asa Gray.

Journal of the Chemical and Physical Society, vol. xvi. fa[illegible] —On the action of aldehydes on zinc-organic compound[illegible] the formation of secondary alcohols, by G. Wagner. [illegible] of the fatty and aromatic series give, with zinc-ethyl [illegible] of secondary alcohols, these last being the excl[illegible] exclusive, produce of the reaction, which circ[illegible] easy means for preparing secondary alcohols [illegible] the reactions are, however, very different. [illegible] temperature on the acceleration of certain r[illegible] communication by M. Menschutkin.—Qua[illegible] of zinc in zinc-powder, by Th. Beils[illegible] On anhydride of erythrite, by S. Pryb[illegible] tinctorial substance discovered by O. [illegible] koff. It is not soluble in water, spir[illegible] only in bases, according to the [illegible] different colours from pale yellow [illegible]

mannite, by A. Sivoloboff and A. Alekhin.—On the structure of the atmosphere and on the general laws of gases (second paper), by E. Rogovsky. The criticism of the author brings him to the conclusion that the kinetic theory of gases must be revised before deducing the hypsometrical formula. The inquiry is to be continued.—On the magnetism of iron wires which are partially inclosed by a magnetising bobbin, by P. Bakhmetieff. The curve which expresses the relations between the magnetic momentum (m) and that part of the wire (l) which is directly submitted to the action of the bobbin has an irregular shape; the fraction $m : l$ reaches a maximum, which is reached sooner when the magnetising force is greater.—On the specific heat of liquids, by A. Nadejdin.—On the theory of dimensions, by N. Sloughinoff.—On a general law of dilatation of liquids, by M. Avenarius.—Remarks on M. Bardsky's paper on the intramolecular force.

Vol. xvi. fasc. 5.—On alizarine oils, by P. Loukianoff. They are found to consist chiefly of basic salts of common fatty and sulpho-fatty acids, the former in greater amount.—On the dependency of photo-chemical phenomena upon the amplitude of the luminous wave, by C. Timiriazeff. On the ground of several observations the author concludes that it is probable that the more energetic reactions are due to waves having a greater amplitude; and that, out of the waves absorbed by a body, those having a greater amplitude act more energetically.—Action of ethylic iodide on the azobenzoate of silver, by P. Goloubeff.—On naphtochinone and its derivatives, by O. Miller.—On the separation of calcium from strontium by Snidersky's method, by J. Bogomoletz.—On triphenylamidomethan, by W. Hemilian and G. Silberstein.—On some salts of mesotartaric acid, by [illegible] Pribytek.—On the heat of magnetisation of a circular mag[illegible] P. Bakhmetieff. It is much less than in rectilinear [illegible] and seems to follow other laws; the development of heat [illegible] altogether doubtful in such magnets.—The steam-engine made by Polzounoff in Siberia in 1763, by W. Lermontoff.—Notes on elementary optics.—Note on M. Kraevitch's paper on a hydrodynamic equation, by N. Petroff.—On the dilatation of liquids and its relation to their absolute boiling-points; an answer to M. Avenarius, by D. Mendeleeff, being a few remarks on the history of the subject and on M. Avenarius's logarithmic formula of dilatatiin.

Schriften der Physikalisch-Ökonomischen Gesellschaft, Königsberg, 1883.—On hybrid varieties of the violet; inaugural dissertation, by A. Bethke.—Memorial address on Charles Darwin, by Dr. Richard Hertwig.—Report on the twenty-first meeting of the Prussian Botanical Society at Osterode, October 1883, by Dr. Caspary, President.—Memoir on the latest discovery of the Stone Age in the East Baltic region, and on the beginning of plastic art in North-East Europe, by Dr. Otto Tischler.—On the sources whence plants derive their nourishment, by Dr. Klien.—Report on the expedition to Aiken to observe the transit of Venus, by Dr. Franz.—On some disputed questions connected with the anatomy of the eye, by Dr. Schwalbe.—On the degrees of sensitiveness in living substances, by Dr. Grünhagen.—On abnormal vision, by Dr. Richard Hilbert.—On the geology of the region between Elbing and Dirschau.—On the primeval history of the Caucasus, by Dr. Otto Tischler.—Anatomical description of the cinnamon plant, by Prof. Sanio.—On the microscopic Algæ and spores of the Russian coal-measures, by Prof. Robert Caspary.—Anatomical and physiological remarks on the wasp family (*Nematus pollitus* and *N. rufipes*), by Prof. Gustav. Zaddach and C. G. A. Prijschke.—Description of a new myograph for measuring the [illegible] take[illegible]city of the nervous processes, by Prof. A. Gruenhagen.—[illegible] nei[illegible]jective impressions of colour, by Dr. Berthold.—On some [illegible]w and rare plants found in Prussia, by Prof. Caspary.—On the fossil fishes in the provincial museum, by Dr. Jentzsch.—On the Jurassic system of the Inovrazlav district, by Dr. Jentzsch.—On the site of the Oracle of Dodona, by Dr. G. Hirschfeld.

Atti della R. Accademia dei Lincei, April 20.—Report on the archæological discoveries made in various parts of Italy during the month of March, by S. Fiorelli.—On the normal annual recurrence of certain meteorological phenomena deduced from the observations made at the Collegio Romano, by Pietro Tacchini.—Note on the equilibrium of elastic and rigid surfaces (continued), by S. Betti.

May 4.—Inaugural address by the new President, Cavaliere Francesco Brioschi.—Obituary notice of M. Dumas, by S. Cannizzaro.—On the relations existing between the refrangent power and chemical constitution of organic substances, by Drs. R. Nasini and O. Bernheimer.—On the groups of the series of $a, b \ldots k$ dimensions, by Giovanni Frattini.—Observations of the new planet 236 between Mars and Jupiter, made at the Observatory of the Collegio Romano, by Elia Millosevich.—Observations of the Pons-Brooks comet made at the Observatory of the Campidoglio, by Francesco Giacomelli.—Remarks on the declination and horizontal composition of terrestrial magnetism in Rome during the last ten years, by Filippo Keller.—Influence of magnetism on the embriogenesis and sterility of the ovum, by Carlo Maggiorani.—Meteorological observations at the Observatory of the Campidoglio during the month of March.

Rendiconti del R. Istituto Lombardo, June 19, 1884.—The concept of linear length is independent not only of the idea of derivation but also of that of continuity, by Prof. G. Ascoli.—A contribution to the study of the Northern Apennines, by Prof. T. Taramelli.—On the representation of the Newtonian forces, by means of the elastic forces, by Prof. E. Beltrami.—On the integration of the differential equations of the conic pendulum, by Dr. Gian Antonio Maggi.—On the revival of the critical philosophy of Kant, by Prof. C. Cantoni.—Note on a poem of Alessandro Volta in honour of Saussure's ascent of Mont Blanc in 1787, by Zanino Volta.—Meteorological observations made at the Brera Observatory, Milan, during the month of May.

July 3.—New measurements of the planet Uranus, by Prof. G. V. Schiaparelli.—Researches on the alkalis of the blood and their variations in intensity artificially produced; physiopathological and therapeutic importance of these experiments, by Prof. C. Raimondi.—Integration of the differential equation $\Delta^2 u = 0$ in the area of a circle, by Prof. Giulio Ascoli.—A pathological study of the cellules and parasites in the animal system, by Prof. G. Sangalli.—Meteorological observations made at the Brera Observatory, Milan, during the month of June.

SOCIETIES AND ACADEMIES

PARIS

Academy of Sciences, August 4.—M. Rolland, President, in the chair.—Reply to two notes of M. Wroblewski on the subject of the liquefaction of hydrogen and other gases, by M. L. Cailletet.—On the influence of temperature on the property of absorbing and losing moisture, possessed by vegetable earth and other substances exposed to contact with the atmosphere, by M. Th. Schlœring.—On the change in the excentricities of the planetary orbits due to the concentration of matter in space, by M. Hugo Glydén.—Report of Messrs. Gosselin, Vulpian, Marey, Bert, Pasteur, Richet, Bouley, and Charcot on various communications received by the Academy on the subject of cholera. An examination of forty-three letters, notes, and memoirs has led to no results calling for special consideration. The chief remedies proposed are hypodermic injections of chloride of pilocarpine, the internal application of sulphate of quinine, of oxygenated water, sulphuric lemonade, &c. More important are the views of Dr. Duboué of Pau, who recommends as a preventative the strengthening of the endothelial and epithelial systems by the daily administration of two doses of 0·25 grain of pure tannin prepared with ether. His curative method consists in restoring the circulation by copious intravenous injections of an artificial serum to which should be added one grain per litre of pure tannin.—Observations of the Barnard comet made in Algiers, by M. Trépied.—Note on the distribution of the facules on the solar disk during the year 1883, with tabulated results, by M. P. Tacchini.—Description of a fixed astronomic telescope, being a modification of M. Lœwy's "*equatorial coudé*," by M. G. Hermite.—An account of the method by which the absolute value has been determined of the horizontal component of terrestrial magnetism at the observatory of the Park Saint-Maur, Paris, by M. Mascart.—Description of a new apparatus for collecting the snow of carbonic acid required in producing low temperatures (one illustration), by M. Ducretet.—On the decomposition of white cast iron by heat, by M. L. Forquignon.—Note on the composition of the cyanides of mercury, zinc, and of some other elementary compounds of cyanogen, by M. G. Calmels.—On the nature of the visual faculty, and on the respective parts played by the retina and the brain in the elaboration of optical impressions, by M. H. Parinaud.—Researches on the biological *rôle* of phosphoric acid, and on the part played by this

substance in the formation of the animal tissues, by M. A. Mairet. —On the permanent immunity from charbon of rabbits vaccinated with the attenuated virus of this disease, by M. Feltz. Seven months after the vaccination six rabbits so treated and six others were operated on with a strong preparation of the virus. The six fresh animals all died of charbon, while the six that had been vaccinated remained unaffected by the second operation. But when again treated, eighteen months afterwards, they yielded to the virus, and all ultimately perished. The author infers that the operation preserves its efficacy in the rabbit not longer than eighteen months.—Description of a filter which yields absolutely pure water free of all animal life, by M. Ch. Chamberland.—On the anatomical origin of spermaceti; description of the so-called spermaceti case, by MM. Pouchet and Beauregard.—Memoir on the carboniferous measures of the Central Pyrenees, by M. L. Lartet. —On the composition and quality of coal in connection with the nature of the plants from which it has been formed, by M. Ad. Carnot.—On the oxychloride of calcium, and the simple and chloruretted silicates of lime, by M. Alex. Gorgen.—On the origin of the phosphorites and of the ferruginous clays in limestone districts, by M. Dieulafait.—Account of the effects produced by a stroke of lightning at Campan on July 24, by M. A. Soucaze. A house near the telegraph station was entered through the closed door by a living mass of flame, which, after a few seconds withdrew by the same way without injuring any of the inmates or damaging the furniture.—A hypothesis on the temperature of the zone of the solar protuberances, by M. Tardy. The author suggests that in this zone the hydrogen is rendered luminous by an atmosphere of oxygen, in which case the temperature would be that of the fusion of platina, while the temperature of the inner zone would be still higher.

BERLIN

Physiological Society, July 18.—The conception that, just as the chemical elements in *status nascendi* are characterised by greater energy of action than in the ordinary state, so also in the living organism the substances in process of generation and development would exhibit a different or more intense action than substances already fully formed, has been subjected to an experimental proof by Dr. Falk. He first made an examination in the case of prussic acid. A dilute mixture of emulsin and amygdalin, which yielded prussic acid both outside as well as in the body, was divided into two halves, one being injected by a syringe, immediately after the process of mixture, subcutaneously or directly into the sanguineous channel of one of the animals operated on, the other into that of the other animal intended to serve the purpose of comparison, but not till twenty-four hours after the process of mixture, and therefore after all the hydrocyanic acid had become completely formed in the solution. In both cases the phenomena of poisoning occurred, produced by the prussic acid. In the first case, however, in which the prussic acid was developed in the organism, the phenomena of poisoning occurred always at a later stage and in a milder form than in the second case, in which the prussic acid was administered when it was already completely formed. The second substance examined by Dr. Falk was the oil of mustard, which was produced from the myrosin and myronic acid salts contained in black mustard. The experiment in this case was performed in the same manner, and yielded a similar result, as in the former case. Thirdly, an experiment was instituted with hydroquinine, which was formed from arbutin; and here, too, the substance acted more weakly and slowly when it had first to develop itself in the body. From these experiments Dr. Falk drew the conclusion that substances in process of formation, or in the so-called *status nascendi*, possessed no peculiar or greater activity than in the ordinary state.—Prof. Kronecker spoke of a series of precautionary measures to be observed in cases of saving life by an infusion of common salt solution. He first described how animals after severe loss of blood recovered in the best and most rapid manner by introducing into their blood-channels a like quantity of physiological common salt solution. In the case of infusions of albuminous solutions, of serum sanguinis, and even of the blood of another individual of the same species deprived of its fibrin, there was, according to direct measurements, an invariable destruction of blood-corpuscles. With infusions of common salt solution, on the other hand, blood-corpuscles were seen to increase somewhat rapidly. Prof. Kronecker then proceeded more particularly to lay down precautionary rules to be observed in applying this agency to man. In the first place, the composition of the solution must be such as was most compatible with the human organism. It would appear that a solution of 0·73 per cent. exercised the least irritation on the human body, and was therefore the most appropriate for infusions designed to save life. The addition of carbonate of alkali, recommended by some, had an injurious effect. Of great importance were the velocity and pressure with which the infusion was injected; both ought to correspond with the velocity and pressure in the vein into which the solution entered. The common salt solution should, further, be disinfected beforehand by boiling, and the air which penetrated into the reservoir while it was being emptied must be filtered off by means of a wadding stopper. The injurious effect of too strong pressure was illustrated by a comparative experiment on two rabbits.—Dr. Krause reported some attempts towards the experimental production of contractions of the vocal chords. The possibility he had demonstrated on a former occasion, by pulling forward the tongue and pushing back the epiglottis, of observing the vocal chords of dogs by daylight, facilitated these experiments in a very considerable degree. He applied a prolonged, weak, mechanical stimulation of the nervus recurrens or vagus. A thin slice of cork having, by means of a piece of catgut, been loosely wound together with the nerve so as to exercise on it a continuous moderate pressure, he observed, about the second day of the experiment, the vocal chords under inhalation lie close to each other, and only under exhalation form a small opening between each other. This continuous closure of the glottis was followed, in about four to five days, by a paralysis of the chords, which lasted to the death of the animal. Sections showed in the first stages of the experiment reddening of the nerve and infiltration of the surrounding tissue; later on were found inflammation and extravasation in the nerve; and ultimately molecular decay of the nerve-fibrillæ. The closure of the glottis during the continuance of a prolonged m[illegible] pressure on the recurrens or vagus was explained by Dr. [illegible] as a contraction of the laryngeal muscles, of which the stronger sphincters of the glottis obtained the preponderance. That the contraction occurred only the second day after the operation was effected, according to the ideas of the speaker, in this way: that the moderate pressure in the normal nerve produced no stimulation beyond what caused the minimum of irritability, and that only after the nerve had become inflamed by the pressure did that pressure suffice to produce a contraction of the muscles and to maintain it till the destruction of the nerve-fibrillæ brought about a paralysis.

CONTENTS

	PAGE
The Report on Technical Instruction	357
British Mining	358
Letters to the Editor:—	
The International Geological Congress.—Prof. John McKenny Hughes, F.R.S.	359
The Volcanic Dust Phenomena.—T. W. Backhouse	359
Upon the Occurrence of Bacteria and Minute Algæ on the Surface of Paper Money.—Jules Schaarschmidt	360
Fireballs.—W. M. Flinders Petrie	360
Museums.—F. T. Mott	360
Measuring Heat.—Prof. J. Joly	361
Circular Rainbow seen from Hill-top.—Consul E. L. Layard	361
The Migration of Salmon	361
The Trinity House Experiments on Lighthouse Illuminants. (*Illustrated*)	362
The International Conference on Education	363
The Voyage of the "Vettor Pisani." By Lieut. G. Chierchia and Dr. Albert Günther, F.R.S.	365
Pyrometers. By W. R. Browne	366
The Agricultural Institute of Beauvais	367
Is Salpa an Example of Alternation of Generations? By W. K. Brooks. (*Illustrated*)	367
Colonial and Foreign Reports	370
Notes	371
Our Astronomical Column:—	
The Next Minimum of Mira Ceti	374
The Double-Star 99 Herculis	375
The Water Supply Conference. By C. E. de Rance	375
The City and Guilds of London Institute	377
Scientific Serials	378
Societies and Academies	379

THURSDAY, SEPTEMBER 25, 1884

MODERN STEAM PRACTICE AND ENGINEERING

Modern Steam Practice and Engineering. By John G. Winton, assisted by W. J. Millar, C.E. (London: Blackie and Sons, 1883.)

THE want has long been felt by those employed in the engineering works of this country of a book which shall serve as a guide to the various operations in the workshop, giving a practical yet concise description of the various methods employed, and the reason for using any particular method. In some works we find the business conducted in an old-fashioned stereotyped way, and in others all the latest improvements are introduced. The number of workmen who can give the real reason for using any particular method is very small, the reason generally given being, "The work has always been done that way?" It is here where the apprentice finds one of the many difficulties he has to overcome; he can see the work done, but cannot fathom the reason for doing it any particular way; his foreman perhaps being too busy to help him, he has to do the best he can.

[illegible] one [illegible]ne before us will go a long way towards [illegible]nglose difficulty. The author, being a practical man, treats the subject in a thoroughly practical way, using the technical language of the shops, thereby making the various descriptions and plates throughout the volume exceedingly clear. At the same time the higher principles involved in the various machines described are not overlooked, so that it is also a valuable book of reference in the drawing office, as well as a useful companion to those who have charge of men engaged in the various branches of mechanical engineering. For students attending the workshops and classes of the various engineering colleges it will be found to be very useful, giving as it does a *practical* description of the work, and helping considerably to get that knowledge which can alone be got in the workshops of the country.

The book is divided into five sections, subdivided into chapters.

Section I. is on the boiler and steam, commencing with a short chapter on coal and coal-mining. The author gives a short account of the troubles of the miner, and tells us of the methods in use for lining the shafts. Ventilation is dealt with; the various exhaust fans are next mentioned, with an illustration of the gimbal fan; then the author goes on to the usual methods for getting the coal. The chapter is a very appropriate commencement to the volume, although it gives a rather short account of the coal-mining industry.

We then come to a long chapter on stationary boilers, giving a good description of the various types in use. We miss the Lancashire boiler, with its two flues and conical water-tubes, from the illustrations. The author discusses the strength of riveted joints, giving the results of some experiments. We should have liked to find here a short account of the important researches on the strength of riveted joints carried out by Prof. Kennedy at the Engineering Schools of University College, London. The strength of cylindrical boilers is gone into fully, the various strains tending to rupture the plates are pointed out, and tables are given showing the proper thickness of plates for the different diameters. It is impossible here to give anything like a complete *résumé* of this chapter, no pains having been spared to get together as much information as possible; the author has succeeded in making it one of the most useful chapters in the work. He goes on to the foundations and settings for the different types of boiler, giving an account of the dimensions for the chimney. Smoke prevention is discussed, the conclusion at which the author arrives being thus stated: "We unhesitatingly give as our opinion that unless the attendant sees that the furnace is kept in proper trim, firing with the least quantity of coal, ofttimes replenished, all the refinements for the prevention of smoke will not attain the desired object, for careful firing is the main secret to arrive at."

Boilers for marine purposes are dealt with in a similar manner, the various types being discussed and illustrated. The arrangement of boilers for ships of war is gone into, high-pressure boilers having a fair share of the text. The proportions of marine boilers are treated, and suitable rules given for calculating the various dimensions, the chapter concluding with an illustration of the boilers of the s.s. *Parisian*, of the Allan Line of Atlantic steamers.

After showing the various methods for superheating and drying the steam by means of superheaters, both tubular and cylindrical, the author explains the methods of manufacture of boilers, more especially the best arrangement of plates and angle iron, and the staying of flat surfaces. We agree with the author when he says that this subject closely affects the interests of steam users, and the extract from a report of the National Boiler Insurance Company is well worth studying. Section I. concludes with the regulation and expansion of steam. The action of the slide valve is thoroughly explained, and the benefits derived from lap and lead pointed out. The different arrangements of the link motion are illustrated and clearly explained, then equilibrium slide valves are discussed and the arrangements clearly illustrated. The action of the indicator and the mode of driving the roller cylinder is shown; some very good examples of indicator diagrams taken from simple and compound engines are given; the section closing with a short chapter on the expansion of steam, with tables of hyperbolic logarithms, and the properties of saturated steam at different pressures.

Section II. is entirely devoted to stationary engines, commencing with the Cornish pumping-engine, afterwards dealing with the several different types of pumping-engines,—as pumping-engines for water-works, drainage works, and general purposes. The reader will here grasp the immense amount of trouble the author has taken to get all the information together, down to the smallest detail; each class of engine being well illustrated, its leading features pointed out, and the explanations of the different parts being very clear. Nor are the underground appliances overlooked, the pumps, valves and other parts in connection with the gear are thoroughly described and illustrated.

Pumping-engines for water-works are very similar

to those used for draining mines. We have several good examples; the description of the Tottenham pumping-engines is very interesting; and we have another example in the engines of the Berwick-on-Tweed Waterworks.

Of pumping-engines for drainage purposes, the London drainage system furnishes perhaps the best possible example; the Abbey Mills pumping-station with its eight engines giving an aggregate of 1140 horse-power, capable of dealing with 15,000 cubic feet of sewage per minute, lifting it 36 feet high; the Deptford pumping-station, with a horse-power of 500, lifting 10,000 cubic feet of sewage per minute to a height of 18 feet The pumping-engines at Crossness are also described, having a collective horse-power of 500, dealing with 10,000 cubic feet of sewage per minute, with a varying lift of from 10 to 30 feet according to circumstances.

After a short account of an arrangement of centrifugal pumping machinery, the author deals with winding engines, giving a clear description of this class, and as an example we have a full-page engraving of an engine for the Benhar Coal Company, by Messrs. Gibb and Hogg, Airdrie.

The various types of blowing-engines are described; afterwards rolling-mill engines, having as examples some engines erected at the Dowlais Ironworks, and compound reversing rail-mill engines at the Hallside Steel-works, near Glasgow: these latter are shown in a full-page engraving and are fully described in the text.

Under water-pressure engines we find the accumulator and charging pumps illustrated, the hydraulic crane, and the usual hydraulic machinery for dock gates is described, the section concluding with an account of the hydraulic machinery for warehousing grain at the Liverpool Docks and a full-page engraving of hydraulic machine tools, designed by Mr. R. H. Tweddell.

In Section III. we have the marine engine thoroughly and completely explained. We here see what a tremendous advance has been made in the science of marine engine building, the engines of the latest additions to our mercantile navy being nearly theoretically perfect as far as the economical consumption of steam is concerned, and the proportions of the different parts more in accordance with the individual strains they have to withstand. The author treats the subject fully, each part and detail being illustrated, and reasons given for any peculiarity of construction in the engines described; he then goes on to screw propellers, and kindred appliances, the section concluding with a full-page engraving of the compound engines of the steam-ships *Servia* and *Parisian*, the descriptions being very clear and to the point. Rules for the horizontal marine engine finish the section.

Perhaps the locomotive engine, which is treated in Section IV., has advanced by greater strides than any other machine within the last twenty years, the reasons being that the traffic on the railways has got heavier, competition has forced the companies to run the trains at higher speeds, at the same time that the vehicles composing the trains have increased both in size and weight.

This increase means that the engine must have a higher tractive power, which can only be got by increasing the weight on the driving-wheels; larger cylinders must be used, and consequently a larger boiler and fire-box for the increased consumption of steam. As an example of an express passenger locomotive of the present day, we may take the engines designed by Mr. Stirling for the Great Northern Railway, having driving-wheels 8 feet in diameter, cylinders 18 inches in diameter with a stroke of 2 feet 4 inches. Compare these engines with one built fifteen or twenty years ago, and the marvellous change will be at once apparent.

The author commences the section with a variety of fire-boxes designed to consume the smoke when burning coal, some being very complicated. All locomotives of the present day burn coal, and from the very complicated fire-boxes illustrated, the fire-box has resolved itself into a perfectly plain box, having a brick arch, to mix the products of combustion previous to their passage through the tubes. This when fired properly is quite capable of consuming all the volatile hydrocarbons in the coal without the formation of any smoke.

The illustrations in the earlier part of the section are somewhat old-fashioned; the one showing the stays inside a locomotive boiler might have been of more recent design. We remember having seen a boiler of the same type on a locomotive built in 1847. With this as the only drawback, the section treats the subject in a clear and practical way; we do not know of any work in which one can find so much information.

In the description of the American locomotive [illegible] finds many arrangements which look strange to [illegible] accustomed to English practice, but we cannot notice any peculiarity which we think could be adopted in this country with advantage. After a short account of the different classes of automatic continuous brakes, in which the Westinghouse and vacuum automatic brakes are discussed, we have some very good examples of the latest locomotive practice of this country. The engraving showing the vertical and horizontal sections of a bogie passenger engine, for the Caledonian Railway, is very clear, and the description good. Afterwards we find engines for the Great Northern, London and North-Western, and North British Railways thoroughly and clearly discussed, the general constructions being explained. The section concludes with a specification for a bogie locomotive, designed by Mr. William Kirtley for the London, Chatham, and Dover Railway, and a set of rules are compiled for the construction of locomotives.

In Section V. there is a very interesting and useful account of the construction of iron ships. The section of necessity treats the subject generally, the scope of iron shipbuilding being so large. The transverse and longitudinal methods of construction are explained, an account is given of the late Mr. William Froude's experiments with ship models, and as an example of recent practice we have the longitudinal section and deck plans of the s.s. *Orient*, with a concise description of her construction; afterwards the rigging is explained, with illustrations of the sparring and sail plan of a full-rigged ship. Then comes a short account of armoured war-ships, with a description of H.M.S. *Polyphemus*, the section concluding with dredgers, and examples of specifications for iron ships to Lloyd's rules.

Under the head of engineering works, the author gives a description of floating docks, the construction of iron roofs, the construction of, and strain on, wrought-iron

girders. There is a very clear analysis of the strains on the struts and ties in the lattice girder; the construction and sectional area of each strut and tie is worked out; next the suspension bridge is discussed, the general construction being explained.

The last few subjects treated in the volume include the fire-engine and gas-engine, with several other short accounts of the newest inventions, concluding with a chapter on the strength of materials.

In the publishers' preface we read that the present work is intended to furnish a reliable guide to practical engineers and others connected with the engine-shop and building-yard. This end has been most satisfactorily accomplished, and both authors and publishers may be congratulated on having placed before the public a most useful book; the printing is exceedingly clear, and the illustrations in the text good; the separate series of engraved plates add much to the value of the volume, without which many long descriptions would have been necessary. The book deserves a place in every technical library in the country. Those learning any branch of mechanical engineering will do well to study it, for it is one of the few really practical works published.

OUR BOOK SHELF

Catalogue and Handbook of the Archæological Collections in the Indian Museum. Part II. By John Anderson. (Calcutta.)

WE have already drawn attention to the first part of this excellent Catalogue, which thoroughly fulfils its promise of being not only an exhaustive list of the valuable objects in the Indian Museum, but a scholarly guide to them as well. The second part is occupied with Buddhist, Jain, Brahminical, and Mohammedan sculptures, and with the collections from Southern India, Persia, and other parts of the East. Appendixes have been added at the end of the book, including two by Prof. Warden and Mr. Growse. The work will be of great value to students of Indian archæology, and more especially to those who are devoting themselves to Buddhistic research. The Indian Museum is naturally a storehouse of antiquities throwing light on the past history of India and its relations with the West, and these have now been brought to the knowledge of scholars in a thoroughly satisfactory way.

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.*]

Barnard's Comet

LAST night (September 22) this comet was well seen in the 3-foot telescope. It was large (at least 4′ over), brighter to the middle, but without nucleus; a position was measured from a faint star involved in the light of the head. At 8h. 20m. the position by circle reading was *a* 19h. 45m. 50s., and 117° 16′ 30″ N.P.D.

A. A. COMMON

Ealing, September 23

The Krakatoa Eruption

BY this morning's post I have received, in a rather roundabout way from India, a translation of a Dutch account of the Krakatoa eruption, which, if you have not had it already, seems to contain some interesting variations on, or additions to, the mass of matter that you have already printed on that subject. Indeed the only postscript that could now be well added to it is the comfortable and encouraging discovery of the late French scientific expedition to the effect that the eruption is now positively over. The Batavians, as you are probably aware, feared that another eruption was preparing, in consequence of the immense number of stones still being ejected and clouds of smoke emitted. But the French *savants* discovered that no stones were being thrown up, only immense quantities of them tumbling down the mountain's sides; and this because the material, of which those new sides of the mountain are now composed, is so extraordinarily friable that the heat of the sun each day breaks them up, and the quiet force of gravitation brings the pieces galloping down the steep slopes, and plunging at last into the sea, to the danger of passing vessels,—but only by day, and when the sun is shining, for at night everything is quiet; and if by day and night a cloud forms above the mountain-top, it is neither smoke nor gaseous emanation, but merely the infinitely fine powdery matter of the broken-up and rolling stones of the day rising into the air and moving along with its currents up along the slopes which have been warmed by the sun.

C. PIAZZI-SMYTH

15, Royal Terrace, Edinburgh, September 15

The Sky-Glows

I WAS not aware before reading Mr. Leslie's letter in NATURE of the 11th inst. (p. 463) that any of the phenomena supposed to be connected with the volcanic dust had been seen before the eruption of Krakatoa in May 1883. Would the whole text of the description of those seen in February 1883 in Natal, from which Mr. Leslie gives a quotation, indicate them to be exactly similar to those seen since the great eruption? Where can a description of them be found?

The remarkable sunsets reported as seen in Mauritius after May 1883 and before the great eruption of Krakatoa, were by some attributed to the earlier volcanic disturbance, while others have expressed doubts whether they were really similar to those so generally noticed last autumn and winter.

It was not in the least the purpose of my former letter to imply the necessity of visiting a mountainous country to see the red corona round the sun; I am aware it is still plainly visible in England, and do not doubt even in London in fairly clear weather, having observed it when there in May last, not only within an hour of sunset or sunrise, but at all times of the day. But I wished to draw your readers' attention to the fact that this corona is much better seen in the clearer air at great altitudes, where also it is not necessary, as in England, that the sun be hidden by a cloud for it to be well seen.

I had not seen it stated before that the phenomena have been visible in England for years past. There is much more to be seen than a "blanching of the sun," as Mr. Leslie calls it, so that perhaps we are not both discussing the same phenomenon. Besides the bluish or greenish light immediately round the sun, which is not very striking, there is a broad red or brown band beyond, which is so. Has this been seen in England previous to last November? It has been habitual for me to scan the neighbourhood of the sun for halos during twenty-five years, and I never observed it previously to the date mentioned. It is true that the circumstances favourable for producing halos are unfavourable for seeing the red ring; nevertheless, since the latter first appeared in November I have not unfrequently seen it at the same time with a halo. It is also true that I saw portions of this red ring some days before I recognised them as a new phenomenon, but then they were only visible in gaps between clouds, so that I took them to be on thin cloud, and simply examples of the nacreous hues of thin films; any large extent of sky would probably have enabled me to perceive their true character. It is therefore very difficult for me to believe that the corona was visible in this country much, if at all, before last November.

Whether the phenomenon is ordinarily noticeable in volcanic countries I have not learnt; information from observers in such places would be of much value towards the elucidation of this interesting question. I gather from Prof. G. H. Stone's statement (NATURE, vol. xxix. p. 404) that a somewhat similar appearance is commonly visible in Colorado, where it may perhaps be attributed to the higher layers of dust of that very dusty region.

T. W. BACKHOUSE

Sunderland, September 20

THE glowing sunsets having reappeared, though far less brilliant than in November and December last, I send you a list of the most remarkable of them which have been noticed at Clairvaux, in the Department of Aube. They appeared with the same features as have been so often described in NATURE, and were especially glowing on the following days:—November 25, 27, 28; December 12; January 7, 12; August 6, 22 (feeble, sky not quite bright), and 23 (more brilliant); September 10 (feeble, bright sky, beautiful pink coloration in the east) and 17 (bright sky, bright pink coloration one hour after sunset). When the sky is bright, the rise of the moon is preceded, for nearly one hour, by a bright illumination of the sky.

Clairvaux, Aube P. K.

FOR the last four evenings, the 15th, 16th, 17th, and 18th, and again to-night, the colour of the sky from 20 to 25 minutes after sunset has taken that deep magenta glow looking very like the effect of a great fire, only lighter in tone. Last night, the 18th, this lasted until after 7 o'clock, and stars were then shining through it as they do through an aurora.

The reappearance of these glows was to be expected, as the haze and ruddy glow about the sun by day has, so far as I have been able to see, never really been long absent since attention was first drawn to it last autumn. I have now received a letter from Sydney, dated July 24, in which the writer says: "Since we have been in the Southern Hemisphere the sunsets have certainly had more striking colours, and on many occasions I have seen that peculiar magenta or mauve tint in the sky like aurora, only bluer in colour, while the sky has been very white just before sundown." The writer of the above is used to the look of the sun and sky, being an officer on board a mail steamer. I had suspected that absence of colour more or less in the sunsets here during our summer might be owing to the position of the sun rather than to any diminution in the quantity of vapour in the higher atmosphere, and had asked the writer of the above to note as he went south, in their winter, whether there was any increase in the colour of the after-glows, &c., being led to think this might be the case from reading the report of Mr. Neison, Director of the Natal Observatory, in which he speaks of having "first observed these phenomena in February 1883, from which time they increased in intensity until June, after which there was an interruption until the month of August." This led me to expect a return of strongly marked colour in our after-glows in autumn, increasing probably in intensity and duration during our winter months, when the weather is clear enough to see the sky. ROBT. LESLIE

Moira Place, Southampton, September 19

The Diffusion of Species

THE vast and altogether exceptional assemblage of Salpæ mentioned in NATURE (September 11, p. 462) by the Duke of Argyll as having been observed by him whilst recently cruising in the Hebridean seas, was due, in all probability, to the extension in a north-easterly direction of the ordinary surface-current of the Atlantic, or to an unusually long continuance of steady south-westerly wind, the effect of which would be to drive the superficial water of the Atlantic before it to the British coasts, and, with the water, the enormous multitudes of Salpæ which are occasionally to be met with in the latitude of the Canaries and Cape Verd Islands.[1]

During voyages to and from Bengal, *viâ* the Cape, in the good old days of sailing vessels, I repeatedly came across vast aggregations of these creatures, my attention having been specially called to them whilst engaged as I generally was for many hours by night as well as by day, in using a towing net from the stern ports for the capture of natural history specimens.

On my last voyage from Bengal in 1857 the ship sailed through some fifty or sixty miles of what the Duke aptly describes as Salpa soup, and which looked exactly like boiled tapioca. The quantity of Salpæ present in a bucket of the sea-water was, at least, equal in volume to the volume of water, but then the bodies of the Salpæ themselves consist in reality of more than 90 per cent. of water. On the occasion referred to, almost the entire mass consisted of a small species of Salpa about an inch in length, but nevertheless large enough to render the bright yellow digestive cavity of each, which is about the size of the smallest pin's head, distinctly visible. This was invariably full of certain species of oceanic diatoms the endochrome of which imparted the yellow colour. It is worthy of remark that in the case of the Salpæ, as well as many other organisms holding a yet lower position in the animal scale, there undoubtedly exists a selective power which enables them to pick out certain kinds of food in the midst of a superabundance of different kinds.

In the tropical Atlantic and Indian Oceans also I have seen, during calms, immense numbers (though not to be compared with the gatherings of the smaller Salpæ) of the larger chain Salpæ. These sometimes attain a length of from 8 to 10 inches, and have stomachs as large as a good-sized marble or hazel-nut.

But the most interesting assemblage of the lower forms of pelagic life was noticed by me about 200 miles from Ceylon, during a dead calm of four days' duration, when the sea was as smooth as a mirror, and undisturbed save by its never-ceasing majestic swell. Deep down, as far as the eye could penetrate, were to be seen numbers of brightly coloured water-snakes, delicately tinted "Venus's girdles," "Velellæ," and countless multitudes of those more minute living things which, though barely visible as mere specks to the unaided vision, are full of beauty and interest when observed under the microscope. Such a calm is a veritable pandemonium to the "skipper,"—to the naturalist it is a paradise. G. C. WALLICH

September 14

[1] As is well known, vast assemblages of Salpæ and kindred forms constantly occur at the surface in Arctic and Subarctic seas during the prevalence of moderate weather.

I AM specially interested in the Duke of Argyll's letter on the above subject (p. 462), being a resident during nearly half the year in the most southern of the Hebrides. His Grace is so competent a naturalist, and so accurate an observer, that I assume at once he had evidence which satisfied himself that an adder swam from Mull to Iona. Still I must be pardoned if I say that your readers have not been supplied with the proofs which have satisfied his Grace. A boy and girl in Iona, who, I presume, had never seen an adder in their lives, killed a creature in the sea there. Might it not have been an eel?

As regards distribution of species I may mention the following. In this island (Islay) we have multitudes of *stoats* but not a single *weasel*, while I am informed on trustworthy authority that in the neighbouring island of Colonsay there are many weasels but not a single stoat. R. SCOT SKIRVING

Sunderland House, Islay, September 18

Shifting of the Earth's Axis

IN the very interesting address of Prof. Young (NATURE, September 18, p. 501) he refers to the variability of the earth's axis, and states that a change of 1″ per century has been detected at Pulkowa, but that "the Greenwich and Paris observations do not show any such result." Now only last year, in the "Pyramids and Temples of Gizeh," I had (p. 126) noted that the Greenwich observations *did* appear to show a change, and that a change of the same amount and same direction as is stated by Prof. Young for Pulkowa; the observations of this century showing a decrease of 1″ of latitude per century, or with those of Maskelyne a decrease of 1″·38 per century.

This change I adduced as corroborating the result shown by four very accurate orientations of the earliest buildings, the Gizeh pyramids. These structures, whose errors are but a few seconds of angle, agree in standing as much as 4′ or 5′ to the west of the present north. This would imply a change of about 5″ or 6″ per century in the direction of long. 120°; a result quite comparable to the motion of 1″ or 1″·4 per century in long. 0° and 30°. Such a change might be effected by causes which are beyond our observation; as, for instance, unbalanced ocean circulation equal to a ring of water only 4 square miles in section moving at a mile an hour across the poles. If this motion of 6″ per century in long. 120° is still in action, we might now expect to find a change of about 5″ in the meridian determined at the beginning of the Ordnance Survey, a ground of observation which should not be neglected. W. M. FLINDERS PETRIE

Bromley, Kent

Salmon-Breeding

MR. FRANCIS DAY'S interesting communication last week (p. 488) on this subject is likely to attract more attention from biologists and pisciculturists than any other recently-ascertained fact in the natural history of the Salmonidæ, and it opens the large ques-

tion how the migratory instinct became established in certain members of the family, when it appears not to be physiologically indispensable to them. At the period of migration, when the smolts are fit to go to the sea, they evince, I believe, the utmost restlessness (like all migratory animals), and frequently leap out of the fresh water in which they are confined, and die on the banks. This has taken place year after year in the nursery ponds on the Plenty River, Tasmania, where it was first placed beyond question that a migratory salmonid could remain and breed perfectly freely year after year in fresh water. On January 20, 1866, Mr. J. A. Youl, C.M.G., sent out to Tasmania a consignment of salmon, salmon-trout, and brown trout (*S. fario Ausonii*). On June 25, 1869, several parrs of the salmon-trout, then weighing in some instances more than a pound, were busy nesting, the result being that many thousands of fry from their ova were subsequently sent to stock other rivers. The imprisoned salmon-trout have continued to breed for several years in succession, but there has been noticed in them a tendency to become sterile as they grow older. There is also some reason to believe that *Salmo salar* has bred in the ponds on the Plenty. Two young specimens which, from certain circumstances, the Commissioners believed to be true salmon, were sent to Dr. Günther for examination, with full information as to their origin and history; and he, while expressing his reluctance to give a decided opinion, stated that they "presented all the anatomical characters of *S. salar*." Full details of the breeding in fresh water of *S. trutta* will be found in "The Acclimatisation of the Salmonidæ at the Antipodes—its History and Results." ARTHUR NICOLS

A Sea Monster

A FRIEND of mine, Capt. W. Hopkins, of the schooner *Mary Ogilvie*, who has just returned from a voyage all round Australia, has given me the following information, which I forward you for publication, not so much because of its interesting character, but in order that other travellers may throw some light upon the character of the animal, which, if an Octopus, must be of much larger dimensions than those usually met with. On June 15, when in S. lat. 21° 37′ and E. long. 113° 49′, about five miles off the Exmouth Gulf on the western coast of the continent, he saw an immense creature which he took to be a species of Octopus. His attention was drawn to it by a perfect cloud of sea birds, and at first he naturally thought it must be a dead carcass. On approaching it, however, he found it was alive, and sluggishly disporting itself. In shape it was like a violin, but of immense size, with some six feelers about the greater diameters of the violin. It lay almost flat upon the water, was of a dark gray above and lighter gray below, and was continually elevating one of its feelers, apparently twice the thickness of a man's arm, to a height of from six to eight feet. It appeared to be vomiting, and as the birds were evidently feeding, that accounted for their presence in such numbers. Its size was so great that, had it grasped the vessel, it could easily have capsized it. The captain therefore got out of the way as quickly as possible, and without making definite measurements; but a large whale in the vicinity looked quite diminutive. It is a pity that something more exact as to size is not available, but I think the description is sufficient to convey an idea of the nature of the monster. All along the northern and western coasts of the continent vast shoals of pumice, in portions varying in size from ordinary gravel to about a foot in diameter, and completely covered with barnacles, were passed through.

Sydney, N.S.W., August 4 ALFRED MORRIS

Hail

WILL any of your readers kindly oblige me with particulars of the formation of a hailstone, and the effect produced upon it by falling through the air. How does it become frozen? increase in size? and what are the conditions for its increase? up to what point in its passage does it increase? what effect has temperature upon it in its downward career? after a certain point in its fall should it not theoretically decrease in size? does it do so actually? how is it that larger stones generally fall in tropical or hot climates during thunderstorms than we witness during our English winters? Does a raindrop increase in size as it nears the earth? If so, please give reasons. A. D.

Lisbon, September 1

[The best account of the formation of hail is given in Ferrel's "Meteorological Researches for the Use of the Coast Pilot," Part II. p. 85, a brief *résumé* of which is given in the "Encyclopædia Britannica," article *Meteorology*, p. 132.—ED.]

THE "COMMA-SHAPED BACILLUS," ALLEGED TO BE THE CAUSE OF CHOLERA[1]

WITH a view of studying the phase which the cholera question has now entered upon, in consequence of the publication of the results of the investigations of the German Cholera Commission in Egypt and India, I availed myself of the opportunity which the present vacation at the Army Medical School afforded of proceeding to Marseilles, where the disease has been prevalent since the end of June. Sir Joseph Fayrer was so kind as to enlist for me the valuable assistance of Dr. Le Roy de Méricourt, Médecin en Chef of the French Navy, who in various ways did his utmost to further my wishes. Dr. Marroin, the Chief of the Sanitary Department in Marseilles, was so good as to introduce me to the authorities of the Pharo Hospital, where the cholera cases are treated, and where, with the permission of the principal medical officer, Dr. Trastour, I was able to renew my acquaintance with the disease, and to collect material for studying afresh the microscopy of the intestinal discharges.

Before, however, referring to the results of my own observations, it will be convenient to epitomise the published history of the German Commission; to point out the salient features of the results of their investigations in Egypt and in India; and to make a few brief comments on such of the circumstances and conclusions as appear to call for notice. Shortly after the arrival of the Commission in Egypt, Dr. Robert Koch reported, on behalf of himself and his colleagues, that no special micro-parasites had been discovered in the blood, the lungs, the spleen, the kidneys, or in the liver in cholera, but that the intestinal mucous membrane was permeated by certain Bacilli which nearly resembled in size and form the Bacilli found in glanders. As is well known, these Bacilli are straight, and are, in fact, uncommonly like the ordinary microphytes associated with decay. Dr. Koch also states in connection with this subject that he had, previous to proceeding to Egypt, found similar Bacilli in the intestinal mucous membrane of four natives of India, but that he had then looked upon them as due to merely *post mortem* changes. When he came to Egypt, however, and found these same Bacilli in the intestines of perfectly fresh cases, he felt that an important link was furnished towards establishing the identity of the disease in Egypt with Indian cholera.

It is highly probable that the specimens from India which Dr. Koch had examined were those which were sent, at the request of the Imperial Health Department in Berlin, by the Sanitary Commissioner with the Government of India. These consisted of numerous dry cover-glass specimens of blood which I had collected from several cholera patients, and of portions of the viscera of four natives who had died of the disease. All these were examined by me before they were despatched, and portions of each were reserved for further study. I had heard nothing further of them, but the publication of the remarks above referred to in Dr. Koch's Report of September 17, 1883, from Alexandria, recalled them to my mind, and I was glad to infer that my own negative results had been confirmed in Berlin. As already observed, no importance had been originally attached to the organisms which were present in the intestinal mucosa. During the last six months I have examined hundreds of stained microtome-sections of these four, and of other specimens of cholera intestines in my possession, and have found that, when the mucosa is infiltrated with

[1] A Memorandum by Surgeon-Major Timothy Richards Lewis, M.B., Assistant Professor of Pathology, Army Medical School. Communicated by the Director-General, Army Medical Department.

microphytes at all, they are either Micrococci, Bacteria, or long-oval, and straight Bacilli.

In the Report of the Commission, dated Calcutta, February 2, 1884, Dr. Koch, however, announces for the first time that the specific Bacillus of cholera is curved or comma-shaped, and not straight; so that apparently it had become necessary to abandon the microbe first fixed upon. Assuming that the four specimens from natives of India which had been examined by Dr. Koch were those which passed through my hands, the evidence they furnish seems to be in accordance with this view, as in not one of them have I been able to detect any invasion by unmistakable "commas," though at least one of the specimens may fairly be characterised as abundantly infiltrated (in the manner described by Dr. Koch) by straight (and as I prefer to call them) putrefactive Bacilli. Judging from my own experience, therefore, any extensive infiltration of the intestinal mucous membrane in cholera by comma-shaped Bacilli must be exceedingly rare; and this, I believe, is likewise the experience of the members of the late French Cholera Commission, MM. Straus, Roux, and Nocard, whose acquaintance I had the pleasure of making at M. Pasteur's laboratory on my return through Paris.

Whilst at Marseilles I had, as already stated, opportunities of observing numerous specimens of choleraic excreta, and found that comma-shaped Bacilli were, more or less conspicuously, present in all of them, though in some instances more than one slide had to be examined before any could be satisfactorily detected. It may also be mentioned that some of the discharges in which these organisms were present manifested an acid reaction when tested with litmus paper. As Dr. Koch himself remarks, the proportion which the comma-shaped Bacilli bear to other organisms in the dejecta varies greatly. In some instances only one or two specimens are to be found in the field of the microscope, while in others they are very numerous, and Drs. Nicati and Rietsch (who are at present engaged in the study of the disease at Marseilles) were so kind as to show me a specimen of choleraic material they had obtained from the small intestine, in which the "commas" existed almost to the exclusion of all other organisms. This is a condition, however, which, I understand, is exceedingly rare. On the other hand, I have seen samples of choleraic dejecta in which totally different organisms prevailed to a like exclusion of others; and in one instance at Marseilles spirilla of various sizes and forms were the most conspicuous of the micro-organisms present. So far, therefore, the selection of the comma-shaped Bacilli as the *materies morbi* of cholera appears to be entirely arbitrary.

Dr. Koch and his colleagues have adduced no evidence to show that they are more pernicious than any other microbe; indeed, as a matter of fact, the sole argument of any weight which has been brought forward in favour of the comma-shaped Bacillus being the cause of cholera, is the circumstance that it is more or less prevalent in every case of the disease, and that the German Commission had not succeeded in finding it in any other. With regard to the suggestion that the cholera process may in some way favour the growth of these Bacilli, and that these are not necessarily the cause of the disease, Dr. Koch remarks, in the Report from Calcutta above cited, that such a view is untenable, inasmuch as it would have to be assumed "that the alimentary canal of a person stricken with cholera must have already contained these particular Bacteria; and, seeing that they have invariably been found in a comparatively large number of cases of the disease both in Egypt and India—two wholly separate countries—it would be necessary to assume, further, that every individual must harbour them in his system. This, however, cannot be the case, because, as already stated, the comma-like Bacilli are never found except in cases of cholera."

Had Dr. Koch and his colleagues submitted the secretions of the mouth and fauces—the very commencement of the alimentary canal—to a careful microscopic examination of the same kind as that to which they have submitted the alvine discharges, I feel persuaded that such a sentence as the foregoing would not have been written, seeing that comma-like Bacilli, identical in size, form, and in their reaction with aniline dyes, with those found in choleraic dejecta, are ordinarily present in the mouth of perfectly healthy persons.[1]

There is no difficulty in putting this statement to the test; and to any one acquainted with the methods ordinarily adopted for staining and mounting fungal organisms of this character, no special directions need be given. The procedure followed by me to demonstrate these "commas" in the saliva is precisely that adopted for finding them in the dejections. A little saliva should be placed on a cover-glass (preferably in the morning before the teeth are brushed) and allowed to dry thoroughly, either spontaneously or aided by a gentle heat. The dry films thus obtained should be floated for a minute or two with one or other of the ordinary solutions of aniline dyes adopted for such purposes, such, for example, as fuchsine, gentian-violet, or methylene blue. The cover should then be gently rinsed with distilled water, and the film re-dried thoroughly. The preparation may now be mounted in dammar varnish or Canada balsam dissolved in benzol, and should be examined under a 1/12th or 1/16th of an inch oil-immersion lens.

As in choleraic discharges so in the saliva the number of comma-shaped Bacilli will be found to vary greatly in different persons, and at different times in the same person. Sometimes only one or two "commas" will be seen in the field, at others a dozen may be counted, and, occasionally, little colony-groups of them may be found scattered here and there throughout the slide.

It may be remarked in passing, and as bearing upon what has been already said regarding the general absence of comma-shaped Bacteria from the intestinal mucosa itself, that they do not appear to manifest any special tendency for attacking the decaying epithelial scales of the mouth, but that, on the contrary, they are for the most

[1] Since this Memorandum was submitted, I have observed that Dr. Koch states, in his recent address on the subject, that, after his return to Berlin he had examined, amongst other things, the secretions of the mouth for comma-shaped Bacilli, but had found none; and, further, that he had consulted persons of much experience in bacterial researches as to whether they had ever seen such organisms, and was told that they had not.

It may be of assistance to future observers if I give the dimensions of half-a-dozen comma-shaped Bacilli as found in each of the following:—(*a*) In the alvine discharges of three cholera-affected persons; (*b*) in the small intestine of a person who had died of the disease and in whom they existed almost to the exclusion of other organisms; (*c*) in a cultivation of them in Agar-Agar jelly; and (*d*) in the secretions of the mouth of three healthy persons, ranging from four to fifty years of age. The measurements were made (with the valuable assistance of Mr. Arthur E. Brown, B.Sc. Lond.) under a magnifying power of 1000 diameters—a Powell and Lealand's 1/16th of an inch oil-immersion lens, with a wide angle condenser, being used.

LENGTH AND WIDTH (IN MICRO-MILLIMETRES*) OF COMMA-SHAPED BACILLI IN CHOLERAIC MATERIAL

Nos.	Alvine discharges I.	Alvine discharges II.	Alvine discharges III.	Intestinal contents (autopsy)	Cultivation in Agar-Agar jelly
	μ μ	μ μ	μ μ	μ μ	μ μ
1.	2·4×0·40	2·0×0·60	1·1×0·25	2·0×0·40	1·6×0·40
2.	2·0×0·40	2·5×0·65	1·8×0·35	1·2×0·40	1·4×0·60
3.	2·0×0·50	3·2×0·70	2·0×0·60	1·5×0·45	1·8×0·[illegible]
4.	2·2×0·45	3·0×0·70	3·0×0·70	1·3×0·60	2·0×0·50
5.	2·8×0·35†	2·5×0·60	2·2×0·50	2·1×0·50†	2·6×0·45†
6.	1·5×0·35	2·0×0·50	1·6×0·40	1·2×0·50	1·1×0·35

LENGTH AND WIDTH (IN MICRO-MILLIMETRES*) OF COMMA-SHAPED BACILLI IN SECRETIONS OF THE MOUTH IN HEALTH

Nos.	I. μ μ	II. μ μ	III. μ μ
1.	2·0×0·50	1·4×0·35	1·5×0·50
2.	1·3×0·35	2·0×0·40	1·3×0·50
3.	1·6×0·40	1·7×0·40	1·0×0·30
4.	1·2×0·35†	1·3×0·45	1·2×0·40
5.	2·2×0·65	2·1×0·50	2·1×0·50
6.	2·0×0·40	2·8×0·40†	1·4×0·55

* One micro-millimetre (μ) = ·001 millimetre (= 1/25,000").
† z-shaped comma-bacilli.

part found free in the fluid, the epithelium being studded with other bacterial forms.

Persons who have not been in the habit of examining dried saliva-films will probably be surprised at the number and variety of the organisms which are, more or less, constantly to be found in the mouth; and especially at the number of spirilla with which the fluid is generally crowded.

The alvine discharges in cholera sometimes swarm with precisely similar spiral organisms, and, indeed, as has long been known, the fluid exuded into the intestines in this disease is peculiarly suitable for the growth of these and allied microbes. But, so far as my own experience—dating from 1869—of the microscopic examination of such a fluid goes, all the microphytes ordinarily found in it are likewise to be found, to a greater or less extent, in the secretions of the mouth and fauces of unaffected persons. And with reference to the comma-like Bacilli found in cholera, to which such virulent properties have been ascribed, I shall continue to regard them as identical in their nature with those ordinarily present in the saliva until it has been clearly demonstrated that they are physiologically different.

Pathological Laboratory, Netley, September 1

FORESTS IN COBURG, GERMANY, AND RUSSIA

A BLUE-BOOK under the title of "Reports by Her Majesty's Representatives abroad on the Cultivation of Woods and Forests in the Countries in which they reside," has just been published by Messrs. Harrison & Sons. These Reports are of an extremely interesting character, and we gladly draw attention to them, appearing as they do at an opportune moment before the close of the Forestry Exhibition at Edinburgh.

The Reports come from Coburg and Gotha, Germany, Norway, Russia, and Sweden, and in the form of an appendix is a *précis* by Dr. Lyons, M.P., of the Reports on Forestry of the United States Department of Agriculture. In each one of these Reports much valuable information is given and information of a very varied character. Thus in the first we are told that the forests in Gotha consist of 85 per cent. of pine and 15 per cent. of other wood. The principal timber-trees are pine and beech, whereas the remaining sorts of wood, namely Scotch fir, spruce, larch, oak, maple, ash, birch, and elm are found only in small quantities or mixed with the other species. The period during which the different woods are gradually brought into use is such that pine forests and mixed forests shall yield as large an amount as possible of saleable timber, whilst in the beech woods the greatest amount of wood as fuel is sought without allowing the trees to attain an age at which they would no longer pay the interest on the value of the soil. Pine and beech wood in higher situations are, according to these principles, usually cultivated and worked in cycles of one hundred years, while spruce on the lower heights and in the plains are worked on an eighty years' cycle. The woods for protection on the high grounds are subject to especial treatment, as no clear fellings take place, and care is taken to leave standing groups of foliage trees equally distributed over the whole surface. The usual rules followed are: early felling of the trees in a cycle of eighty years, leaving occasional large shelter trees, and utilising the undergrowth for purposes of renewal. The administration of the Domain forests in the Duchy of Coburg is carried on on scientific principles, and consists of regular felling at stated periods over certain areas; pine timber trees are usually cut every ninety years, while oak, ash, beech, birch, &c., are not cut till after 120 years' growth.

The Report on the general administration of Prussian State Forests treats of their organisation, expenditure, and results, and points to the desirability of introducing others than indigenous trees into the forests. On the subject of education in forestry it is stated that the School of Forestry at Eberswalde completed in June 1880 the fiftieth year of its existence, and had at that period in all nearly 1600 pupils. There is also a School of Forestry at Münden, and the half-yearly attendance at both schools showed in 1878 an average of 148 pupils, whereas in 1880 the number had increased to 210. The attendance was therefore largely on the increase, and it was then proposed to give voluntary education in these matters to the "Jäger Bataillonen" of the army. This plan has, according to latest accounts, been attended with so much success that the education has become obligatory, and forms a regular portion of their service.

From Russia a very elaborate Report treats, amongst other things, of the various kinds of trees found in Russia, with notes on their distribution, and some interesting facts on the consumption of wood and the uses to which it is put, showing that house and ship building consume a very large proportion, and that the minor industries when put together form a not unimportant total. After showing the extensive destruction of forests that has been going on in different parts of Russia for some years past, the Report considers the question of plantations along railways, the object of which is to protect the track from snowdrifts, and a list of the best trees and shrubs for this purpose is given. On the subject of tree-planting on the steppes of South Russia, it is stated that Count Kisseleff, when travelling through several provinces in 1840, found, much to his surprise, amongst the German colonists not only good kitchen gardens but also flourishing plantations of forest trees. The colonists had been obliged on every plot of land to plant a certain number of trees. The first experiences, however, were so severe that many of the colonists preferred to return to Germany; those that remained were forced to plant their allotments with trees which, with infinite trouble, they succeeded in doing, and these plantations are now a great ornament to the steppes, and from a climatic as well as an agricultural point of view have been of great importance to the colonists, and have laid the foundation of the planting which is now carried out on the steppes in a scientific manner. A forestry school was established, but closed in 1866, and the allowances for planting which had been granted were reduced to a minimum. Since that, however, matters have been put on a more satisfactory footing, and planting is conducted in a systematic manner.

STONE HATCHETS IN CHINA

LITTLE has yet been done to illustrate the Stone Age in China, and this is very likely to be true for some time to come from the fact that the people of the country worked in metals four thousand years ago.

To begin with the Han dynasty, B.C. 206 to A.D. 220, one chief source of revenue was iron in those days, and Shansi had grown rich and powerful because of her iron foundries. The correct Confucianists objected to the spirit of gain-seeking which they saw showing itself in the expansion of trade. In the reign of Chauti, B.C. 80, a book was written on the salt and iron duties, which was a record of the views then maintained by the purists of the Confucian school in contrast with those of the political economists of that day. The advantages of the encouragement of trade were detailed in full, and the sympathy of the modern reader goes with the economists, who saw that the strength and prosperity of the country must be increased by developing her resources. The country was then old, and the stone hatchet period must be sought much earlier. The same state of things existed in the time of Kwan chung, B.C. 700. Living before Confucius,

he could, as Minister of the Tsi kingdom, encourage trade without opposition from the literary class. His book speaks of the trade then existing between the different parts of China and the outside countries, and mentions gold as a product of the Ju and Han Rivers. Pearls come from the south; jade comes from Tartary; white ring plates come from the Kwun lun Mountain. Money was threefold. Pearls and jade were money of the first class. Gold was money of the second class. Knife money and cloth were money of the third class. This being the state of things at the beginning of the seventh century before Christ, the stone hatchet period must be sought farther back. It is said of the Emperor Cheng Tang, B.C. 1766, that he coined gold; and of the Emperor Shun, B.C. 2255, that he hid gold in the earth to check the covetous spirit of the people. In the book of history is recorded the tribute which was offered to the Emperor from various parts of China in the time of Yü, B.C. 2205. All the common metals were included among the articles offered.

Recently a stone hatchet was found near Kalgan in a mound forty feet high. The mound belongs to a large collection of graves, large and small, about seven miles east of the city Yü cheu, and 110 miles west of Pekin. An ancient wall, nearly round, twenty feet high and about eight miles in circuit, is still in existence there. The mound in which the hatchet was found is in the line of this wall—that is, the wall runs north-west and south-east from it. Hence the wall-builders did not regard the mound as sacred, for it would not in that case have been made to serve the purpose of a wall to their city on the south-west side.

There is another large mound known as the grave of Tai wang. It is a little to the east of the centre of the inclosed space once a city, and the principal road runs through the city by this mound from east to west. Rev. Mark Williams of Kalgan, who found the hatchet, and was the first foreigner to draw attention to the old city, was struck with the general resemblance of the mounds, the wall, and the hatchet to what he is familiar with in Ohio. So close was the similarity that it seemed to him to require that the same class of persons who made the one should have made the other.

A Chinese archæological work of the seventeenth century, "Fang yü kì yau," mentions the city but not the mounds. The city, it says, was built in the reign of Han kau tsu, B.C. 206 to 194. Han kau tsu gave to his brother Hì the title and principality of Tai wang, and this was his residential city. The traces remain (it is added in this book) of nine gates. A river from the north enters the wall in the west, proceeds to the south-east, and from thence flows to the Tsz River. This prince was attacked by the Hiung Nu Tartars, and they must have taken the city, for he fled to his brother in Shensi, and was degraded to a lower title of nobility for cowardice shown on this occasion. Before this, in the interval between the fall of the Tsin dynasty and the establishment of the Han, there had been two other persons who had been styled Tai wang. Hiang yü, who took the capital of the Tsin dynasty and burnt its palaces, resolved to restore the feudal system and made several kings.

Chau hie was one of these, but he removed shortly after to a different locality. After this there was another occupant of this principality, Chen yü. He was appointed by the ruler of Chau. But soon Lieu pang subdued all China, and everything was changed. Besides these persons there is mentioned in the year B.C. 457 another Tai wang. The account which speaks of him is in the "Shih kì," chapter xliii., where the author is relating the fortunes of the house of Chau. The elder sister of the Prince of Chau was the wife of Tai wang. While brother and sister were in mourning for their father, the former invited Tai wang, his brother-in-law, to a feast, and directed the cooks to attack and kill him with their copper ladles, which they had first used in presenting food to him. The widow afterwards committed suicide with her hair-pin. The object of the ruler of Chau in the murder was to obtain the dominions of the Tai wang for himself. The people of the locality, adds the historian, pitied the unhappy queen, and after her death named the mountain where this event took place "the hill of the suicide with a hair-pin," *mo kì chi shan*. When the Prince of Chau had effected the murder, another work adds, he sent a messenger to his sister to say, "To feel indifference for a husband's death because it was caused by a brother would not be kindness. To hate a brother for a husband's death would not be right." After hearing this speech she committed suicide, and the envoy at once followed her example and put an end to himself. The feelings of the people were much stirred by these events, and it seems likely that one of the large mounds would be raised to the assassinated Tai wang. This however is not certain, and the number, names, and dates of other persons who bore the title are now beyond the reach of investigation.

Several pieces of broken pottery were found by Mr. Williams in the neighbourhood of the mound, and their pattern is different from modern crockery ware. The small mounds are in groups chiefly outside the wall, and seem to be all placed irregularly. The hatchet is about five inches long, and is made of a black stone not heavy when held in the hand. It resembles in shape those preserved in Ohio museums.

On the whole, as the reader of this account will agree, the highest of the two large mounds is most likely the tomb of the prince assassinated, in the manner here described, in the year B.C. 457. The village in the centre, and the large mound second in size near it, popularly called Tai wang, probably indicate that a later personage was buried there.

I should add to this statement that there is in Kwan chung a passage in the twenty-fourth chapter which is as follows:—"Hwan kung, ruler of Tsi, asked Kwan chung, 'What produce is there in the Tai country?' The philosopher replied, 'White fox-skins. They are, however, dear to buy. They appear in the sixth month, when the yang principle changes to yin. If you, the ruler of Tsi, offer to buy them at a high price, the people of the Tai kingdom will at once, from the hope of gain, go out in force to hunt for them. Tsi keeps its gold and waits. While the Tai people are hunting in the wilds and off their guard, their enemies on the north, the Lai ti, will attack them, and in this case the Tai country will fall to Tsi.' The ruler of Tsi adopted this plan for obtaining possession of Tai, and sent envoys with money to negotiate for white fox-skins. The King of Tai, hearing what they desired, said to his chief councillor, 'The money offered to us by Tsi is the very thing for want of which we are not equal to the Lai ti people. It is fortunate that this proposal is made to us.' He then ordered his people to go out hunting for white fox-skins. During twenty-four months they searched without finding any. The Lai ti people learned that the Tai kingdom was not in a state of defence, and attacked its northern frontier. The Tai wang in great fear gathered his troops and posted them above a defile called the valley of Tai. The invasion proceeded, and the Tai wang took his soldiers with him and submitted to Tsi. So in less than three years Tai submitted to Tsi without its being necessary to spend any money on the purchase of the skins which Kwan chung praised."

This passage must by fair criticism be ascribed not to Kwan chung himself but to some unknown author of the age of the contending States three or four centuries later. There was no Tai kingdom in the time of Kwan chung, and invention of this sort was common in the period of the contending States. Kwan chung had ascribed to him many expedients of statecraft which never occurred to him, and this of the fox-skins was amongst them.

JOSEPH EDKINS

NOTES

M. JANSSEN has been appointed by the Paris Academy of Sciences to represent the French Government in the Congress which is to be held at Washington to determine the choice of the first geographical meridian. It is just to state that the original idea of a universal first meridian belongs to France, and that as far back as 1632 a decree signed by Louis XIII. and proposed by Cardinal Richelieu established a universal meridian on the island of Ferro. This meridian was ultimately abandoned by Cassini to gratify Louis XIV.'s pride, and the Paris one was retained by the Metric Commission in 1793 under the pretence that an arc of this meridian had been measured for determining the length of the unit of measure.

WE regret to announce the death of Dr. Heinrich Schellen, formerly director of the Cologne Realschule, and author of two well-known works, "Der electromagnetische Telegraph" and "Die Spektralanalyse." Besides these, Dr. Schellen published a book on arithmetic, an excellent German version of Padre Secchi's great work on the sun, and various other works on physical subjects. It was under his directorship and by his efforts that the Cologne School was raised from the rank of "Bürgerschule" to that of "Realschule erster Ordnung," and that it attained the high reputation it now enjoys. He died in Cologne in the first week of September, aged sixty-six years.

WE regret to announce the death of M. Jean Augustin Barral, the Perpetual Secretary of the French Société d'Agriculture, and the chief editor of *L'Agriculture*, a periodical of large circulation, and which, of all the Continental agricultural papers, was the most intensely devoted to the adaptation of English principles of rural economy to French conditions. M. Barral was born in Metz in 1820, and was a pupil of the Polytechnic School, where he was a *repetiteur* of chemistry for some time. He became most intimately connected with Bixio, the editor of *Maison Rustique*. Bixio and Barral made two daring aeronautical ascents from the Observatory grounds in 1850, when they ascended to an altitude of 18,000 feet, a height unsurpassed except by Glaisher and Tissandier. When Arago died he selected M. Barral, who had acted as his secretary for a long period, to publish his works. The Barral edition contains twelve large octavo volumes, exclusive of the "Astronomie Populaire," which fills four other volumes, and has been translated into almost every language. M. Barral edited the *Revue Horticole* and the *Journal d'Agriculture Pratique* for many years; it was on the occasion of the death of his friend Bixio that he resigned and started *L'Agriculture*, of which he was not only the editor but also the proprietor. He edited for ten years the *Revue de la Presse Scientifique*, an influential paper whose publication was stopped after a brilliant existence of eight years. M. Barral was a very popular character, much appreciated in Paris, where his loss will be heavily felt. Besides his editorial work he has written some popular works on scientific topics, and he leaves a number of academical essays, of which some have been edited under the form of pamphlets.

THE death is announced at Meran of Dr. Settari, one of the authorities on Lepidoptera.

A WARSAW correspondent informs us that on the 16th inst. there died in that city Jakób Natanson, formerly Professor of Chemistry in the principal school there. The late Prof. Natanson prepared carbamide synthetically by the action of ammonia gas on phosgene ($COCl_2$) in 1856. Prof. Natanson wrote many scientific papers in the Polish language; the most valuable are a text-book of chemistry ("Krótki myklad chemii organiérnéj") and a treatise on organic chemistry. He also improved the methods of determining the density of vapours.

MESSRS. CASSELL AND CO. announce the forthcoming publication of "A History of British Fossil Reptiles," with 268 plates, by Sir Richard Owen, K.C.B. The edition, it is stated, consists of 170 copies only (each copy being signed by Prof. Owen), and no further number can be produced, as the plates from which the illustrations have been printed have been destroyed.

THE German Association of Naturalists and Physicians met last week at Magdeburg.

THE French Association for the Advancement of Science has decided that its next meeting will be held at Nancy. The President of this session, which promises to be most interesting, will be M. Friedel, member of the Academy of Sciences and Professor of Chemistry at the Sorbonne. The general secretary will be M. Collignon, Professor of Mechanics to the École des Ponts and author of the text-book on mechanics used in almost every French academy.

THE autumnal meeting of the Iron and Steel Institute was opened at Chester on Tuesday, when Dr. Percy, F.R.S., was elected President.

THE Social Science Congress has been meeting at Birmingham during the past week. In the Education Department Mr. Oscar Browning was President, and in his inaugural address he contrasted the ardent desire for a University education displayed by the Germans, who were content to beg to obtain it, with the apathy displayed in England. Our primary education was organised in a manner which became more effective every year. A complete system of University education which should lead the best scholars from the primary school to the University, and which should educate the bulk of the middle class, could not be said to exist. This was a crying want; it paralysed the activity of England in many directions, and the want could not be adequately supplied without the initiative of the State. On the Continent there might be too much theory and too little practice, but in England we had suffered until lately from having no theoretical training at all. He advocated such a technical education as that by which the Continent had progressed so much during the last half-century. Contrasting Germany and England he showed how a youth naturally fitted for an academic career could, however poor, by State aid go to the German University, while he had no such sure road in England. The best means by which this deficiency in our national life could be supplied, he thought, would be, first, by putting ourselves on an equality with other nations by determining that in every town in England of a certain size there should be at least one State school, where, for a very moderate charge, an education of the classical type should be given equal to the best which the country could supply, and that by the side of this, either in the same school or in a separate establishment, according to the population of the town, there should be facilities for passing a curriculum of modern education which should fit a man either for a commercial or for a scientific career. It could not be hoped that such schools would be self-supporting, and the time would come when the amount contributed by the Budget to national education would mark the national prosperity.—In a paper in the same Section, Dr. H. W. Crosskey said that in order that science may be effectively taught in public elementary schools, it must be taught experimentally. Actual demonstrations must accompany the lessons at every stage. It must be taught systematically and continuously. The "getting up" of some branch of science during three or four months as a "specific subject" is of little use. Special science demonstrators must be appointed. No man can be a good demonstrator who does not devote to the work the greater part of his daily

life. The ordinary master of a school has many duties to discharge. He cannot by any possibility give any sufficient proportion of his time to the art and practice of scientific demonstration. By the peripatetic system experimental lessons can be given at every school, by a trained man of science, at a moderate cost. A central laboratory is erected in which experiments are prepared. The demonstrator visits each school in succession, the apparatus being brought by a hand-cart from the laboratory. The results actually attained in Birmingham were described. It was argued that experimental teaching gives the death-blow to cram, and that the elements of ordinary education are better mastered when the intellectual life of the scholars is aroused by science. The arrangements of the peripatetic system will suffice until the Sixth Standard is passed; but special provision must be made for those lads who can remain a year or two longer at school, and whose future employments render the extension of their scientific training desirable. To meet the wants of this class, a school has been opened as an experiment in New Bridge Street, Birmingham, in premises belonging to the Chairman of the Board (Mr. George Dixon), who, at the cost of more than 2000*l.*, has adapted them for the purpose, and placed them rent free at the service of the Board. It is specially intended for scholars who will have to become working-men, but whose parents can keep them at school after they have passed the Sixth Standard, and the fee (*3d.* a week) is adapted to their means. There is a special master for chemistry and metallurgy, another master for mechanics and physics, a drawing-master, and a mathematical master, a highly-qualified scientific man being placed at the head. Workshop instruction is provided, and includes a knowledge of the chief wood tools, and the properties of materials, while it supplements the mechanical drawing of the schoolroom, and it is an aid to the study of theoretical mechanics. The course of instruction is arranged to extend over two years. It is not an attempt to benefit a few picked scholars, or to provide a higher-grade school for those able to pay high fees, but it is a continuation of the science training given by means of the peripatetic method in every ordinary elementary school under the Board.

THE Americans are not content with an Electrical Exhibition at Philadelphia; we see that there is to be another at Boston this year, opening on November 24 and closing on January 5, 1885. Space and power to be found free, but there is an entrance fee of ten dollars. The object of the Exhibition is stated to be "to show the rapid advancement that has been made in electricity, its methods and appliances, and all its possibilities and probabilities."

WE are requested to announce that the Fifth Annual Cryptogamic Meeting of the Essex Field Club will be held on Friday and Saturday, October 3 and 4, in Epping Forest. The meeting will be under the direction of Dr. Cooke, Dr. H. J. Wharton, Mr. Worthington Smith, Rev. Canon Du Port, Rev. J. M. Crombie, Prof. Boulger, Mr. David Houston, Mr. F. J. Hanbury, Mr. Henry Groves, Mr. W. W. Reeves, Dr. Spurrell, and other well-known botanists. Those wishing to attend the meeting should apply for programmes and tickets to the Honorary Secretary, Buckhurst Hill, Essex.

WE stated some months ago that Capt. Scheele of the Swedish trading barque *Monarch*, before leaving Sweden for Melbourne, had asked the Zoological Museum at Upsala to lend him the necessary apparatus, vessels, &c., for deep-sea researches, with which request the Museum gladly complied. The results appear to have been so fruitful, that the *New York Herald* and the *Sun*, on the vessel recently arriving in New York, sent representatives on board, and devoted a great deal of space to descriptions of the collection made by "the intelligent Swedish seaman." The collection is, it is stated, very rich, filling two hundred vessels, and contains many new varieties. It will be forwarded to Upsala, while Capt. Scheele proceeds with his scientific researches during a voyage to the West Indies.

ONE of the most remarkable articles of export ever despatched for scientific purposes from any country is without doubt the consignment which has just left Norway for Germany. It is no less than fifty-two skeletons of Lapps, which have during the summer been unearthed at Utsjok in Russian Lapland, and which an enterprising dealer of Vardö has sold to various museums and societies on the Continent at the price of 6*l.* a piece. Two of the skeletons are those of children, the rest those of adults.

THE Berlin Academy of Sciences has commissioned Dr. Georg Volkens, a young botanist, to proceed to the sulphur-baths of Heluan, which are situated some 20 kilometres west of Cairo, in order to make a thorough investigation of the anatomy of desert plants, and micro-scopical researches concerning the growth of these plants.

UP to the present the North Cape on Mager Oe was considered to be the northernmost point of Europe. Capt. Sörensen, however, has recently found that Cape Knivskjaerodden, on the same island and west of the North Cape, lies 30" to the north of the latter; 30" of arc would correspond to about 926 metres. The latitudes found by Capt. Sörensen for the two capes are 71° 10' 15" N. for the North Cape, and 71° 10' 45" N. for Cape Knivskjaerodden.

A SEVERE earthquake occurred at Windsor, Ontario, at a quarter to three on the afternoon of September 19. Shocks were felt at twenty minutes past two at Grasslake, Michigan, where some school children fainted with alarm, and at Toledo, Ohio, and neighbouring towns. The shocks lasted fifteen seconds, and in some instances buildings rocked and their contents were displaced.

MM. D. TOMMASI AND RADIQUET have brought out a new battery with two carbon electrodes. The positive electrode consists of a carbon plate placed at the bottom of a porcelain vessel and covered with peroxide of lead, the negative electrode consists of a carbon plate containing on its upper surface platinised coke. The two plates are separated by a sheet of parchment paper. The liquid used is a saturated solution of common salt, which must not completely cover the upper plate. The E.M.F. on closed circuit is 0·6 volts.

IN a paper on "Electric Lighthouses" M. De Meritens gives some very interesting figures in comparing oil and electricity as illuminants. The figures, he states, are taken from two memoirs by M. Allard. As an example, the light at Dunkirk, obtained from mineral oil, is 6,250 candles, which in weather of mean transparency is seen for 53 km.; if this be compared with an electric light of 125,000 candles, it is found that the electric light is seen for 75·4 km. Thus, an increase in the illuminating power of twenty times only increases the penetrative distance 22 km. or 42 per cent. If we now take a less transparent state, the ratio is reduced to an increase from 24 to 32 km. or 34 per cent. Or, lastly, in very foggy weather the distances are 3·7 and 4·6 km., showing an increase of 24 per cent. From these general figures M. Allard has calculated that in foggy weather in the Channel the luminous intensity with oil of 6250 carcels is 3·805 km.; then, if this be increased to an oil illumination of 125,000 carcels, the luminous intensity of 4·740 km. Now, comparing this with an electric light of 125,000 carcels, he finds the luminous distance to be 4·696, or the penetrating power of the electric light is less than 1 per cent. less than mineral oil, whilst its cost, as computed by both English and French engineers, is from four to six times less than that of oil.

THERE is unfortunately now no doubt that Phylloxera has begun to appear in Rhenish Prussia. The districts of Heimersheim and Lohrsdorf in the valley of the Ahr are hopelessly infected and considered lost. Every effort is being made to prevent the pest from spreading.

THE Japanese appear to be determined to render themselves, as far as possible, independent of foreign countries. They have, says the *Pharmaceutical Journal*, established in Tokio a factory for the production of pharmaceutical chemicals on a large scale. A company with a capital of about 40,000*l.* has been formed for this purpose. Of this amount the Government has contributed one-half free of interest for twenty years, besides making a free grant of land and erecting the necessary buildings. A similar company is taking up the utilisation of the waste *saké* from the native breweries in the manufacture of alcohol, and the manufacture of bleaching-powder on a large scale has been commenced. Whether with the object of "protecting" the first of these enterprises or not does not appear, but we learn from the same authority that an increased tax has been placed in Japan on imported patent medicines, and the nature of the articles to which this has been extended is stated to have largely affected the import of some chemicals into that country. Santonin, which was at one time much in request among the Japanese, decreased 20,000 ounces in import last year, although the price was lower; on the other hand, the consumption of quinine showed an increase.

IN a paper read before the Vaudois Society of Natural Sciences, M. Schnetzler explained the results of his studies on the colour of flowers. He argues that only one colouring substance exists in plants, and that the various colours of flowers are only due to the modifications made in this substance by the acids or alkalis contained in the plants themselves.

A VICTORY has been gained by Van Rysselberghe in Belgium by the solution of the problem of transmitting a telegraphic and a telephonic message along the same wire at the same time. A trial of this has been made at the Antwerp Universal Exhibition, where concerts held in important towns in Belgium were heard; the transmission being made with ordinary instruments along ordinary telegraph lines and with earth returns.

M. COLLADON has observed a curious phenomenon connected with hailstones. He observed, on some occasions, that two or three seconds after they had fallen they sprung into the air again, to a height of 0·25 m. or 0·30 m., as if they had been struck upwards by the earth.

THE additions to the Zoological Society's Gardens during the past week include a Green Monkey (*Cercopithecus callitrichus* δ), a Ludio Monkey (*Cercopithecus ludio*) from West Africa, presented by Mr. A. Bowden; an Australian Fruit Bat (*Pteropus poliocephalus*) from Australia, presented by Capt. C. D. Long; a Tawny Owl (*Syrnium aluco*), British, presented by Miss H. Freeman; a Coypu Rat (*Myopotamus coypus*) from South America, presented by Mr. Frank Parish, F.Z.S.; two Black-billed Tree Ducks (*Dendrocygna arborea*) from Antigua, West Indies, presented by Mr. C. Arthur Shand; a Blackcap (*Sylvia atricapilla*), British, presented by Mr. H. Keilich; a Spanish Terrapin (*Clemmys leprosa*), South European, presented by Master A. Brierly; a Horned Lizard (*Phrynosoma cornutum*) from California, presented by Mr. Alfred R. Wallace, F.Z.S.; an Indian Python (*Python molurus*) from Ceylon, presented by Mr. A. A. Dalmege, F.R.G.S.; a Bonnet Monkey (*Macacus sinicus*) from India, two North African Jackals (*Canis anthus*) from Spain, deposited; two Half-collared Turtle Doves (*Turtur semitorquatus*), two Triangular-spotted Pigeons (*Columba guinea*), two Bronze-spotted Doves (*Chalcopelia chalcopilos*), four Harlequin Quails (*Coturnix histrionica*), an Allen's Porphyrio (*Hydrornis allent*) from West Africa, received on approval; a Levaillant's Cynictis (*Cynictis penicillata*), three Long-fronted Gerbilles (*Gerbillus longifrons*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

THE FIGURE OF URANUS.—In a note communicated to the Reale Accademia dei Lincei, Prof. Millosevich collects the measures of Uranus which have been made by various observers, and adds the results of several series made by himself at the Observatory of the Collegio Romano. While the recent measures of Schiaparelli at Milan are in accordance with those of Madler at Dorpat, as regards a very sensible ellipticity, most observers have failed to recognise, or at least have not referred to, any measurable quantity, amongst them Engelmann, Vogel, Lassell, Marth, and Kaiser. It is a point which might be expected to be readily settled if large telescopes were brought to bear upon it, and particularly if the double-image principle of measurement were employed.

THE LUNAR ECLIPSE ON OCTOBER 4.—During this eclipse the moon will be in a somewhat bare part of the sky, and with one exception no star brighter than the tenth magnitude will be occulted while she is immersed in the earth's dark shadow, or between 9h. 16m. and 10h. 48m. One of the tenth magnitude, of which an accurate position is given in vol. vi. of the Bonn Observations disappears at 9h. 33m. 35s. and reappears at 10h. 37m. 54s., the angles being respectively 137° and 271°; No. 800 of Weisse's Bessel, 0h. R.A., disappears at 10h. 35m. 24s. at 100°, but does not reappear till 11h. 45m. 35s. (308°) when the moon will have begun to emerge from the shadow; this star is estimated 9 m. by Bessel. The times are for Greenwich.

OLBERS' COMET OF 1815.—In Nos. 2613–14 of the *Astronomische Nachrichten* Prof. Krueger has printed the sweeping-ephemerides for this comet calculated by Herr Ginzel of Vienna, at least between the dates October 1 and January 1. Although the epoch of perihelion passage directly resulting from the computation of the perturbations during the present revolution does not fall before December 1886, the discussion of the observations in 1815 left an uncertainty of ± 1·6 year in the time of revolution at the instant of perihelion passage in that year, and it may be well to commence a search for the comet forthwith; it is to be remarked, however, that, should it reach perihelion in midwinter in these latitudes, it is not likely to pass unobserved, the intensity of light being then at a maximum, and the comet at a high north declination.

THE COMET OF 1729.—"La Comète de 1729 est de toutes les comètes, observées jusqu'en 1780, celle qui a été vue à la plus grande distance du Soleil et de la Terre," writes Pingré in his "Cométographie." Upwards of a century has since elapsed, and yet no comet observed in the meantime has had a perihelion distance at all approaching that of the comet discovered by Père Sarabat at Nismes on July 31, 1729. The comet was seen until the end of January following, and was observed by Cassini until the 18th of that month. From some of his observations newly reduced, Burckhardt calculated both parabolic and hyperbolic orbits which were first published in the *Connaissance des Temps* for 1821. Recently, employing Burckhardt's reductions of Cassini's observations on September 3, November 10, and January 16, Mr. Hind has found the following parabolic elements:—

Perihelion passage, 1729, June 16·15422 M.T. at Paris

Longitude of perihelion	321	2	46·1	Mean Equinox 1730·0
,, ascending node ...	310	37	8·3	
Inclination	77	4	6·0	
Logarithm of perihelion distance..	0·607513			

Motion—direct

By which the middle observation is represented within 16″ in longitude and 10″ in latitude. The distances from the earth and sun at the times of the three observations are:—

1729 Sept. 3 ..	From Sun, 4·107 ...	From Earth,	3·142
Nov. 10 ...	,, 4·240 ...	,,	4·339
1730 Jan. 16 ...	,, 4·439 ...	,,	5·132

The distance in perihelion is 4·05, the earth's mean distance from the sun being taken as unity. The comet of 1747 had a perihelion distance of 2·198, which is the nearest approach to that of the comet of 1729; it was a very exceptional and extraordinary body.

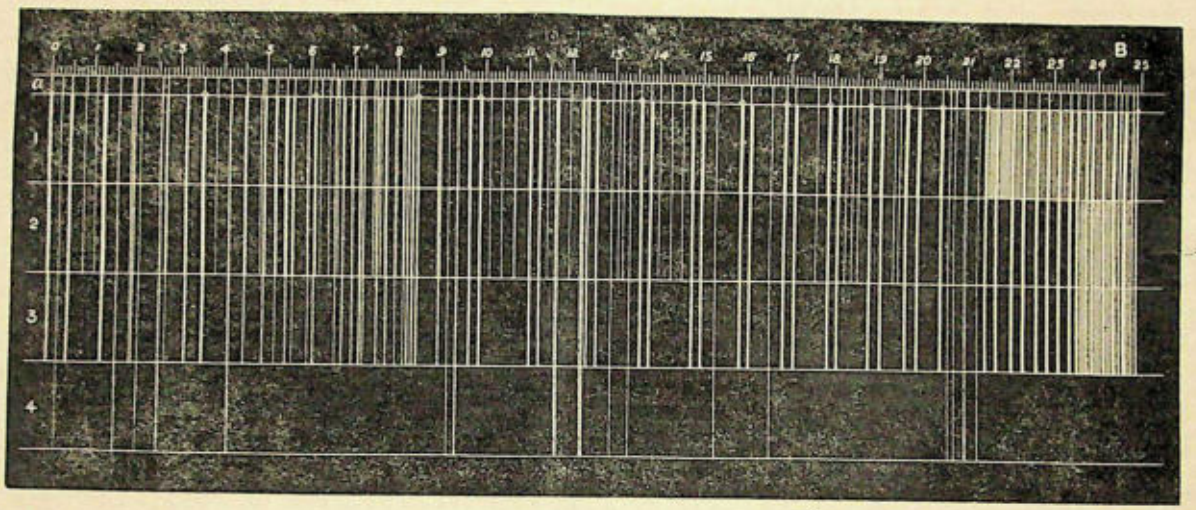
CONSTITUTION AND ORIGIN OF THE GROUP B OF THE SOLAR SPECTRUM[1]

WHEN a single prism spectroscope is directed towards the sun at the moment when it is in the neighbourhood of the zenith, we perceive near C, at about a fourth of the distance separating it from the extreme red, a strong black line, which Frauenhofer has named B. Under a more powerful instrument of five or six prisms this line becomes a very black broad band, separated from the region of C by what may be described as almost an empty space, the lines which do exist in it being few and faint. On the other side this band is followed by well-marked lines, which appear to be very regularly spaced, and the first of which show some indications of being double. Father Secchi had vainly attempted to resolve the band B; on this subject he writes:—

"Certain bands which in ordinary instruments seem to be stumped consist in reality of numerous perfectly distinct lines, as is seen in a spectroscope possessing great dispersive power; but some of them are really massed towards the edge, and there it is impossible to separate them, however powerful the instrument employed. We may cite as an example the lines of the group B" (*Le Soleil*, vol. i. ed. 1875, p. 235).

The statement of the learned physicist shows that, at the time he wrote the above, spectroscopic apparatus had not been brought to very great perfection or power. In point of fact the dispersion of eight or ten prisms suffices to show that the band B is really formed of a large number of distinct lines. With my highly-dispersive instrument it becomes resolved in a truly marvellous manner. The seventeen lines composing it are distinguished with the greatest clearness, and may be very exactly measured. Those following it on the red side are all broadly doubled, presenting in their regularity a very remarkable appearance.

In 1878 Messrs. Piazzi-Smyth and Langley succeeded for the first time and almost simultaneously in resolving this group. Piazzi-Smyth, working with prisms, obtained only an incomplete resolution, whereas, by means of Rutherford's excellent appliances Langley not only separated all the lines, but also determined their wave-lengths. Being unaware of the work of these physicists, I fancied I had been the first to obtain these results in 1879, when making the first essays with my highly-dispersive apparatus. The sulphide of carbon compound prisms, which M. Laurent had just made, were merely mounted on a drawing-board, were badly regulated, badly sheltered from variations of temperature, and could not yield the results that I now obtain. The drawing which on that occasion I published in the *Comptes Rendus* is incomplete and inaccurate. That



Solar Spectrum—Region B, by M. L. Thollon.

a. Position of the lines.
1. Mean aspect of region B when the sun is 80° from the zenith.
2. " " " 60° " moist weather.
3. " " " 60° " dry "
4. Non-telluric lines. Spectrum of region B as it would appear if observed outside the atmosphere.

which accompanies this article has been made with the greatest care and to a scale on which the errors of position can scarcely exceed 1/10 mm. It is more complete than any I have yet seen.

The explanations given at the foot of my design enable us to recognise at a glance: (1) the metallic lines, (2) the telluric lines produced by the variable element of the atmosphere (beyond all doubt aqueous vapour); (3) the telluric lines proceeding from the constant elements (oxygen, nitrogen, carbonic acid). The group is thus seen to consist of a pencil of seventeen rays, constituting properly speaking Frauenhofer's B-band; of a system of twelve couples with intervals increasing regularly from right to left, whereas the distance of the constituents diminishes with equal regularity in the opposite direction; lastly, of a somewhat important group belonging to the vapour of water, the whole interspersed with a few weak metallic lines.

When we survey the solar spectrum given by my apparatus, beginning with the violet, and when we behold the thousands of lines composing it distributed in all the regions without any apparent kind of order, on arriving at the group B we feel, as Mr. Langley remarks, the same impression as does a traveller lost in a virgin forest when he suddenly finds himself in the presence of a perfectly straight avenue of trees planted with mathematical regularity. It should be added that A at the extreme red, and a comprised between C and D are identically constituted. If they attract less attention it is because A is nearly at the limit of the field of vision, while the regularity of a is disguised by a large number of lines foreign to its origin. Beyond these three cases chance alone seems to have presided over the distribution of lines throughout the whole spectrum.

But the interest attaching to these groups is due not only to their remarkable appearance, but also and especially to the question of their origin. In what regions are produced the absorptions which give them birth? In the solar atmosphere, in the terrestrial atmosphere, or in some medium comprised between the sun and the earth? Do these absorptions proceed from a common element, and if so what is its nature? The most contradictory answers have been given to these various questions, which have already long since been asked.

To speak only of B, after his memorable experience of La Villette in 1866, M. Janssen asserted that this group was at least to a great extent due to aqueous vapour. The little sketch published by him in the *Annales de Chimie et de Physique* (4th series, vol. xxiv. p. 217) in fact shows, facing B, bands of absorption due to the vapour of water, and corresponding exactly to the spectral bands yielded by the setting sun in this region. On the other hand, Ångström, who had devoted much study to the question, tells us that at the low temperature of 27° C.,

[1] Paper by M. L. Thollon in *Bulletin Astronomique*, May 1884.

when the other telluric lines had almost entirely disappeared, he saw B perfectly distinct. At a like zenith distance from the sun this group seemed to him even blacker and more intense than usual. Hence his inference that it could not proceed from the vapour of water. This eminent physicist, a thoroughly convinced partisan of spectral unity for the simple gases, had ascertained that in the spectrum of atmospheric emission there was no trace of any ray or band corresponding to B. It followed for him that the air could not absorb radiations it was incapable of emitting. If therefore this group, variable like the other telluric rays, could be attributed neither to aqueous vapour, to nitrogen, nor to the oxygen of the air, from what element did it derive its origin? Ångström spoke of carbonic acid, but perhaps without believing in it. He seemed deeply interested in Tyndall's experiments on the absorbing power of gases by heat. We know that this skilful investigator had found that the coefficients of absorption of oxygen and nitrogen by no means corresponded with the coefficient of absorption of the air. The difference he attributed to some unknown element sufficiently rarefied to escape our analyses, and endowed with immense absorbing power. Ångström had probably this unknown element in his mind, but he remained uncertain to the last.

The great authority of the Swedish physicist could not fail to have its influence on the judgment of those approaching the question after him. Captain Abney, who has so greatly distinguished himself by his remarkable scientific labours, asserts in NATURE (October 12, 1882, p. 585) that the groups A and B cannot be regarded as telluric, but as proceeding from a medium lying between the sun and the earth. Piazzi Smyth, who had at first looked on B as telluric, seems to have finally adopted Captain Abney's views, and is disposed to think that B as well as A may after all be the product of some interplanetary medium. In his opinion the recent theories of Siemens seem to confirm his view of the case.

The attention that I have for several years paid to the portion of the solar spectrum stretching from A to *b* has naturally led me to deal with this subject. Here is the method by which I succeeded in separating and classifying the spectral lines. After certain preliminary measures taken with the greatest care to determine their exact position, each region of the spectrum is drawn on two maps. The first is intended to reproduce the appearance of this region when the sun is at 60° from the zenith, the second when at 80°. These distances have been chosen in such a way that in the latitude of Nice the observations may be continued throughout the year. When the weather seems favourable at the hour when the sun is in the desired position, the intensity of each line is marked on the map itself with all possible exactness, the hygrometric state of the air being indicated each time. The process is slow, delicate, and laborious, but the result is certain. After I have thus made eight or ten series of observations on each drawing, they are carefully examined, and the indications relative to any given line enable me confidently to decide:—(1) whether it is not metallic; (2) whether a telluric line belongs to a constant or to a variable atmospheric element. By this method I have been able to satisfy myself that A, B, and a are telluric groups due to the constant elements of the air. *At the same distance from the zenith they have always the same intensity.* I refer of course only to the main groups in each of them, and to the couples following them on the least refrangible side.

It remained to determine exactly to what atmospheric element the groups in question were to be attributed. M. Egoroff, Professor of Physics at the University of Warsaw, has recently succeeded in solving the problem. He had for several years ardently devoted himself to this inquiry, and in 1882 we jointly made a series of experiments on the subject in the Paris Observatory. A pencil of electric light directed from Mount Valérien on the Observatory, distant 10 km., gave us the spectrum of the telluric rays all but complete. There was no difficulty in distinguishing A, B, and a, which are so easily recognised. Capt. Abney has questioned the results obtained by us. Yet they are incontestable, and in any case the experiment can be easily repeated.

At last, after these preliminary studies, M. Egoroff, operating directly on oxygen closely compressed in a metallic tube, and traversed lengthwise by a pencil of strong light, has obtained the groups A and B. The thickness of the oxygen thus traversed was doubtless insufficient for the production of a. But however this be, it may now be confidently asserted that these three, which are of such remarkable appearance, and which so closely resemble each other, have their origin in the absorption due specially to atmospheric oxygen.

I need not dwell upon the importance of this result; but how is it to be reconciled with the observations of Messrs. Janssen, Ångström and Piazzi Smyth? To judge from the sketch contained in the *Annales*, and above referred to, M. Janssen must have seen in the spectrum of aqueous vapour bands corresponding to those of the solar spectrum in the region of B. One of them even coincides exactly with the chief member of the group. According to my own observations, to produce this effect the vapour of water would have to yield at this point a non-resolvable band, which would simply obscure the intervals between the lines, as is seen in the spectrum 1 of my drawing. This observation should then vary according to the hygrometric state of the air, and not, as it has always seemed to me, according to the height of the sun. Or else this band is not represented in the exact position it ought to occupy, and should be shifted more to the left, where in fact are found many lines of the vapour of water constituting an important group (see plate).

If, on the other hand, Ångström saw B more intense at a temperature of 27° C., it was doubtless owing to a simple effect of contrast. The other telluric lines being greatly weakened, those that retain their intensity must naturally appear blacker. Such an effect is frequently produced in the course of my observations, and against it I have to be constantly on my guard. And now how can we explain why the spectrum of absorption of the oxygen differs so much from its spectrum of emission? The lack of sufficient data renders all explanation impossible; but the certainty of the fact obliges us to conclude that *cold* has not the same properties as *incandescent* oxygen, and allows us to suspect that it may be the same with all gases.

In asserting that A and even B do not really vary in intensity when the sun approaches the horizon, such an eminent observer as Piazzi Smyth would have greatly surprised professional spectroscopists, were they not aware how difficult and delicate a matter is the management of an apparatus of highly dispersive power. Let but the luminous pencil be badly adjusted, the prisms less than faultlessly regulated, the slightest cloudiness settle on the surfaces, the images, especially in the extreme red, will at once appear as if drowned in the diffused light, which obscures the most evident effects and even disfigures their essential characters. Strange phenomena are often produced, the causes of which it seems impossible to discover, and which easily give rise to illusions. But when we work under favourable conditions with a well-designed and well-constructed apparatus, it becomes superabundantly evident that A and B vary considerably in intensity according to the height of the sun, and are certainly telluric.

During the total eclipse of 1882, both M. Trépied and myself fancied we observed on the edge of the lunar disk a notable strengthening of the rays of the B group. If Captain Abney's theory could have been confirmed, it would have certainly added great weight to our observations, and for my own part I should have felt highly satisfied at the result. Unfortunately, the atmosphere of oxygen which should now be attributed to the moon in order to produce the observed effects, seems scarcely reconcilable with the absence of refraction in the luminous rays striking the edge of our satellite. I greatly fear the results obtained in Egypt are one of those illusions, of which nearly all spectroscopists have been more or less the victims.

It would now be important to ascertain whether the nitrogen and carbonic acid of the air may not be represented by any line or any group in the solar spectrum. The study I am at present engaged in, according to the above described method, will not fail, I trust, to yield precise results on this important point. Hitherto, apart from the oxygen groups, I have discovered no line that may be confidently attributed to the constant elements of the atmosphere. Hence it is desirable to await the result of my researches before giving effect to the project adopted by M. Bischoffsheim to establish on Mont Gross metallic tubes of considerable length, in which the spectra of absorption of gases may be studied on a grand scale.

THE MIGRATIONS OF "SALMO SALAR" (L.) IN THE BALTIC

THE following statement gives further details supplementary to our recent article on this subject:—

Since the earliest times salmon have been caught in the Finnish rivers which had in their mouths or entrails hooks

of a peculiar shape entirely unknown in Finland. Such hooks have been found in salmon taken in all Swedish and Finnish rivers falling into the Gulf of Bothnia. At one of the salmon fisheries in the Uleå River, for instance, where the fish is sold cleaned, twenty-five such hooks, all of brass, were collected last summer and handed to me. With a few exceptions the hooks are of one kind, viz. made of brass wire 2 to 2·5 mm. thick, a little compressed in the hook itself, while the length varies from 9·5 to 11·5 cm. Most of the hooks are 10·5 cm. in length, and the width of the bend 2·5 to 3·5 cm. Generally a bit of line 1 to 2 mm. thick, made of flax, hangs to the hook, while, when the line is long enough, a lead, conical in shape and 10 to 20 grm. in weight, is found on the same. Sometimes Latin characters are engraved on the lead, as, for instance, in one taken in the above-mentioned river last summer, which had on it "C" and "K" on each side. I am of opinion that all the hooks which have passed through my hands are of the same type and manufacture.

As it is of great practical value to discover whence these peculiar brass hooks have come, I have given considerable attention to the question, the result of which is that I have come to the conclusion that they were brought from the north coast of Germany, where they are used for salmon-fishing in the winter. Great fisheries are carried on along this coast in a depth of 30 to 60 m. and 10 to 30 km. from the shore, as far as, and probably beyond, the Russian frontier. The lines used are very like those used on the south coast of Sweden, but the hooks and leads are quite different. Prof. Benecke, of Königsberg, to whom I sent a hook taken from a salmon in the Uleå River, asserts too that these have come from the shores of Prussia and Pomerania. As hooks of this kind are not used in any other part of the Baltic or outside of it, it is evident that the salmon must have brought these from the above-mentioned places to the shores of the Gulf of Bothnia.

It is, on the other hand, but seldom that hooks of iron and tin are found in salmon in our rivers, which is caused, I believe, by the circumstance that the Scandinavians use far stronger lines for salmon-fishing than the Germans. I have, however, two in my possession which are of the exact kind used by fishermen in the sea about Bornholm and the south-east coast of Sweden.

Besides the above-mentioned kinds of hooks I have obtained a very peculiar one taken from a salmon off the town of Kristinestad. It is 4 cm. long, of hammered thick brass wire, and of a very uncommon shape, and through two holes fastened to two double-twined brass wires 40 cm. long, and 1 mm. thick. I do not know from what part of the Baltic this strange hook hails, but I believe from the Russian shore of the same.

The discovery of hooks of a foreign shape in salmon in the northern rivers of Sweden and Finland was made about 200 years ago, as may be seen in the journals of the Swedish Academy of Sciences of the seventeenth century, and even at that date their remarkable shape and manufacture attracted attention.

The relatively great number of brass hooks found in salmon taken in the rivers around the Gulf of Bothnia demonstrates beyond doubt that the fish, after visiting the coast of Northern Germany, return to the northernmost shores of Sweden and Finland, while some have visited the southern part of Sweden on their way north, as the iron hooks clearly indicate. If it is true, as is generally believed, that the salmon returns for spawning to the rivers of its birth, we may with equal force assume that the great takes of young salmon on the southern coast of Sweden and the shores of Baltic Germany during recent years is due to the rigid closing in of the rivers of Northern Sweden and Finland, whence they migrate south. During the last fifteen years, since when closing began in the Finnish rivers, the takes of young salmon—from 1 lb. to 2 lb. in weight—in nets about Bornholm and on the shores of Germany, have fabulously increased, and my opinion is that these fisheries are of such a destructive nature to this noble fish in Sweden and Finland that some arrangement ought to be made between the Baltic Powers to put a stop to the same.

By marking the salmon in England and Scotland, pisciculturists have come to the conclusion that varieties of salmon during their stay in salt water visit preferably certain parts of the coast for their food; thus, according to the late Frank Buckland, the shores around Yarmouth are the favourite haunts of the "bull-trout" of certain English and Scottish rivers. The great student of the salmon fisheries of Scotland, particularly those of the River Tweed, David Milne Holme, relates as an example of how quickly fish of the salmon kind can travel to a favourite feeding-ground, that a "bull-trout" marked with a silver thread with an inscription in the River Tweed, on March 29, 1852, was taken, on April 2, near Yarmouth, having thus accomplished a distance of nearly 300 miles in four days. Another fish was marked in the same river on March 10, 1880, and was caught at Yarmouth on May 5, having taken fifty-five days for the journey.

As the salmon, *Salmo salar*, according to the experience gained in Scotland, prefers sandy feeding-grounds during its stay in salt water, and as the bottom of the Baltic on the coast between Memel and Rügen, at Bornholm and South-East Sweden, is sand at a certain depth, where its favourite food is found, the cause of the migrations of the salmon in the Baltic southwards may be accounted for, while their return to the northern rivers of Sweden and Finland in the spring is unquestionably due to their breeding-instincts.

Helsingfors AND. JOH. MALMGREN

THE BRITISH ASSOCIATION

REPORTS

Report of the Committee, consisting of Major-Gen. Sir A. Clarke, R.E., C.B., Sir J. N. Douglass, Capt. Sir F. J. O. Evans, R.N., K.C.B., F.R.S., Capt. J. Parsons, R.N., Prof J. Prestwich, F.R.S., Capt. W. J. L. Wharton, R.N., Messrs. E. Easton, R. B. Grantham, J. B. Redman, J. S. Valentine, L. F. Vernon-Harcourt, W. Whitaker, and J. W. Woodall, with C. E. De Rance and W. Topley as Secretaries, appointed for the Purpose of Inquiring into the Rate of Erosion of the Sea-coasts of England and Wales, and the Influence of the Artificial Abstraction of Shingle or other Material on that Action. Drawn up by C. E. De Rance and W. Topley.—The importance of the subject referred to this Committee for investigation is universally admitted, and the urgent need for inquiry is apparent to all who have any acquaintance with the changes which are in progress around our coasts. The subject is a large one, and can only be successfully attacked by many observers, working with a common purpose and upon some uniform plan. The Committee has been enlarged by the addition of some members who, by official position or special studies, are well able to assist in the work. In order fully to appreciate the influence, direct or indirect, of human agency in modifying the coast-line, it is necessary to be well acquainted with the natural conditions which prevail in the places referred to. The main features as regards most of the east and south-east coasts of England are well known; but even here there are probably local peculiarities not recorded in published works. Of the west coasts much less is known. It has therefore been thought desirable to ask for information upon many elementary points which, at first sight, do not appear necessary for the inquiry with which this Committee is intrusted. A shingle-beach is the natural protection of a coast; the erosion of a sea-cliff which has a bank of shingle in front of it is a very slow process. But if the shingle be removed the erosion goes on rapidly. This removal may take place in various ways. Changes in the natural distribution of the shingle may take place, the reasons for which are not always at present understood; upon this point we hope to obtain much information. More often, however, the movement is directly due to artificial causes. As a rule, the shingle travels along the shore in definite directions. If by any means the shingle is arrested at any one spot, the coast-line beyond that is left more or less bare of shingle. In the majority of cases such arresting of shingle is caused by building out "groynes," or by the construction of piers and harbour-mouths which act as large groynes. Ordinary groynes are built for the purpose of stopping the travelling of the shingle at certain places, with the object of preventing the loss of land by coast-erosion at those places. They are often built with a reckless disregard of the consequences which must necessarily follow to the coast thus robbed of its natural supply of shingle. Sometimes, however, the groynes fail in the purpose for which they are intended—by collecting an insufficient amount of shingle, by collecting it in the wrong places, or from other causes. These, again, are points upon which much valuable information may be obtained. Sometimes the decrease of shingle is due to a quantity being taken away from the beach for ballast, building, road-making, or other purposes. Solid rocks, or numerous large boulders, occurring between tide-marks, are also important protectors of the coast-line. In some cases these have been removed, and the waves have thus obtained a greater power over the land. To investigate these various points

is the main object of the Committee. A large amount of information is already in hand, much of which has been supplied by Mr. J. B. Redman, who for many years has devoted special attention to this subject. Mr. R. B. Grantham has also made important contributions respecting parts of the south-eastern coasts. But this information necessarily consists largely of local details, and it has been thought better to defer the publication of this for another year. Meanwhile the information referring to special districts will be made more complete, and general deductions may be more safely made. As far as possible the information obtained will be recorded upon the six-inch maps of the Ordnance Survey. These give with great accuracy the condition of the coast, and the position of every groyne, at the time when the survey was made.

Appended is a copy of the questions circulated. The Committee will be glad of assistance, from those whose local knowledge enables them to answer the questions, respecting any part of the coast-line of England and Wales. Copies of the forms for answering the questions can be had on application to the Secretaries.

Appendix—Copy of Questions.—1. What part of the English or Welsh coast do you know well? 2. What is the nature of that coast? (*a*) if cliffy, of what are the cliffs composed? (*b*) what are the heights of the cliff above H.W.M.? Greatest, average, least. 3. What is the direction of the coast-line? 4. What is the prevailing wind? 5. What wind is the most important—(*a*) in raising high waves? (*b*) in piling up shingle? (*c*) in the travelling of shingle? 6. What is the set of the tidal currents? 7. What is the range of tide? Vertical in feet, width in yards between high and low water, at spring tide, and at neap tide. 8. Does the area covered by the tide consist of bare rock, shingle, sand, or mud? (*a*) its mean and greatest breadth; (*b*) its distribution with respect to tide-mark; (*c*) the direction in which it travels; (*d*) the greatest size of the pebbles; (*e*) whether the shingle forms one continuous slope, or whether there is a "spring full" and "neap full," if the latter, state their heights above the respective tide-marks. 10. Is the shingle accumulating or diminishing, and at what rate? 11. If diminishing, is this due partly or entirely to artificial abstraction (*see* No. 13)? 12. If groynes are employed to arrest the travel of the shingle, state—(*a*) their direction with respect to the shoreline at that point; (*b*) their length; (*c*) their distance apart; (*d*) their height—(1) when built, (2) to leeward above the shingle, (3) to windward above the shingle; (*e*) the material of which they are built; (*f*) the influence which they exert. 13. If shingle, sand, or rock is being artificially removed, state—(*a*) from what part of the foreshore (with respect to the tidal range) the material is mainly taken; (*b*) for what purpose; (*c*) by whom—private individuals, local authorities, public companies; (*d*) whether half-tide reefs had, before such removal, acted as natural breakwaters. 14. Is the coast being worn back by the sea? If so, state—(*a*) at what special points or districts; (*b*) the nature and height of the cliffs at those places; (*c*) at what rate the erosion now takes place; (*d*) what data there may be for determining the rate from early maps or other documents; (*e*) is such loss confined to areas bare of shingle? 15. Is the bareness of shingle at any of these places due to artificial causes? (*a*) by abstraction of shingle; (*b*) by the erection of groynes, and the arresting of shingle elsewhere. 16. Apart from the increase of land by increase of shingle, is any land being gained from the sea? If so, state—(*a*) from what cause, as embanking salt-marsh or tidal foreshore; (*b*) the area so regained, and from what date. 17. Are there "dunes" of blown sand in your district? If so, state—(*a*) the name by which they are locally known; (*b*) their mean and greatest height; (*c*) their relation to river mouths and to areas of shingle; (*d*) if they are now increasing; (*e*) if they blow over the land, or are prevented from doing so by "bent grass" or other vegetation, or by water channels. 18. Mention any reports, papers, maps, or newspaper articles that have appeared upon this question bearing upon your district (copies will be thankfully received by the Secretaries). 19. Remarks bearing on the subject that may not seem covered by the foregoing questions. [N.B.—Answers to the foregoing questions will in most cases be rendered more precise and valuable by sketches illustrating the points referred to.]

SECTION A—Mathematical and Physical Science

On Loss of Heat by Radiation and Convection as affected by the Dimensions of the Cooling Body; and on Cooling in Vacuum, by J. T. Bottomley.—In the course of a series of experiments on the heating of conductors by the electric current, which were carried on during the past winter, I obtained a considerable number of results which both gave me the means of calculating the *emissivity* for heat in absolute measure of various surfaces under different circumstances, and also caused me to undertake a number of special experiments on the subject. These experiments are still in progress, and I am making preparation for a more extended and complete series; but a brief notice of some of the results already arrived at may not be without interest to the British Association.

The experiments were made on wires of various sizes, some of them covered and some of them bare, cooling in air at ordinary temperatures, and at normal and also at very much reduced pressures.

The mode of experimenting was as follows;—

A current passing through a wire generates heat, the amount of which is given by Joule's well-known law—

$$H = C^2 R/J \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where C is the current, R the electrical resistance, J Joule's equivalent, and H the quantity of heat generated per unit of time; each being reckoned in C.G.S. units. Let l be the length of the wire, d its diameter, and σ_t the specific resistance of the material at temperature $t°$ (at which temperature let us suppose that the wire in the given external conditions is maintained by the current). Then

$$R = \frac{\sigma_t l}{\frac{1}{4}\pi d^2} = \frac{4\sigma_t l}{\pi d^2}$$

Hence from (1)—

$$H = \frac{C^2}{J} \cdot \frac{4\sigma_t l}{\pi d^2} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

Consider, now, that the wire suspended in the air is losing heat by its surface, and let us suppose that it neither loses nor gains heat by its ends. Let H' be the quantity lost by emission from the surface per unit of time. Let e be the emissivity, or quantity of heat lost per unit time per unit area of the cooling surface per unit difference of temperatures between the cooling surface and the surroundings; and $t°$ being, as has been said above, the temperature of the wire, let θ be the temperature of the surroundings. Then

$$H' = \pi d l : e \,.\, (t - \theta) \quad . \quad . \quad . \quad . \quad . \quad (3)$$

But when the wire has acquired a permanent temperature, with the current flowing through it, there is as much heat being lost at the sides as is being generated by the current. In this case $H = H'$; and we obtain the expression for e—

$$e = \frac{4\,C^2\sigma_t}{J\pi^2 d^3 (t - \theta)} \quad . \quad . \quad . \quad . \quad . \quad (4)$$

My experiments consist in measuring the strength of the current and the temperature of the wire, the latter being effected by measuring the electric resistance of a known length of the wire while the current is flowing through it, and hence inferring the temperature. These being known, and likewise the temperature of the surroundings, we have all the data for finding e, the emissivity of the surface in absolute measure. The experiments of Mr. D. Macfarlane giving emissivities in absolute measure are well known, and are of undoubted accuracy. They were communicated to the Royal Society (*Proc.* Roy. Soc., 1872, p. 93); and the results are quoted in Prof. Everett's "Units and Physical Constants" (chap. ix. § 137). These experiments were made with a copper globe about 4 cm. in diameter, suspended in a cylindrical chamber, with top and bottom, about 60 cm. in diameter, and 60 cm. high. The results may be briefly summed up as follows:—

Macfarlane finds an emissivity of about 1/4000th of the thermal unit C.G.S. per square centimetre per second per degree of difference of temperatures between cooling body and surroundings for a polished surface, with an excess of temperature of a little more than 60° C.; and, for a blackened surface, the same emissivity with an excess of 5° C. or under.

Using round wires of small diameter (0·85 mm. and under), and with the surfaces either brightly polished or in common dull condition of a wire fresh from the maker, I have found a much larger emissivity than 1/4000. I have obtained different values of e for wires of different sizes, varying from 1/2000 down to 1/400, which was obtained with a wire of 0·40 mm. diameter, and with an excess of temperature of 24° C. It seems to be shown by all the experiments I have made that, other things being the same, the smaller the wire the greater the emissivity.

To do away with the part of the emissivity which is due to convection and conduction by the air, I have commenced experiments on loss of heat by small wires in the nearly perfect vacuum afforded by the modern mercurial air-pump. This part of the subject was experimented on long ago by Dulong and Petit, and within the last few years by Winkelman and Kundt and Warburg; lastly, and much more perfectly, by Mr. Crookes (*Proc. Roy. Soc.*, vol. xxxi. p. 239), though in no case, I believe, were the emissivities in absolute measure determined. The conclusion come to by all these experimenters is the same, namely, that there is a decrease of emissivity due to lowering of the air-pressure, this decrease being very small for a reduction down to one-half or one-third of the ordinary atmospheric pressure, but becoming very great as the vacuum approaches completeness.

The very interesting experiments of Mr. Crookes seem to show that, even with the high vacuum which he obtained, the effect of the residual gas in carrying off heat from the cooling body was far from being annulled.

The following table shows the emissivity of a copper wire with bright surface half a metre long, 0·40 mm. in diameter, and sealed into a glass tube about 1·5 cm. in internal diameter:—

Current amperes	Pressure, 760 millims.		Pressure, 380 millims.		Pressure, 180 millims.		Very high vacuum pump worked continuously	
	$t-\theta$	e	$t-\theta$	e	$t-\theta$	e	$t-\theta$	e
	°		°		°		°	
1	4·7	1·1822	4·5	1/1784	5·5	1/2176	17	1/6443
2	22·5	1/2084	21·5	1/1996	23·5	1/2174	68	1/5620
3	56	1·2114	58	1/2180	55	1/2082	140?	1/4606 [1]

The following table may also be found interesting. It shows the emissivity in absolute measure of some materials commonly used as insulating coverings for wires.

Specifying number B.W.G. and nature of covering	Length of wire. Centims.	Resistance of 100 centims. B.A. units	Diameter of wire in millims.	Diameter of covered wire, outside measurement	Current (amperes)	$t-\theta$	Emissivity
						°	
No. 22, silk-covered ...	100	·0395	·76	·96	10	23·4	0·001533
No. 26, cotton-covered	100	·094	·50	·88	10	58	0·001585
No. 26, silk-covered ...	100	·1115	·45	·57	9·8	70	0·002020
No. 22, gutta-percha...	100	·0455	·72	1·67	10	24	0·000854
No. 22, tinned, gutta-percha-covered, and double cotton covered outside	100	·0432	·73	1·86	10	23	0·000759

On Some Phenomena Connected with Iron and other Metals in the Solid and Molten States, with Notes of Experiments, by W. J. Millar, C.E., Sec. Inst. Engineers and Shipbuilders in Scotland.—1. *Object of Paper.*—Results of experiments by the author with various metals, such as cast-iron, gun-metal, phosphor-bronze, lead, copper, and type-metal. The object being to determine the cause of the well-known phenomena of the flotation of cold cast-iron on molten cast-iron, and as to whether any expansion took place upon solidification in the metals above noted. 2. Notes of some of the experiments from which the author concludes that the cause of flotation of the solid metal on liquid metal of the same kind is *buoyancy*, due to expansion suddenly set up in the immersed pieces, and that this expansion was found by careful measurement to be at least equal to the shrinkage or total decrease in length of the piece from white hot solid to finally cooled down solid. Further, that the expansion observed is obtained within much lower limits of temperature than the shrinkage; as the pieces, which were in all cases removed from the molten metal, immediately on appearing floating hardly showed redness, and when broken it was found that the crystalline character of the metal remained. 3. Notes of experiments made by gradually heating pieces of cast-iron—the results of all these experiments leading the author to conclude that the *rate* of expansion in cast-iron is at first much more rapid at low temperature than afterwards at high temperature. 4. From experiments carried on with pieces of lead and copper and type-metal, it was found that if any flotation occurred it was only with small light pieces—heavy pieces sinking and remaining at bottom of ladle. Gun-metal and phosphor-bronze behaved like cast-iron. 5. Consideration of the peculiar appearance, or "*break*," observed on the surface of molten cast-iron, the figures presenting a geometrical pattern, like interlacing circles or stars. The author believes that this appearance is due to cracks forming upon the rapidly forming skin—these cracks taking more or less a circular form from the convex forms into which the various parts of the surface are thrown, due to the bubbling up of gas or air. This appearance is limited to cast-iron, and experienced observers can tell the quality of the iron from the form of pattern or figures showing on the molten surface. 6. From observation and experiments carried out from time to time, the author concludes that no perceptible increase of volume of the metals noted occurs at the moment of solidification; at least when free from air or gas confined within the casting.

On a Gyrostatic Working Model of the Magnetic Compass, by Sir William Thomson.—In my communication to the British Association at Southport,[1] I explained several methods for overcoming the difficulties which had rendered nugatory, I believe, all previous attempts to realise Foucault's beautiful idea of discovering with perfect definiteness the earth's rotational motion by means of the gyroscope. One of these, which I had actually myself put in practice with partially satisfactory results, was a

Gyrostatic Balance for Measuring the Vertical Component of the Earth's Rotation.

It consisted of one of my gyrostats supported on knife-edges attached to its containing case, with their line perpendicular to the axis of the interior fly-wheel and above the centre of gravity of the fly-wheel and framework by an exceeding small height, when the framework is held with the axis of the fly-wheel and the line of knife-edges both horizontal, and the knife-edges downwards in proper position for performing their function. The apparatus, when supported on its knife-edges with the fly-wheel not spinning, may be dealt with as the beam of an ordinary balance. Let now the framework bear two small knife-edges, or knife-edged holes, like those of the beam of an ordinary balance, giving bearing-points for weights in a line, cutting the line of the knife-edges as nearly as possible, and of course (unless there is reason to the contrary in the shape of the framework) approximately perpendicular to this line, and, for convenience of putting on and off weights, hang, as in an ordinary balance, two very light pans by hooks on these edges in the usual way. Now, with the fly-wheel not running, adjust by weights in the pans if necessary, so that the framework rests in equilibrium in a certain marked position with the axis of rotation inclined slightly to the horizontal, in order that the axis of the fly-wheel, whether spinning or at rest, may always slip down so as to press on one and not on the other of the two end plates belonging to its two ends. Now, unhook the pans and take away the gyrostat and spin it; replace it on its knife-edges, hang on the two pans, and find the weight required to balance it in the marked position with the fly-wheel now rotating rapidly. This weight, by an obvious formula which was placed before the Section at Southport, gives an accurate measure of the vertical component of the earth's rotation.[2]

Gyrostatic Model of the Dipping Needle

I also showed at Southport that the gyrostatic balance described above, if modified by fixing the knife-edges, with their line passing as accurately as possible through the centre of gravity of the fly-wheel and framework, and with the faces of the knives so placed that they shall perform their function properly when the axis of the fly-wheel is parallel to the earth's axis of rotation, and the rotation of the fly-wheel in the same direction as the earth's, will act just as does an ordinary magnetic dipping needle; but showing latitude instead of dip, and dipping the south end of the axis downwards instead of the end that is

[1] Temperature probably much too low. The wire, sagging down, touched the inside of the glass tube in several points.

[1] No report of this communication has, so far as I know, hitherto appeared in print.

[2] The formula is

$$gw = \frac{1}{a} W k^2 \omega \gamma \sin l;$$

where w denotes the balancing weight; gw the force of gravity upon it; a the arm on which this force acts; W the weight of the fly-wheel; k its radius of gyration; ω its angular velocity; γ the earth's angular velocity; and l the latitude of the place.

towards the north as does the magnetic dipping needle. Thus, if the bearing of the knife-edges be placed east and west, the gyrostat will balance with its axis parallel to the earth's axis, and therefore dipping with its south end downwards in northern latitudes and its north end downwards in southern latitudes. If displaced from this position and left to itself, it will oscillate according to precisely the same law as that by which the magnetic needle oscillates. If the bearings be turned round in azimuth, the position of equilibrium will follow the same law as does that of a magnetic dipping needle similarly dealt with. Thus, if the line of knife-edges be north and south, the gyrostat will balance with the axis of the fly-wheel vertical, and if displaced from this position will oscillate still according to the same law; but with directive couple equal to the sine of the latitude into the directive couple experienced when the line of knife-edges is east and west. Thus this piece of apparatus gives us the means of definitely measuring the direction of the earth's rotation, and the angular velocity of the rotation. These experiments will, I believe, be very easily performed, although I have not myself hitherto found time to try them.

Gyrostatic Model of a Magnetic Compass

At Southport I showed that a gyrostat supported frictionlessly on a fixed vertical axis, with the axis of the fly-wheel horizontal or nearly so, will act just as does the magnetic compass, but with reference to "astronomical north" (that is to say, rotational north) instead of "magnetic north." I also showed a method of mounting a gyrostat so as to leave it free to turn round a truly vertical axis, impeded by so little of frictional influence as not to prevent the realisation of the idea. The method, however, promised to be somewhat troublesome, and I have since found that the object of producing a gyrostatic model of the magnetic compass may, with a very remarkable dynamical modification, be much more simply attained by merely suspending the gyrostat by a very long, fine wire, or even by floating it with sufficient stability on a properly planned floater. To investigate the theory of this arrangement let us first suppose a gyrostat, with the axis of its fly-wheel horizontal, to be hung by a very fine wire attached to its framework at a point, as far as can conveniently be arranged for, above the centre of gravity of fly-wheel and framework, and let the upper end of the wire be attached to a torsion head, capable of being turned round a fixed vertical axis as in a Coulomb's torsion balance. First, for simplicity, let us suppose the earth to be not rotating. The fly-wheel being set into rapid rotation, let the gyrostat be hung by the wire, and after being steadied as carefully as possible by hand, let it be left to itself. If it be observed to commence turning azimuthally in either direction, check this motion by the torsion head; that is to say, turn the torsion head gently in a direction opposite to the observed azimuthal motion until this motion ceases. Then do nothing to the torsion head, and observe if a reverse azimuthal motion supervenes. If it does, check this motion also by opposing it by torsion, but more gently than before. Go on until when the torsion head is left untouched the gyrostat remains at rest. The process gone through will have been undistinguishable from what would have had to be performed if, instead of the gyrostat with its rotating fly-wheel, a rigid body of the same weight, but with much greater moment of inertia about the vertical axis, had been in its place. The formula for the augmented moment of inertia is as follows. Denote by—

W, the whole suspended weight of fly-wheel and framework;
K, the radius of gyration round the vertical through the centre of gravity of the whole mass regarded for a moment as one rigid body;
w, the mass of the fly-wheel;
k, the radius of gyration of the fly-wheel;
a, the distance of the point of attachment of the wire above the centre of gravity of fly-wheel and framework;
g, the force of gravity on unit mass;
ω, the angular velocity of the fly-wheel; the virtual moment of inertia round a vertical axis is

$$WK^2\left(1+\frac{w^2k^4\omega^2}{W^2K^2ag}\right) \quad . \quad . \quad . \quad . \quad . \quad (1)$$

The proof is very easy. Here it is. Denote by—

ϕ, the angle between a fixed vertical plane and the vertical plane containing the axle of the fly-wheel at any time t;
θ, the angle (supposed to be infinitely small and in the plane of ϕ), at which the line a is inclined to the vertical at time t;
H, the moment of the torque round the vertical axis exerted by the bearing wire on the suspended fly-wheel and framework.

By the law of generation of moment of momentum round an axis perpendicular to the axis of rotation requisite to turn the axis of rotation with an angular velocity $d\phi/dt$, we have

$$wk^2\omega\frac{d\phi}{dt}=gWa\theta \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

because $gWa\theta$ is the moment of the couple in the vertical plane through the axis by which the angular motion $d\phi/dt$ in the horizontal plane is produced. Again, by the same principle of generation of moment of momentum taken in connection with the elementary principle of acceleration of angular velocity, we have

$$wk^2\omega\frac{d\theta}{dt}+WK^2\frac{d^2\phi}{dt^2}=H \quad . \quad . \quad . \quad . \quad (3)$$

Eliminating θ between these equations we find

$$\left(\frac{w^2k^4\omega^2}{gWa}+WK^2\right)\frac{d^2\phi}{dt^2}=H \quad . \quad . \quad (4)$$

which proves that the action of H in generating azimuthal motion is the same as it would be if a single rigid body of moment of inertia given by the formula (1), as said above, were substituted for the gyrostat. Now to realise the gyrostatic model compass: arrange a gyrostat according to the preceding description with a very fine steel bearing wire, not less than 5 or 10 metres long (the longer the better; the loftiest sufficiently sheltered inclosure conveniently available should be chosen for the experiment). Proceed precisely as above to bring the gyrostat to rest by aid of the torsion head, attached to a beam of the roof or other convenient support sharing the earth's actual rotation. Suppose for a moment the locality of the experiment to be either the North or South Pole, the operation to be performed to bring the gyrostat to rest will not be discoverably different from what it was, as we first imagined it when the earth was supposed to be not rotating. The only difference will be that, when the gyrostat hangs at rest, relatively to the earth, θ will have a very small constant value; so small that the inclination of a to the vertical will be quite imperceptible, unless a were made so exceedingly small that the arrangement should give the result, to discover which was the object of the gyrostatic model balance described above; that is to say, to discover the vertical component of the earth's rotation. In reality we have made a as large as we conveniently can; and its inclination to the vertical will therefore be very small, when the moment of the tension of the wire round a horizontal axis perpendicular to the axis of rotation of the fly-wheel is just sufficient to cause the axis of the fly-wheel to turn round with the earth. Let now the locality be anywhere except at the North or South Pole; and now, instead of bringing the gyrostat to rest at random in any position, bring it to rest by successive trials in a position in which, judging by the torsion head and the position of the gyrostat, we see that there is no torsion of the wire. In this position the axis of the gyrostat will be in the north and south line, and, the equilibrium being stable, the direction of rotation of the fly-wheel must be the same as that of the compotent rotation of the earth round the north and south horizontal line, unless (which is a case to be avoided in practice) the torsional rigidity of the wire is so great as to convert into stability the instability which, with zero torsional rigidity, the rotational influence would produce in respect to the equilibrium of the gyrostat with its axis reversed from the position of gyrostatic stability. It may be remarked, however, that even though the torsional rigidity were so great that there were two stable positions with no twist, the position of gyrostatic unstable equilibrium made stable by torsion would not be that arrived at: the position of stable gyrostatic equilibrium, rendered more stable by torsion, would be the position arrived at, by the natural process of turning the torsion head always in the direction of finding by trial a position of stable equilibrium with the wire untwisted by manipulation of the torsion head. Now by manipulating the torsion head bring the gyrostat into equilibrium with its axis inclined at any angle, ϕ, to that position in which the bearing wire is untwisted; it will be found that the torque required to balance it in any oblique position will be proportional to the sin ϕ. The chief difficulty in realising this description results from the great augmentation of virtual moment of inertia, represented by the formula (1) above. The paper at present communicated to the Section contains calculations on this subject, which

throw light on many of the practical difficulties hitherto felt in any method of carrying out gyrostatic investigation of the earth's rotation, and which have led the author to fall back upon the method described by him at Southport, of which the essential characteristic is to constrain the frame of the gyrostat in such a manner as to leave it just one degree of freedom to move. The paper concludes with the description of a simplified manner of realising this condition for a gyrostatic compass—that is to say, a gyrostat free to rotate about an axis either rigorously or very approximately vertical.

SECTION C—GEOLOGY

On Ice-Age Theories, by Rev. E. Hill, M.A., F.G.S., Tutor of St. John's College, Cambridge.—On the Montreal Mountain, in the neighbouring quarries, at the mouth of the Saguenay River, and more or less everywhere over all Canada and all the north and north-west of this continent, are seen phenomena which imply a former vastly extended action of ice. The like are found over Europe and Asia, thus completely encircling the Pole. Many theories have been propounded to account for these facts. It is proposed to pass these before you in review. Any explanation ought to account not only for cold greater than the present, but for accumulations of snow and ice. A kindred phenomenon is the greater size of the Antarctic ice-cap. The supposed interglacial warm periods, and the unquestioned luxuriance of Miocene vegetation in Greenland, ought also to find their causes in any thoroughly satisfactory theory. The theories which have been propounded fall into three groups, as Cosmical, Terrestrial, and Astronomical (or Periodical). The Cosmical theories are Poisson's Cold-Space theory – incomprehensible; and the Cold-Sun theory of S. V. Wood and others—lacking any evidence. The Terrestrial theories are numerous. Lyell's suggestion of Polar-continent and Equatorial-ocean is opposed by evidence that continents and oceans lay on much the same areas as now. The contrary view, Polar-ocean and Equatorial-land, would deserve consideration but for the same opposing evidence. The elevation view (Dana, Wallace), which alleges greater altitude of mountain-chains, disagrees with the strong evidence for land-depression during the period. The submergence view of Dr. Dawson agrees with this evidence, but requires elucidation. Alteration of ocean-currents (Gunn, J. S. Gardiner) is a most powerful agency, but would act locally rather than universally round the Pole. Alteration of prevalent winds, hitherto worked out by no one, deserves attentive consideration. Conditions are conceivable which would produce over an area winds from cold quarters almost permanently. However, this seems open to the same objection as the preceding theory. Last come the Astronomical or Periodical theories. A tilt of the earth's axis was suggested by Belt, but suggested as owing to causes which are wholly insufficient. Tilting from astronomical agencies is slight, though its action would be in the direction required. Herschel suggested the Eccentricity theory, but abandoned it. Adhémar's Precession theory, as explained by himself, involved an absolute fallacy. The celebrated view of Dr. Croll combines the Precession and Eccentricity theories into one. It exactly agrees with the Antarctic greater extension of ice, and provides an explanation of interglacial warm periods. The great difficulty in its way is to see how a mere difference in distribution through the year of an unchanged total heat-receipt can produce consequences so vast. The laws of radiation explain but a very minute part, the laws of evaporation perhaps rather more; but, so far as can at present be seen, both together are inadequate. Another serious objection is that the theory seems to require the climate of the northern hemisphere to be now in a state of change for the better, of which at present there appears no evidence. Dr. Croll's elaborate explanations of the reaction of one effect upon another—fogs, deflection of currents, and the like—have no special connection with his own theory. They would act in all cases, and support all theories equally. The arguments, if admitted, would only prove that the earth's climates are in a state of highly unstable equilibrium, in which a slight cause may produce an enormous change. Nor are his arguments universally admitted. In conclusion, Dr. Croll's theory seems inadequate: alteration of currents and winds are the most powerful causes suggested hitherto: further investigations ought to be made as to the nature and extent of the last series of changes in the outlines of the continents of the globe.

What is a Mineral Vein or Lode? by C. Le Neve Foster, B.A., D.Sc., F.G.S., H.M. Inspector of Mines.—The author quoted briefly the definitions of a mineral vein given by Werner, Carne, Von Cotta, Grimm, Von Groddeck, Geikie, Sandberger, and Serlo, who, in common with most geologists, have looked upon mineral veins as "the contents of fissures." While admitting that a very large number of veins may be so described, the author contended that the exceptions are sufficiently important and numerous to warrant a change in the definition. He is of opinion that many of the principal and most productive tin-lodes in Cornwall are simply tabular masses of altered granite adjacent to fissures; and he brought forward the opinions of other geologists to show that certain veins in the English Lake district, the Tyrol, Nova Scotia, Nevada, Colorado, California, and Australia, are not filled-up fissures. In conclusion, he proposed the following definition: "A mineral vein or lode is a tabular mineral mass formed, more or less entirely, subsequently to the inclosing rocks."

The Acadian Basin in American Geology, by L. W. Bailey, Geological Survey of Canada.—The Acadian Basin, embracing the region bordering on and including the Gulf of St. Lawrence, together with the provinces of New Brunswick, Nova Scotia, Newfoundland, and Prince Edward Island, constitutes one of the natural physical divisions of the continent of North America, and exhibits many marked peculiarities of climate and floral and faunal distribution. In its geological structure, and in the history which this reveals, its individuality is not less clearly marked, being often in strong contrast with that of other portions of the continent farther west; and in some periods and features even exhibiting a closer relationship with the geology of Europe. In the present paper, the facts bearing upon this individuality are summarised and discussed; including the consideration of the varying land-surfaces of Acadia in different eras, the time and nature of its physical movements, its climate, and its life. A review of recent progress in the investigation of its geological structure is also given.

Upon the Improbability of the Theory that former Glacial Periods in the Northern Hemisphere were due to Eccentricity of the Earth's Orbit, and to its Winter Perihelion in the North, by W. F. Stanley, F.G.S., F.R.Met.S.—The theory of Dr. Croll, accepted by many geologists, is that former glacial periods in the northern hemisphere were due to greater eccentricity of the earth's orbit, and to this hemisphere being at the time of glaciation in winter perihelion. This theory is supported upon conditions that are stated to rule approximately at the present time in the southern hemisphere, which is assumed to be the colder. Recent researches by Ferrel and Dr. Hann, with the aid of temperature observations taken by the recent Transit of Venus expeditions, have shown that the mean temperature of the southern hemisphere is equal to, if not higher than the northern, the proportions being 15·4 southern and 15·3 northern. The conditions that rule in the south at the present time are a limited frozen area about the South Pole, not exceeding the sixtieth parallel of latitude; whereas in the north frozen ground in certain districts, as in Siberia and North-Western Canada, extends beyond the fiftieth parallel; therefore by comparison the north, as regards the latitude in which Great Britain is situated, is at present the most glaciated hemisphere. As it is very difficult to conceive that the earth had at any former period a lower initial temperature, or that the sun possessed less heating power, glaciation in the north could never have depended upon the conditions argued in Dr. Croll's theory. The author suggested that glaciation within latitudes between 40° to 60° was probably at all periods a local phenomenon depending upon the direction taken by aerial and oceanic currents; as, for instance, Greenland is at present glaciated, Norway has a mild climate in the same latitude, the one being situated in the predominating northern Atlantic currents, the other in the southern. Certain physical changes suggested in the distribution of land would reverse these conditions and render Greenland the warmer climate, Norway the colder.

On the Occurrence of the Norwegian "Apatitbringer" in Canada, with a few Notes on the Microscopic Characters of some Laurentian Amphibolites, by Frank D. Adams, M.Ap.Sc., Assistant Chemist and Lithologist to the Geological Survey of Canada.—The paper first gives a short account of the investigations which have been made on this amphibole-scapolite rock in Norway, where all the principal deposits of apatite either traverse it or occur in its immediate vicinity. The deposits of apatite in Canada generally occur associated with some variety of highly pyroxenic rock, often holding orthoclase and quartz. The "Apatitbringer" has, however, recently been found in the

vicinity of the town of Arnprior on the River Ottawa. It closely resembles the Norwegian rock, both in external appearance and in its microscopic characters, containing hornblende, scapolite, and pyroxene as essential constituents. A number of amphibolites in the Museum of the Geological Survey of Canada, which resemble this rock in appearance, have been sliced and examined with the microscope, and one of them found to contain scapolite in large amount. It was collected at Mazinaw Lake, in the township of Abinger, and is from the same belt of hornblendic rocks as that in which Arnprior is situated. The paper closes with a short account of some of these amphibolites.

The Geological Age of the Acadian Fauna, by G. F. Matthew, A.M., F.R.S.C.—In this sketch an attempt is made, by comparison with the Cambrian fauna of other countries, and especially of Wales, to fix more exactly than has hitherto been done the position of the assemblage of organisms found near the base of the St. John group. The trilobites are taken as a criterion for this purpose. A brief statement of the position and thickness of the beds is given, showing the relation of the fauna to the formation as a whole. It is shown that the genera and species of the Acadian trilobites do not agree with those of the Menevian, in the restricted application of that term now in vogue; the great *Paradoxides* with short eyelobes, and the genera *Anopolenus*, *Agraulos* (= *Arionellus*), *Erinnys*, and *Holocephalina* being, so far as known, absent from it. On the other hand, it shows very close relationships in its genera to the Solva group fauna, especially in the following species:—

Solva Group	Acadian Fauna
Conocoryphe solvensis, Hicks	*Ctenocephalus matthewi*, Hartt sp.
Conocoryphe bufo, Hicks	*Conocoryphe elegans*, Hartt sp.
Paradoxides harknessi, Hicks	*Paradoxides eteminicus*, Matthew

As bearing on the question of the age of the Acadian fauna, the development of the eyelobe in *Paradoxides* is referred to, and it is shown that while in the Cambrian rocks of Wales the length of the eyelobe is in direct relation to the age of the strata, the *Paradoxides* of the Acadian fauna, having continuous or nearly continuous eyelobes, are more primitive in their facies than those of the Menevian, and agree with the species found in the Solva group. The family of Conocoryphidæ, restricting the name to such species as those described by Corda under *Conocoryphe* and *Ctenocephalus*, are a marked feature of this early fauna; and *Conocoryphe* has a characteristic suture not observed in the Menevian genera. The Acadian *Ctenocephalus* also differs in this respect from the Bohemian species.

On the More Ancient Land Floras of the Old and New Worlds, by Principal Dawson, LL.D., F.R.S.—In the Laurentian period vegetable life is probably indicated, on both sides of the Atlantic, by the deposits of graphite found in certain horizons. There is good evidence of the existence of land at the time when these graphitic beds were deposited, but no direct evidence as yet of land plants. The carbon of these beds might have been wholly from subaquatic vegetation; but there is no certainty that it may not have been in part of terrestrial origin, and there are perhaps some chemical arguments in favour of this. The solution of the question depends on the possible discovery of unaltered Laurentian sediments. The Silurian land flora, so far as known, is meagre. The fact that *Eopteris* has been found to be merely a film of pyrite deprives us of the ferns. There remain some verticillately-leaved plants allied to *Annularia*, the humble Acrogens of the genus *Psilophyton*, and the somewhat enigmatical plants of the genera *Pachythecа*, *Prototaxites*, and *Berwynia*, with some uncertain Lycopods. We have thus at least forerunners of the families of the *Arteropkyllitæ*, the *Lycopodiaceæ*, and the *Coniferæ*. The comparison of the rich Devonian or Erian flora of the two sides of the Atlantic is very interesting. On both continents it presents three phases—those of the Lower, Middle, and Upper Erian—and there is a remarkable correspondence of these in countries so wide apart as Scotland, Belgium, Canada, Brazil, and Australia. Examples of this were given in the Rhizocarps, at this period very important, in the Lycopods, the Equisetaceæ, the Ferns, and the Conifers. The number of coniferous trees belonging to *Dadoxylon* and allied genera, and the abundance of ferns, often arborescent, were especial features in the Middle and Later Erian. The flora of the Erian age culminated and then diminished. In like manner that of the succeeding Carboniferous period had a small commencement quite distinct in its species from the Erian; it culminated in the rich vegetation of the true coal formation, which was remarkably similar over the whole world, presenting, however, some curious local differences and dividing lines which are beginning to become more manifest as discovery proceeds. In the Upper Carboniferous the flora diminishes in richness, and the Permian age is, so far as known, one of decadence rather than of new forms. Great progress has recently been made by Williamson and others in unravelling the affinities of the coal-formation plants, and we are on the eve of great discoveries in this field. Throughout the Silurian the conditions do not seem to have been eminently favourable to plants, but the few forms known indicate two types of Acrogens, and one leading to the Gymnosperms, and there is no reason to doubt the existence of insular land richly clothed at least with the few forms of vegetation known to have existed. In the Erian and Carboniferous there seem to have been two great waves of plant-life, proceeding over the continents from the north, and separated by an interval of comparative sterility. But no very material advance was made in them, so that the flora of the whole Palæozoic period presents a great unity and even monotony of forms, and is very distinct from that of succeeding times. Still the leading families of the *Rhizocarpæ*, *Equisetaceæ*, *Lycopodiaceæ*, *Filices*, and *Coniferæ*, established in Palæozoic times, still remain; and the changes which have occurred consist mainly in the degradation of the three first-named families, and in the introduction of new types of Gymnosperms and Phænogams. These changes, delayed and scarcely perceptible in the Permian and Early Mesozoic, seem to have been greatly accelerated in the Later Mesozoic.

On the Structure of English and American Carboniferous Coals, by Edward Wethered, F.G.S., F.C.S.—The author had examined several seams of coal from England and America. He pointed out that they were not always made up of one continuous bed of coal, but often comprised several distinct beds. In the case of the well-known Welsh "four-feet" seam there were four distinct strata of coals, separated by clay beds of a few inches thick. In the case of the "splint coal" from Whitehill Colliery, near Edinburgh, the seam presented three clearly-defined beds of coal, but these were not separated by partings of any kind. With a view of testing the "Spore theory" of the origin of coal, as propounded by Prof. Huxley, the author had obtained a portion of the "better-bed" seam intact for a thickness of 10 inches from the top. He had examined this inch by inch, by preparing thirty-three microscopic sections. At the top were 3½ inches of dull lustrous coal, termed "laminated coal." This the author found to be practically a mass of macrospores and microspores. Below this there was a change in the character of the seam. Spores became less numerous; in places they were scarce, the mass being made up of vegetable tissue and a substance to which the author gives the term "hydrocarbon." He could not, therefore, support Prof. Huxley in saying that the "better-bed" coal was "simply the sporangia and spore-cases of plants." The assertion would, however, apply to the first 3½ inches of the seam. The "splint coal" from Whitehill Colliery was a better example of a spore coal than the "better-bed." The bottom stratum was 4 inches thick, and presented a dull lustre, with thin bright layers traversing at intervals. The dull portion was a mass of spores and spore-cases, but these did not enter the bright layers. A vertical section cutting a bright layer, bounded on either side by dull lustrous coal, showed plenty of spores in the dull coal, but in the bright not one was detected. The second bed in this seam was 1 foot thick; it was of a brighter lustre than the 4 inches below, but two layers could be distinctly made out, one more lustrous than the other. In the dullest of the two, spores were found, which, however, were less numerous than in the bed below, and were also of a different variety. In the bright layers the spores were absent. The top bed of the seam was also 1 foot thick, and might be defined as a mass of spores, chiefly microspores, except in the bright layers. The American coals examined were collected by the author from the Warrior Coalfields of Alabama, and from near Pittsburg, Pennsylvania. The same structural affinities were noticed as in the English coals, and the author therefore came to the conclusion that the English and American Carboniferous coals had a common origin. The spores in the coal from both countries were closely allied. Some microspores from Alabama were identical with those which occur in the lower bed of the Welsh "four-feet" seam. A feature in spores obtained from all the coals was the triradiate markings which they exhibited. Whether this was to be regarded as superficial or not, it was very characteristic of them, and was therefore to be considered in attempting to ally them with modern vegetation. The

author regarded peat in the light of post-Tertiary coal; lignite as peat in a transition state to coal; and coal as the remains of Carboniferous bogs. The author referred to the practical application of a knowledge of the microscopic structure of coal, as enabling an expert to judge of the nature of a coal from an examination of it with a pocket lens.

Points of Dissimilarity and Resemblance between Acadian and Scottish Glacial Beds, by Ralph Richardson, F.R.S.E., V.P. G.S.Edinb.—Mr. Richardson said that, in his "Acadian Geology," Principal Dawson gave the following as a typical section of the superficial geology of Acadia—that is, Nova Scotia, New Brunswick, and Prince Edward Island—and as, in some respects, also applicable to Canada and Maine, viz.: At the bottom, peaty deposits; then unstratified Boulder Clay; then stratified Leda Clay, indicating deep water; and, lastly, gravel and sand beds, the Saxicava sand indicating shallow water. Mr. Richardson pointed out wherein such a section differed from and resembled the glacial beds of Scotland. He said the latter showed no such orderly arrangement as the Acadian, and could not, as a rule, be divided into deep and shallow water-beds. The marine shells in the Scottish beds are all mixed up together, regardless, as a rule, of the province—whether Arctic or British, or both—to which they properly belong, regardless of the depths which they usually tenant, and regardless of the deposit (whether clay, gravel, or sand) in which they are now found fossil. They are likewise met with at all heights, from the level of the sea to more than 500 feet above it. No system of dispersion of boulder-erratics from definite centres in Scotland seems as yet ascertained. The peaty deposits, occurring in Principal Dawson's section *below* the Boulder Clay or till, occur in Scotland above it. With regard to points of resemblance, the facies of the shells in Acadia and Scotland is similar, being of the Arctic and British-Arctic type. Again, both in Acadia and Scotland, all the fossiliferous glacial beds occur above the unstratified Boulder Clay or till. Mr. Richardson cited various Scottish sections to prove this, and remarked that the belief in earlier and later Boulder Clays is of long standing in Scotland. He concluded by pointing out that, in their cardinal features, the Acadian and Scottish glacial beds seemed to coincide. In both Acadia and Scotland that great mass of unstratified clay known as *till* existed; and doubtless the geologists of the New World were, like those of the Old, puzzled to account for its origin with certainty and satisfaction. The question was left unsolved by the meeting of the British Association in Edinburgh in 1850; although then discussed by Hugh Miller and Prof. John Fleming. The author hoped that during the present meeting some advance would be made in solving this great problem, as well as in correlating and arranging the glacial beds of Canada, Acadia, and Britain.

On the Mode of Occurrence of Precious Stones and Metals in India, by V. Ball, M.A., F.R.S.—For full 3000 years India has been known as the source of precious stones and metals, but scarcely 200 years have elapsed since other countries yielding precious stones have entered into competition with her; and it is only within the present century that she has ceased to hold a pre-eminent position as a supplier of the markets of the world. In order to arrive at a full and satisfactory elucidation of this subject, two branches of inquiry must be undertaken—one based upon what has been actually ascertained by careful geological exploration of the country, and the other upon such historical records as are available of the former production of the minerals in question, and of the indications of the sites where they were mined. By means of our present knowledge of the geology, it has become possible to give definite form to many vague statements by early writers, and to recognise the actual positions of mines which are now, by the people of the localities themselves, forgotten and deserted. In the majority of these cases, had the geologist not got the historical hand to guide him, he would be unwilling to predicate the presence of such minerals from mere superficial examination. As a collateral result, many of the widespread myths and fables connected with mining have proved to have originated in peculiar local customs. They rest, therefore, on more substantial bases of facts than could have been suspected by any one unacquainted with these customs. This method of combining the results of geological research with historical records the author has found on previous occasions to have the advantage of bringing the geologist into touch with the rest of humanity, arranging as it does the interest of historians, linguists, and others, who find in the facts so presented to them pabulum applicable to the requirements of their own particular pursuits. In this paper it will not be necessary or suitable to enter at length into details—the author having done so elsewhere.[1] His object is rather to direct attention to the subject generally, and to make known the fact that much has been accomplished of late years which has not as yet found its way into manuals and encyclopædias. Most of the information to be found in such works is far behind our present knowledge; and, where not actually incorrect, has been superseded by fuller and more accurate observations. The subjects taken for special consideration are the following:—Diamond, ruby, sapphire, spinel, beryl, emerald, lapis-lazuli, gold, silver. The steel of India, or *wootz*, might be included here, since, at least 2000 years ago, it was one of the most precious productions of India.

On the Relative Ages of the American and the English Cretaceous and Eocene Series, by J. Starkie Gardner, F.L.S., F.G.S.—The paper is a contribution towards the determination of the ages of the American Cretaceo-Eocene rocks, relative to those of Europe. It briefly describes the chief characteristics of the various stages of the series in America. The lowest beds there are distinguished by the presence of well-developed dicotyledonous leaves, associated with *Ammonites* and other Cretaceous Mollusca, considered to warrant their correlation with the Gault and Chalk of England. Newer beds thought to be intermediate in age between Secondary and Tertiary are distinguished by the incoming of palms and a new flora of Dicotyledons, associated with *Mosasaurus*. The rest are correlated with the various divisions of the Tertiary series recognised in Europe. The entire series seems to have been deposited without any considerable break in continuity, but reveals a sudden transition from a temperate to a subtropical flora, and from a Cretaceous to a Tertiary Vertebrata. The high development of the flora is, however, quite irreconcilable with the accepted correlation. In further comparing the American series with that of Europe, it is observed that the subdivisions of the Cretaceous series were first determined for a limited area, when different ideas of evolution and gradual passage prevailed, and subsequently extended to embrace areas at a distance which may be, rightly or wrongly, correlated with those of England and Western France. The comparisons now drawn are only between the rocks of the original and typical area and of America, excluding the Cretaceous rocks of other countries. Thus restricted, the Neocomian of Europe comprises only shore deposits, characterised by a Cretaceo-Jurassic fauna and a Jurassic flora. The Gault is a deeper sea-deposit, comparable to the "Blue Mud" of the *Challenger*, with a typically Cretaceous fauna and a Jurassic flora. The Upper Greensands are more or less the equivalents of the Gault, deposited under differing physical conditions, corresponding to the "Greensands" of the *Challenger*, and have been assumed to represent the shore or shallower water conditions preceding the Chalk. The Chalk itself is described with a view to prove that it is a truly oceanic deposit, formed at a distance from shore and at a considerable depth, corresponding in all respects with the existing "Globigerina Ooze." The arguments against this view are refuted in detail, and the suggestion made that the alleged shallower habitats in the tropics of the few surviving Mollusca may be due to the lower temperature prevailing now in the abyssal depths of the ocean having driven heat-loving types from the depths at which they were able to live in the Chalk period. The whole Cretaceous series in the British area is the result of a gradual conversion of land into sea, owing to subsidence. The process commenced with the Neocomian, became more serious with the Gault, and continued until the close of the Chalk. The focus of the depression, so far as its results are accessible, was the English Channel, whence it spread in an easterly direction across Central Europe. As the land subsided, the gulf increased in magnitude, and Blue and Green Muds were formed on a wider and wider area, to be succeeded in due time by chalky Ooze. The nearer the focus of subsidence the older the Greensands and Gault, and the farther we recede from it the newer in age they become. The zones of increasing depth travelled outward and forward, and though now represented by continuous bands of the same lithological characters, extending over many countries, it would be rash in the extreme to infer the synchronism of portions of these when separated by degrees of latitude. The time required for these zones to travel from Kent to the Crimea, and to accumulate a mass, mainly composed of minute organisms, of over a thousand feet in thickness, must have been sufficient to account

[1] "Economic Geology of India," and "A Geologist's Contribution to the History of India," *Proc. Roy. Dub. Soc.* 1883.

for a very sensible progress in the evolution of organic forms. The deposition of the Chalk commenced in the English area at a period when the land floras were still of Jurassic character. By the time it had reached Limburg, Saxony, and Bohemia, Dicotyledons had become developed. The period required for the chalk ocean to encroach but 300 to 400 miles must thus have been very vast. The question may, however, arise whether plant development at this stage followed the otherwise universal law of evolution, or was exceptionally rapid. The fauna has to be examined to see whether it discloses an equally appreciable progress. The conclusion arrived at is that while the groups with which the author is less acquainted apparently do so, the progress in the Mollusca is unmistakable. The helicoid, turbinate, and patelloid groups are archaic and stationary, but the fusiform shells betray a tendency to elongate their canals, and the relative abundance of such, and gradual dropping out of now extinct genera, furnish an unmistakable index of the relative ages of the more littoral deposits. From this point of view we are able to demonstrate that the Greensands of Aix-la-Chapelle are far younger than their lithological structure and sequence would indicate, while the appearance of such distinctly new developments as cone and cowry shells further support the views of the relatively almost Tertiary, or, at least, transition, age of the Cretaceous series in Denmark. While, therefore, denudation on a truly colossal scale has produced one of the most considerable gaps in the whole geological record between Cretaceous and Tertiary over the British area, beds of intermediate age may successfully be sought for at a distance from this centre. The erroneous correlation of these, bed by bed almost, with the typical Cretaceous series, as developed in England, has led to a still more untrustworthy correlation of the American series with ours. The Cretaceous series of America contains at its very base a flora composed of angiosperms so perfectly differentiated that they are apparently referable to existing genera. One of the oldest floras in Europe containing angiosperms is that of Aix-la-Chapelle, and even this we have seen is relatively modern; but these are not referable in at all an equal degree to existing genera, and even the Coniferæ are embarrassing on account of their highly transitional characters. The oldest Cretaceous flora of America, so far from possessing any Cretaceous characters, agrees in a remarkable manner with that of the English Lower Eocene, while the Laramie, or supposed Cretaceo-Eocene, flora has very much in common with that of our Middle Eocene, and marks a similarly sudden rise in temperature. The question is whether the evidence of the fauna in favour of the Cretaceous age of the series is so conclusive that the floral evidence must be set aside. Taking the Cretaceous series as represented in California, the older stages possess Mollusca of definitely Cretaceous aspect, but those of the newest have a decidedly Eocene facies. To be Cretaceous a fauna must have some elements which did not survive to a later period; but are we in a position to state that the Ammonitidæ, the Belemnites, and Inocerami did not do so? Even our present limited knowledge is entirely opposed to such a view. It must be remembered that the Eocenes in their typical area, England and France, were deposited under peculiar local conditions, and it would be as logical to infer from the absence in them of Cretaceous types that these existed nowhere else as it would be were the bed of the English Channel now upheaved to class as extinct all forms of life not met with in its sands and muds. If, as there is evidence to show, America was isolated at the time, the survival there of forms of Reptilia elsewhere extinct would be in accordance with ordinary observation at the present day. The flora of the American series is Eocene; the fauna of its earlier stages is Cretaceous. We are compelled therefore to choose whether we will believe that a large Eocene flora was developed there during the Cretaceous, or that some members of a Cretaceous fauna lived on to an Eocene date. The former supposition demands greater rapidity of evolution than we are accustomed to admit, and no external evidence is advanced to support it. The latter is more conceivable from the standpoint of evolution, and is not contradicted by any evidence that has yet come under the author's observation.

On Some Remains of Fish from the Upper Silurian Rocks of Pennsylvania, by Prof. E. W. Claypole, B.A., B.Sc. (London), F.G.S., of the Second Geological Survey of Pennsylvania.—The earliest vertebrate animals yet known from any part of the world are some remains of fish in the Upper Silurian rocks of England. They are for the most part of three types. First, short finspines, named by Agassiz *Onchus tenuistriatus*; second, fragments of shagreen, or the skin of a placoid fish (*Thelodus* and *Sphagodus*), belonging probably to the same that carried the spine; and third, ovate, finely striated plates or shields, supposed to be the defensive armour of some fish, unlike any now living. No one has doubted the ichthyic nature of the first and second of these three forms. But as regards the third there has been much controversy. Evidently allied to *Cephalaspis*, its right to the name of fish has been called in question, and suspicion has been raised in regard to the whole family of the Cephalaspids. On the whole, however, it seems best to retain them in the class of fishes, and to this conclusion Prof. Huxley evidently inclines in the conclusion of his "Essay on the Classification of the Devonian Fish." One may expect some, or even considerable, divergence of structure from the usual ichthyic types in such early forms. These English fossils occur in the lowest beds of the Devonian (Cornwall), and in the highest beds of the Silurian (Shropshire and Hereford). The well-known Upper Ludlow "bone bed" has yielded them in considerable quantity, and one specimen is reported by Sir C. Lyell in his "Elements of Geology" (1865) as discovered from the Lower Ludlow, beneath the Aymestry limestone. Below this horizon I have never heard of their occurrence. The English Ludlow, taken as a whole, has been usually correlated with the Lower Helderberg of North America, and on good grounds, both containing *Eurypterus* and *Pterygotus*. The English Lower Ludlow and the Water-Lime or basal beds of the North-American Lower Helderberg are the lowest strata containing these fossils. On both sides of the Atlantic they range from this level upwards into the Devonian. The oldest vertebrate fossils yet announced from America are those found in the Corniferous limestone or Lowest Devonian of Ohio. Possibly the beds at Gaspé, on the Gulf of St. Lawrence, are somewhat lower, as they have yielded *Cephalaspis*, which is not yet known from Ohio, and *Coccosteus*, of which Ohio has yielded only a single specimen. No authenticated fish-fossil has yet been announced from the Upper Silurian rocks of America. It is true that reports of the discovery of such remains have been published at various times, but investigation has proved them all erroneous. (See "Palæontology of New York," vol. ii. pp. 319, 320, pl. lxxi.; *American Journal of Science*, second series, vol. i. p. 62; "Palæontology of Ohio," vol. ii. p. 262.) During my recent work on the palæontology of Perry County, Pennsylvania, I came upon some fossils which at once suggested relationship to the Ludlow group above described. Among them were a few spines recalling *Onchus tenuistriatus*, but with some differences. I have named them *Onchus pennsylvanicus*. With them I discovered abundance of specimens bearing a strong resemblance to *Pteraspis*, but larger, and differing in some other respects. These I name *Glyptaspis* (*G. elliptica* and *G. bitruncata*). Comparing these with *Pteraspis* we find them much thinner, not exceeding one-tenth of an inch in thickness; whereas specimens of *Pteraspis* in my possession from Cornwall are nearly one-fourth of an inch thick. The striation on both is equally fine, but is rather less regular on the American specimens. These also show no trace of the spine in which the shield of *Pteraspis* terminates, as shown by Murchison in "Siluria." No traces of the English fossil shagreen—*Thelodus* and *Sphagodus*—have been found in the Pennsylvanian beds, though it abounds in the Ludlow rocks. The fossils were found in a bed of sandstone about 200 feet below the base of the water-lime in Perry County, Pennsylvania, near the top of the great mass of variegated shale composing the Fifth Group of Rogers in the First Survey of Pennsylvania. This shale in New York immediately overlies the Niagara limestone, which is correlated on satisfactory evidence with the Wenlock limestone of England. Ten or twelve species are common to the two beds. It seems, therefore, that the great mass of coloured shale, near the top of which these fossils were found, and which is a continuation of the Onondaga group of New York, has no representative in the British series, but corresponds to an interval between the Upper Wenlock and the Lower Ludlow. (For details regarding the correlation of these beds in Pennsylvania with those in New York, see a paper by the author in *Proc. Amer. Phil. Soc.* for 1884.) It is consequently a necessary inference that the beds yielding *Glyptaspis* and *Onchus* in Pennsylvania are somewhat older than those containing *Pteraspis* and *Onchus* in England. Microscopic examination of the specimens, and a comparison of their structure with that of *Pteraspis* and *Cephalaspis* are in progress, and the details will be given in the paper. Other fossils in the author's possession indicate the possible existence of fish at a still earlier date, but the material is not yet worked out.

On Fluxion-Structure in Till, by Hugh Miller, A.R.S.M., F.G.S., Geological Survey of England and Wales.—It has long been recognised as one of the characteristics of the till that its long-shaped boulders are striated lengthwise. They have, as it has been concisely expressed, been "launched forward end-on." From the minute and magnifiable striæ upon the smaller (e.g. almond-sized) boulders it also appears that these at least have been carried forward, involved in the matrix, and were glaciated chiefly by its particles. Under the microscope these particles exhibit most of the varieties of form and glaciation that are found among larger boulders. The structure of the till in open situations shows that the axes of its stones have been turned by a common force in the direction of glaciation; it exhibits a rough structure comparable to the fluxion-structure of igneous rocks, the smaller boulders dividing around and apparently drifting past the larger, like the tide round an anchored skiff. These structures, which have been found by the author over many hundreds of square miles, chiefly in the north of England, indicate that at least a surface-layer of the till was dragged along, with a shearing movement of particle upon particle, producing intimate glaciation within its mass. Proofs are adduced that this moving layer was in general a surface-layer only, and that the till did not, as has often been supposed, move forward *en masse*, licking up its additions from beneath. This is the only intelligible explanation of the order (as well as the structure) of the boulder-clays of which the author has any practical knowledge. In up-lying situations, where the drift consists of raw material, fluxion-structures are seldom detected. In sheltered spots they are not generally developed. They are characteristic of well-kneaded till in open situations, liable, however, to obscuration by contortions within the mass. Of twelve experimental attempts made near the watershed of England in East Cumberland, 600–900 feet above the sea, to determine the ice-movement from this structure alone, eight were correct, three indeterminate, and only one misleading. The pressure and movement capable of producing this widespread fluxion-structure seem to have been that of some mass vast and far-spreading—closely investing, slow-moving, and heavily dragging—such as glacier ice. It needs only to be assumed that the confluent glaciers communicated something of their own movement and structure to the ground-moraine below.

On the Southward Ending of a Great Synclinal in the Taconic Range, by James D. Dana, LL.D.—The Taconic Range, which gave the term "Taconic" to geology, lies in Western New England, between Middlebury, in Vermont, on the north, and Salisbury, in Connecticut, on the south. In former papers, published in the *American Journal of Science*, the author has shown, first, that the rocks constituting the range vary as we go from north to south, from roofing-slate and hydromica (or sericite) schist to true chloritic and garnetiferous mica schists; secondly, that these schists lie mostly in a synclinal or compound synclinal; thirdly, that the crystalline limestone along the eastern foot is one with that along the western, the limestone passing under the schist as a lower member of the synclinal; and fourthly, that since the limestone contains in Vermont (according to the discoveries of the Vermont Geological Survey, and also of Mr. A. Wing), and in the State of New York, fossils of the Lower Silurian, ranging from the inferior divisions to the higher, the Taconic schists are probably of the age of the Hudson River group or Llandeilo flags. The author's papers further show that while a large part of the Taconic Range has eastward dip on both the east and west sides, a southern portion about twelve miles long, consisting of Mount Washington in south-western Massachusetts and its continuation into Salisbury, Connecticut, is a broad tray-shaped synclinal, the dips of the two sides being toward one another, like the sides of an ordinary trough. The width of the broad synclinal between the limestone belt on either side is about five miles. As the result of investigation during the last two years, the synclinal character of this Mount Washington part of the Taconic Range is illustrated in the paper by new sections, and by facts connected with the dying out of the great synclinal (or compound synclinal) in the town of Salisbury. The mean height of Mount Washington above the sea-level is about 2000 feet, and above the wide limestone region on either side and to the south, about 1250 feet. The synclinal virtually ends along an east and west line through the village of Lakeville, in the town of Salisbury, where a beautiful lake lies within the limestone area. The surface of the mountain region descends 1000 feet in the southern, or last, three miles; and in the latitude of Lakeville, the width, as the map presented shows, diminishes abruptly from five miles to a narow neck of six-tenths of a mile. The area south is of limestone, and the neck of schists referred to is hardly 150 feet in height above it. The limestone may in some places be seen emerging from beneath the schist at a small angle; and at one locality a low oven-shaped anticlinal of limestone has the schist covering all but a narrow portion at top; the quarrymen had to remove the schist to work at the limestone. Several narrow strips or belts of limestone, S. 15° W. in direction, corresponding with the direction of this part of the range, show out through the sides of the mountain where local anticlinals have had their tops worn off. Further, the dip of the schist over much of the southern slope is southerly and at a small angle, but with many local anticlinals and synclinals. In addition, there are small areas of schist *in the limestone* region, like straggling portions of the dwindled mountain, which appear in general to be remains of local flexures. There is the plainest evidence that the limestone formation of southern and south-eastern Salisbury comes out from beneath the dwindled, flattened-out, and worn-off mountain synclinal. And the reason why this limestone is exposed to view over plains miles in width, east and west of the Taconic Mountain, as well as to the south, is simply this, that the once overlying schist has been removed because in badly broken anticlinals and synclinals. The paper closes with an allusion to the orographic, stratigraphical, and lithological interest of the facts, and to their important bearing on the question of the origin and chronology of certain kinds of crystalline rocks, such as chloritic, garnetiferous, and staurolitic mica schists, as well as others less coarsely crystalline.

The Primitive Conocorypheæ, by G. F. Matthew, A.M., F.R.S.C.—Relates to the development of the species *Ctenocephalus matthewi* and other Conocorypheans of the Acadian fauna, and is considered under the three heads, viz., the Development of the Glabella; the Acquisition of Sensory Organs; and the Decoration of the Test. Under the first head it is shown that the peculiar glabella of the species above referred to is closely related to the early history of the trilobite. The glabella, in its earliest stage, is very different from that of the adult, and in outline is not unlike that of *Paradoxides*; it also resembles this species in the position of the ocular fillet. At the next stage the glabella or axial lobe becomes trumpet-shaped, as in *Caranxis*, and in the third the glabella proper is developed by the segmentation of the axial lobe: the glabella and ocular fillets now resemble those of *Ptychoparia*. In the following stages the family characters of the Conocorypheans begin to assert themselves, especially the widening of the base of the glabella, the appearance of the canals connected with the ocular ridges, and the development of spines. (2) *The Acquirement of Organs of Sense.*—The ocular fillet appears, in the second stage of growth, as a faint, narrow ridge, close to the anterior marginal fold, and extending but a short distance from the glabella. It is not until the fifth stage of growth that the ramifying branches which spread from the ocular ridge to the anterior margin made their appearance. The ocular lobe and sensory apparatus connected with it are more distinctly visible on the under than on the outer surface of the test, and the canalets connected with the lobe spread over the anterior slopes of the shield, and extend to the anterior margin. In the tuberculated species they connect by hollow spines with the outer surface. In one species they cover a wider space than in the others, extending some distance behind the ocular ridges and over the front of the glabella. (3) *Decoration of the Test.*—In all the Acadian species of this group but one, the surface of the test at maturity is covered with tubercles and spines similar to the surface-markings of *Conocoryphe sulgeri*, &c. In the earliest stages, however, no such tubercles are found, but the surface appears smooth or scabrous. In *Ctenocephalus matthewi* the surface, in the first three stages of growth, appears smooth; in the fourth, tubercles begin to appear, and about the fifth stage all projecting parts of the test are studded with them. Those on the glabella and frontal lobe are arranged in transverse rows, those on the cheeks in interrupted rows conforming more or less to the periphery of these protuberances. Towards the adult stage these tubercles and spines become more irregular in position and number, conforming in this respect to the law of development in the Ammonites, expounded by Prof. Alphonso Hyatt.

The Value of Detailed Geological Maps in relation to Water-Supply and other Practical Questions, by W. Whitaker, B.A., F.G.S., Geological Survey of England.—Those maps of the Geological Survey of England in which various divisions of the

Drift have been coloured tell us, as a rule, a very different tale from the corresponding sheets in which the Drift is ignored, and it is only these Drift maps that really give us a true idea of the nature of the surface. Indeed in many districts a geological map that does not show the Drift is comparatively useless for most practical purposes, at all events in a populous country like England. Moreover, it is not merely enough to mass Drift as such, but its constituent members should be fairly distinguished, not merely with regard to their classification or relative age, but also as to their composition, whether of clay, loam, or gravel and sand. To illustrate this there are exhibited copies of the two versions of many of the Geological Survey maps of the London Basin, with and without Drift, from which the following important points will be at once seen:—(1) Large tracts, shown as Chalk on one version, really consist, at the surface, of the generally impervious Boulder Clay, whilst over others the Chalk is covered by Brick-earth and Clay-with flints: all these beds being such as give an aspect to the country very different to what we find where the Chalk is bare. (2) Parts of the wide-spreading area of the London Clay (of the Driftless maps) are really quite altered and deprived of their clayey character, by the sheets, long strips, and more isolated patches of gravel and sand that occur so often, whether along the river-valleys or over the higher plains. (3) The sandy, permeable Crags are in great part hidden by Drift, which, though often consisting of sand and gravel, is sometimes of Boulder Clay. Indeed, so widespread is the Glacial Drift in the greater part of Norfolk and Suffolk, that only a Drift edition of the Geological Survey maps of the eastern parts of those counties has been issued; a map without Drift would necessarily be a work of fiction. To illustrate the important bearing which these Drift maps have on a great question, that of water-supply from the Chalk, the author also exhibits some special maps, which he has made to show the areas over which rain-water has access to the Chalk, as distinguished from those over which the surface-water cannot sink down into the Chalk, or can only do so very partially. These maps will be more particularly noticed in Section G.

Pennsylvania before and after the Elevation of the Appalachian Mountains, by Prof. E. W. Claypole, B.A., B.Sc., F.G.S. Lond.—The paper, of which the following notes are an abstract, is intended as an attempt to handle, in a necessarily imperfect manner, and only to first approximations, a difficult but important and interesting geological subject. The method of treatment is, in the writer's opinion, one that has not hitherto been employed for the same purpose. The object in view is to form some estimate, as near to the truth as possible, of the amount of compression or shortening produced at the surface by the corrugation of the upper layers of the coast into mountain chains, with especial reference to the American Atlantic seaboard. In order to confine the paper within due limits, certain propositions must be taken as proved. The principal of these are:—(1) That central contraction has developed tangential pressure in the crust; (2) that the tangential pressure has produced crumpling of the crust; (3) that to this crumpling are due long ranges of mountains; (4) that the Appalachian Mountains came into being in this manner in the later portion of the Palæozoic era. These admitted, the conclusion necessarily follows that during the formation of the Appalachian Mountains a considerable contraction of the crumpled area ensued, in a direction at right angles to that of the chain. The following points constitute the main features of the paper:—(1) Short account of the great ranges of Pennsylvania, in plan and section, with diagrams; (2) situation and account of the line of section adopted; (3) limitation of the field to a consideration of eleven great ranges—Blue Mountains, Bower Mountains, Conecocheague Mountains, Tuscarora Mountains, W. Shade Mountains, Black Log Mountains, Blue Ridge Mountains, Jack's Mountain, Standing Stone Mountains, Tussey Mountains, Bald Eagle Mountains; (4) Discussion of the different parts of this section—(*a*) the Mountain Region, (*b*) the Cumberland Valley; (5) attempt to estimate or measure the curved line of the crumpled Upper Silurian (Medina) sandstone; (6) inference that the sixty-five miles of the line of section represents about 100 miles of surface previously to the crumpling of the crust and elevation of the mountains; (7) this result, for several reasons, below rather than above the truth; (8) geographical effects of this contraction; (9) development of the fact that such elevation of mountains by tangential pressure involves not only elevation, but considerable horizontal movement; (10) diminution of motion to north-west; (11) a few words on the failure of attempts yet made to account for this contraction; (12) suggestions and conclusions.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

At King's College Prof. W. Grylls Adams, F.R.S., will deliver a course of lectures on Electricity and Magnetism and their applications to Electric Lighting, Transmission of Power, &c., during the academical year 1884-5. A course of practical work in electrical testing and measurement, with especial reference to electrical engineering will also be carried on under his direction in the Wheatstone Laboratory. The lectures will be given once a week—on Mondays at 2 p.m.—and the Laboratory will be open on Wednesdays and Fridays from 1 to 4.

SOCIETIES AND ACADEMIES

PARIS

Academy of Sciences, September 15.—M. Rolland, President, in the chair.—Address delivered at the inauguration of the Fresnel Monument at Broglie, by M. Jamin.—Remarks on algebraic equations, in connection with a communication from M. de Jonquières on the application of geometry to algebra, by M. Léon Lalanne.—Note on the two methods, proposed by Hamilton and Sylvester, for resolving the linear equation in quaternions, by Prof. Sylvester.—On the composition and properties of the light emitted by insects of the Pyrophore genus, by MM. Aubert and Raph. Dubois. Examined under the spectroscope, the spectrum of this light appeared very beautiful, continuous, and destitute alike of very bright and dark bands. It occupied about seventy-five divisions of the micrometer, extending on the red side to the centre of the interval separating the A and B rays of the solar spectrum, and on the side of the blue a little beyond the F ray. When its intensity diminishes, the red and orange disappear altogether, the spectrum being then reduced to the green with a little yellow and red, the green persisting longest. The reverse takes place when the insect begins to glow. Thus the least refrangible rays are the last to be emitted, a result hitherto observed in the spectrum of no other luminous body, except to a limited extent in that of the sulphide of strontium. Examined to ascertain its photo-chemical properties, this light showed a feeble display of the phosphorescence of the sulphide of calcium.—Remarks on a singular case of deformation in the images observed through telescopes, by M. Govi.

BERLIN

Physiological Society, August 1.—Dr. A. Auerbach had made experiments to ascertain which of the constituents of flesh exercised the acid, alkali-abstracting effect on the blood witnessed in the reaction of the urine of flesh-eating animals compared with that of the urine of plant-eating animals. He found that the acid phosphoric potash increased the ammoniacal contents of the urine in a manner similar to that of the administration of acids. A dog fed on flesh having been brought into nitrogenous equilibrium, and kept in this state for some days, had a portion of acid phosphoric potash given to it in addition to the meat. The nitrogenous excretion remained the same as before, but the quantity of secreted ammonia had considerably increased, and this increase continued for some days after the dog was put back to the former flesh diet without the salt. The quantity of secreted ammonia corresponded, to the utmost nicety, with the quantity necessary for the conversion of the salts which had been taken, PO_4KHH, into PO_4KNO_4H.—Prof. Kronecker gave a report of a series of experiments conducted during the session now ended in the department of the Physiological Institute under his care. He first recounted the experiments of Mrs. Dr. Boll, who investigated whether asphyxiated fishes could recover animation without a supply of oxygen, and simply by withdrawing the carbonic acid from them. Goldfishes were left in boiled water free of air till the symptoms of asphyxia became distinctly manifest, and then a somewhat diluted caustic lye was added to the water without the admission of air. In every such case the fishes soon recovered their lively movements, and swam about freely in the water. It might therefore be concluded that, with the discharge of the surplus of carbonic acid, the symptoms of asphyxia would also disappear.—Prof. Kronecker then reported on the experiments of Dr. Kranzfeld, which had for their subject the movements of the stomach. In the stomach of each of the animals examined, the cardiac part, the pyloric part, and the middle had to be discriminated. Of these three parts the last was in most cases immovable, while the two other parts displayed lively movements. In the act of

swallowing, as observation proved, the stomach took no share. The cardiac and the pyloric parts were excitable in different manners. The pylorus reacted strongly even on slow electric stimulations of moderate intensity such as failed to induce any contraction in the cardiac part. Contraction of the cardiac part followed however more frequent stimulations. The act of vomiting, at least in all the animals examined, was constantly brought about by a swallowing movement. In the discharge of the contents of the stomach, on the other hand, the œsophagus took no part whatever. The motors at work were the abdominal pressure and the movements of the gastric walls, and during the time the vomiting lasted the cardiac orifice was open. The whole mechanism of the act of vomiting was still, however, the subject of investigation.—Dr. Jastreboff has made a particular investigation of the question, important in practice, regarding the effect on the blood-pressure of interference with different parts in the case of operations in the peritoneal cavity. He found that the blood-pressure was raised by all encroachments of this kind, especially that of impinging on the intestine, and, most strongly of all, by a refrigeration of the intestine. In the case of a quick excision of a warm tumour from the peritoneal cavity the blood-pressure rose to quite a rapid rate, and the influence of ether was only able somewhat to abate it.—In continuation of former experiments on the movements of the vagina, Prof. Kronecker has further established that they are not peristaltic movements like those of the intestine, but that the vagina contracts, exactly in the same manner as does the œsophagus, in sections which in definite numbers (mostly three) and in definite series compress themselves from the top downwards. A solution of continuity in the wall of the organ in no respect affected the course of the contraction.—Dr. Ratimoff has studied the effect of chloroform on the heart and the respiration. In order to charge the air with the vapour of chloroform a special apparatus was constructed which allowed an exact registration of the chloroform. Air completely saturated with chloroform contained in every case, whether the process of interfusion took place slowly or rapidly, 30 cubic centimetres of chloroform to 100 litres of air, and invariably caused the death of the rabbits subjected to it, and that through paralysis of the heart. Such a mixture as produced a complete narcosis of the animal, without affecting the heart or the respiration, contained 5·6 or 7 cubic centimetres of chloroform to 100 litres of air, a mixture which was able to maintain the narcosis for hours at a time. In these experiments, however, it appeared that the animals very soon got accustomed to the chloroform, and if, for example, the narcosis was effected at the beginning by a proportion of 5 cubic centimetres of chloroform, the dose had subsequently to be increased to 6 and 6½ cubic centimetres in order to keep up the narcosis.—Dr. Schapiro has investigated the effect of atropine on the frog's heart, and has found it analogous to the effect of heat. The heart became through its application much more accessible to external treatment than in a normal state, and in general its effect may be formulated in the statement that by means of atropine the fissures in the frog's heart become widened.—Mr. Aronsohn had formerly found that 0·73 per cent. solution of ordinary salt was of altogether indifferent and unstimulating effect on the nasal mucous membrane, and offered the best vehicle for the introduction of smelling substances. He now communicated that he had examined other salts, in particular carbonate of soda, sulphate of soda, sulphate of magnesia, &c., with a view to determining in what concentration they affected the nasal mucous membrane with equal indifference as did 0·73 common salt solution. He found that for this purpose much more considerable quantities of these salts were required. In the case of sulphate of soda, for example, four times the quantity that sufficed in the case of common salt was needed to produce the same absence of effect. In such stronger concentrations these solutions might take the place, either in whole or in part, of the kitchen salt solution.—Dr. Heimann reported on a new method for the production of localised pressure on the cerebrum. He placed an animal at the periphery of a round chest made to revolve round its centre, caused it to rotate 300 times a minute, and observed paralytic symptoms which passed away in a short time after the end of the rotation. By experiments he convinced himself that the change in the distribution of the blood in the two halves of the brain produced by the centrifugal force was without influence in this phenomenon, and therefore concluded that it was exclusively the one-sided pressure of the brain against the skull which caused the paralysis. To still further localise this pressure he trepanned the skull at a spot where it was known that the part of the membrane of the cerebrum there situated was the centre for the movements of an extremity, fixed into the opening a cork stopper, which of itself exercised no pressure, and placed the animal in such a posture in the rotating apparatus that the operated side was situated outwardly. In the rotation the spot in question was now pressed against the cork, and so paralysis showed itself in the extremity appertaining to that spot. On the cessation of the revolution the movement of the paralysed part was soon restored. These experiments could be repeated at pleasure without doing any harm to the animal.

VIENNA

Imperial Academy of Sciences, July 17.—K. Laker, on the first microscopic phenomena of coagulation of mammalian blood.—A. Weiss, on a peculiar occurrence of calcium oxalates in the epidermis of the organs of some Acanthaceæ.—On spontaneous movements of vegetable dyeing bodies, by the same.—Preliminary note on a peculiar solved yellow dye in the flowers of some Papaveraceæ, by the same.—L. Boltzmann, on the properties of monocyclic systems and of other systems allied with them.—H. List, on the epithelium of the cloaca of *Scyllium canicula*.—K. Zulkowsky and K. Lepéz, aid to the determination of the halogens of organic bodies.—R. Benedikt and P. Julius, on a new resorcin-blue.—A Nalepa, on the anatomy of Tyroglypha.—O. W. Fischer, contribution to a knowledge of diquinolyles.—On two organic stannum compounds, by the same.—T. Habermann, on some basic salts.—F. Berger, on the action of acetamide in phenylcyanide.—S. Schubert, on the behaviour of the starch-granule if heated.—G. Spitz, on some mixed ethers of resorcin.—K. Natterer, contribution to a knowledge of dichloro-ether.—K. Auer von Welsbach, on rare earths.—Z. H. Skraup and O. W. Fischer, on methyl-phenantroline.—Z. H. Skraup, on a new mode of formation of phenantroline.—L. Szajnocha, contribution to a knowledge of the middle Cretaceous Cephalopod faûna of Elobi Island on the western coast of Africa.—K. Auer von Welsbach, contributions to spectral analysis.—E. von Fleischl, on double refraction of circumpolarising fluids.—E. Steinach, studies on the renal circulation of the blood.

CONTENTS

	PAGE
Modern Steam Practice and Engineering	509
Our Book Shelf:—	
Anderson's "Catalogue and Handbook of the Archæological Collections in the Indian Museum"	511
Letters to the Editor:—	
Barnard's Comet.—**A. A. Common**	511
The Krakatoa Eruption.—**Prof. C. Piazzi-Smyth**	511
The Sky-Glows.—**T. W. Backhouse; P. K.; Robt. Leslie**	511
The Diffusion of Species.—**Dr. G. C. Wallich; R. Scot Skirving**	512
Shifting of the Earth's Axis.—**W. M. Flinders Petrie**	512
Salmon-Breeding.—**Arthur Nicols**	512
A Sea Monster.—**Alfred Morris**	513
Hail.—**A. D.**	513
The "Comma-shaped Bacillus," Alleged to be the Cause of Cholera. By Surgeon-Major Timothy Richards Lewis, M.B.	513
Forests in Coburg, Germany, and Russia	515
Stone Hatchets in China. By Rev. Dr. Joseph Edkins	515
Notes	517
Our Astronomical Column:—	
The Figure of Uranus	519
The Lunar Eclipse on October 4	519
Olbers' Comet of 1815	519
The Comet of 1729	519
Constitution and Origin of the Group B of the Solar Spectrum. By M. L. Thollon. (*Illustrated*)	520
The Migrations of "Salmo salar" (L.) in the Baltic. By Prof. And. Joh. Malmgren	521
The British Association:—	
Reports	522
Section A—Mathematical and Physical Science	523
Section C—Geology	526
University and Educational Intelligence	531
Societies and Academies	531

THURSDAY, OCTOBER 2, 1884

THE "CHALLENGER" REPORTS

Report of the Scientific Results of the Voyage of H.M.S. "Challenger" during the Years 1873-76 under the Command of Capt. George S. Nares, R.N., F.R.S., and Capt. Frank Tourle Thomson, R.N. Prepared under the Superintendence of the late Sir C. Wyville Thomson, Knt., F.R.S., &c., and now of John Murray, F.R.S.E., one of the Naturalists of the Expedition. Zoology—Vol. IX. Text and Plates. Two Vols. (Published by Order of Her Majesty's Government, 1884.)

ANOTHER volume forming Part XXII. of the Zoological Series of Reports on the Scientific Results of the *Challenger* Expedition has just been published, containing an account of the Foraminifera by H. B. Brady, F.R.S. It will be universally acknowledged that the task of preparing this Report could not have been intrusted to abler hands. The representatives of this interesting group of animals, writes Mr. Murray in an editorial note, are universally distributed over the floor of the ocean and in its surface and sub-surface waters, and the presence or absence of certain surface forms in the deposits from different depths and localities is intimately connected with some of the most remarkable and intricate problems of general Oceanography. It was therefore of the first importance that one very familiar with the group of the Foraminifera should have been chosen to undertake so vast an amount of labour as was requisite to investigate the enormous quantity of material that was collected. The Report itself is the best evidence of the great success which has attended Mr. Brady's investigations; it consists of a volume of text of over 800 pages, and is accompanied by a volume of 115 very exquisitely executed plates.

While the chief part of the Report is taken up with the descriptions of the new or rare species of Foraminifera furnished by the various bottom-dredgings and tow-net gatherings obtained during the *Challenger* Expedition, the author has also included some account of the collections made in the regions of the North Atlantic, which, though not visited by the *Challenger*, were explored during the expedition of the *Porcupine* in 1869, and he has made the survey of the group more complete by also referring to the forms found during the cruise of the *Knight Errant* in 1880, and during the British and Austro-Hungarian North Polar Expeditions.

The Report, however, contains a great deal more than descriptions of new or rare species. From Mr. Brady's large acquaintance with the multifarious forms to be met with in the group and with its literature, he has been enabled to treat in a full and able manner the subject of the classification of these forms, and has thereby developed this Report into an elaborate monograph of recent Foraminifera.

In an admirably written introduction a sketch is given of the gradual development of our knowledge of these forms from the time of D'Orbigny (1826) to the present, and an elaborately compiled bibliography is appended. The various classifications of the Rhizopods, from that of Dujardin in 1841 to that of Leidy in 1879, are glanced at. More details are given as to the various attempts at classifying the Foraminifera, and the author proposes a scheme differing in many respects, and often widely, from those given by previous writers, but one which, in its essential elements, is in no way incompatible with the different conclusions at which they had arrived. The nature of the investment of the animal—that is to say, the minute structure of its test—as an exclusive basis for the primary divisions of the order, has been abandoned. While under all circumstances it furnishes important characters, and is even in some families quite distinctive, it is nevertheless a fact that, whilst there are certain groups which are invariably arenaceous, and some which are always calcareous and perforate, there are yet others in which no uniform rule obtains. The author omits any division of the order into sub-orders, not finding any easily-recognised characters to serve as a basis for such subdivision, and he divides the order at once into families. These families are (1) Gromidæ, (2) Miliolidæ, (3) Astrorhizidæ, (4) Lituolidæ, (5) Textularidæ, (6) Cheilostomidæ, (7) Lagenidæ, (8) Globigerinidæ, (9) Rotalidæ, (10) Nummulinidæ. The Gromidæ, a family composed chiefly of fresh-water organisms, "have been a source of considerable trouble, on account of the want of accuracy and detail in the published descriptions of a number of types more or less closely allied to the group, and only such genera have been included as are known to have long, reticulated pseudopodia." In this portion of the subject the author has had the advantage of the advice of his friend William Archer. "The sub-family Dactyloporinæ, which in the original draft was placed with some reservation amongst the Miliolidæ, pending the fuller publication of the results of Munier-Chalmas's researches, is now entirely omitted. The examination of specimens brought under my notice by E. Perceval Wright and C. Schlumberger has removed any doubt left on my mind as to the propriety of the transfer of the entire group to the calcareous Algæ." The singular genus Bathysiphon of Sars has been removed to the Astrorhizidæ.

With reference to the subject of nomenclature, the following are Mr. Brady's views, which seem founded on common sense, and with which we entirely agree. It is surely not requisite in a group like this "that a uniform standard of fixity of characters should be adopted, or that a set of beings of low organisation and extreme variability should be subjected to precisely the same treatment as the higher divisions of the animal kingdom. The advantages of a binomial system of nomenclature have not diminished since the days of Linnæus, though the views of the naturalist as to what constitutes a 'genus' or a 'species' have changed, and will probably continue to change, but, be that as it may, the Linnæan method is too simple and convenient to be abandoned without some better reason than the different value of these terms as employed in different zoological groups." "The practical point upon which all are agreed is that it is impossible to deal satisfactorily with the multiform varieties of Foraminifera without a much freer use of distinctive names than is needful or indeed permissible amongst animals endowed with more stable characters." All who have had any experience of the life-history of these Rhizopods, who know their immense plasticness, and yet

who remember their, within certain limits of deviation, fixedness of type, will cordially agree with this.

The subject of dimorphism is alluded to, and the two quite distinct phenomena among Foraminifera described by this term are explained, but the author does not seem to select one of these above the other for the exclusive right to the term, as would seem desirable.

One of the most interesting subjects in reference to deep-sea deposits is their direct connection with the pelagic species of Foraminifera. As a rule these forms are not of pelagic habit; on the contrary, probably 98 or 99 per cent. of the known species or varieties live in the sand or mud of the sea-bottom, and possess no powers of floating or swimming; but, on the other hand, some few forms, belonging to eight or nine genera, do most certainly pass their existence either in part or in whole at the surface of the ocean, or floating at some depth below that surface. These forms are found, too, in immense profusion, and a relatively very large mass of the oceanic deposits consist of their calcareous shells. A list of the at present ascertained pelagic forms is given. The most prominent genera are Globigerina, Pulvinulina, Hastigerina, Pullenia. The question seems still unsettled as to whether the species are exclusively pelagic, passing the whole of their time living at or near the surface, or whether they can or do pass a certain portion of it on the sea-bottom. Mr. Brady adduces a series of facts which tend to the inference that the Foraminifera which are found living in the open ocean have also the power of supporting life on the surface of the bottom-ooze, and further, so far as our present knowledge goes, there is at least one variety of the genus Globigerina which lives only at the sea-bottom; but the author is most cautious not to express any dogmatic opinion on the subject.

In dealing with the composition of the test, the presence of a considerable percentage (6 to 10) of silica has been established as existing in the arenaceous forms. The substance secreted for the incorporation of the foreign bodies which cover the test has been proved to be composed of ferric oxide and carbonate of lime in variable proportions, the former being often in considerable excess. It is not without interest to note the presence in some of the porcellanous forms of a thin siliceous investment. A few Miliolæ from soundings of a depth of about four and a half miles, with somewhat inflated segments, scarcely distinguishable in form from young thin-shelled specimens of a common littoral species, were found to be unaffected by treatment with acids, and upon further examination it became apparent that the normal calcareous shell had given place to a delicate homogeneous siliceous investment. While immersed in fluid, the shell-wall had the appearance of a nearly transparent film, and this when dried was at first somewhat iridescent.

A list is given of those stations from which soundings or dredgings were obtained in sufficient quantity to furnish good representative series of Rhizopods, and maps are appended showing the tracks of the *Challenger*, with these stations marked, as also of the areas explored by the *Porcupine* and the other northern expeditions.

Any generalised summary of the details of the new forms would be impossible. Of the several hundred species described and figured, over eighty are here noted for the first time, and this without counting numerous well-marked and named varieties, or the numerous new forms already diagnosed in Mr. Brady's preliminary Reports.

The family Astrorhizidæ is the one which has received the largest number of additions; indeed our acquaintance with the larger arenaceous Rhizopods is almost entirely derived from the various recent deep-sea explorations. A knowledge of the life-history of these forms is still needed to place the classification of the group on a secure basis, and as some few of the forms are inhabitants of comparatively shallow water, their investigation would seem to be well worthy of the attention of observers at some of our zoological marine stations. Many other problems to be solved are also pointed out in this Report, the extreme value of which will be recognised by all students of biology.

THE ENGLISH FLOWER GARDEN

The English Flower Garden: Style, Position, and Arrangement. Followed by a Description, Alphabetically Arranged, of all the Plants best suited for its Embellishment; their Culture, and Positions suited for each. By W. Robinson, with the co-operation of many of the best Flower Gardeners of the day. Illustrated with many Engravings. (London: John Murray, 1883.)

A LOVE of flowers seems more or less characteristic of most human beings, and the tending and caring them is to most people a pleasant labour. Their brightness of colour, their charm of form, the sweetness and refreshingness of their varied perfumes please and delight the senses, while the mystery of their lives and deaths captivates the mind and awakes up the pleasures of hope. In no European country has this love of flowers been more manifested than in England, so that a flower garden seems an indispensable adjunct of an English home. It too often happens that many of those who love flowers have not the knowledge requisite to take care of them, and then the flower garden is handed over to the care of others. What to grow and what not to grow becomes then not so much a question of deliberate enlightened forethought as a thing of fashion, commonplace and unstable. No honest lover of Nature, no one who has once known the beauties of plant life, could ever for a moment remain pleased or satisfied with the arrangement of things out of place which is so peculiarly characteristic of one style of modern English gardening. It was not always thus: anywhere in Continental Europe that one visits "Le Jardin anglais" of some fine demesne or of some public park, there one is sure to find some attempt to form a natural prospect by the judicious arrangement of tree, shrub, flower, and grass; but in England itself, the very home of Sylvia, all traces of Nature are too often obliterated, and a meretricious display of colour, inclosed within a sharply defined geometrical sameness of outline, takes the place of a refreshing contrast in contour accompanied with joyful surprises of brightness. What a difference there is in the pleasure of viewing a large mass of *Gentiana acaulis* in the centre of a wide expanse of scarlet geraniums encircled with yellow calceolarias and viewing some few tufts of the same plant opening their blue corollas amid the grass by the borders of some Alpine meadow. Those who love gardens and like to see in them some few touches

of Nature owe a debt of gratitude to Mr. W. Robinson for his life-long labours in disturbing our minds as to the correctness of modern views on gardening, and for in a great measure destroying the miserable conventionality that had made our gardens bad imitations of very inartistic carpets, or of nightmare-giving wall-papers. But in destroying what was bad it was also most desirable to build up something good to replace what was gone, and in the present most welcome volume we find indications, clear and distinct, of the abounding wealth of flowers at our disposal which are fitted for the embellishment of our open-air gardens. In the compilation of this work on the "English Flower Garden," Mr. Robinson has had the co-operation of some of the most practical and thoughtful writers of the day, and also the valuable aid of Mr. W. Goldring, whose experience as superintendent for some time of the Hardy Plant Department of the Royal Gardens at Kew has well qualified him for the task. The first part of the work—On Gardens, their Arrangement, &c.—is for the greater part from the pen of the author. We should have liked that a small portion of this part had been devoted to the subject of town and suburban gardens of small size. Many a modest cottage garden has, we read, its lessons to give, but then our ideas of a modest cottage garden are not helped by an illustration of the charming grounds attached to Sheen Lodge. The second part contains in alphabetical order a list of the more important genera and species of plants which will grow in the open air in Great Britain or Ireland, with figures, some very good, some indifferent, of most of the more attractive species. In some few cases we notice figures given which are not referred to in the text; when these are not of "desirable" species for the flower garden, as in the case of *Gentiana lutea* and *Scilla maritima*, it would have been better to have put others in their place. To all our readers who have or contemplate having a garden we cordially recommend this very excellent book.

OUR BOOK SHELF

The King Country; or Explorations in New Zealand. By J. Kerry-Nicholls. (London: Sampson Low and Co., 1884.)

IN this interesting volume Mr. Nicholls describes a good stroke of exploring work. The King Country, with which his volume is largely concerned, is that district of the North Island of New Zealand which is still under the sway—not entirely nominal—of the King Tawhiao, who has only recently left our shores. It occupies a very large area between the west coast and the Lake Taupo region, having on its north-eastern border that wonderland with which the late Baron Hochstetter has made us familiar. The additional details of the sub-volcanic action of this region, its boiling springs and glistering terraces, are welcome. From Rotomahana Mr. Nicholls travelled southwards in a zigzag to Lake Taupo, and geologists will be specially interested in the observations regarding the great volcanic plateau on the south of Lake Taupo, and Mr. Nicholls's account of his ascent of Mounts Tongariro and Ruapehu, the former still in a state of volcanic activity. In fact there is abounding evidence that at no very remote period volcanic action must have been widespread and copious over a very large area of the North Island. Though not to be compared with the Southern Alps, which Mr. Green and his companions scaled last year, still Mr. Nicholls's feat was formidable and trying enough. In the King Country the natives have retained many of their original characteristics and customs almost unchanged, and therefore such narratives as that of Mr. Nicholls is of considerable value to the ethnologist. The region is richly wooded, the scenery in many places magnificent, and the geological features well worth minute investigation. In an appendix we find a list of the New Zealand tribes with their localities, and careful lists of the flora and fauna met with during Mr. Nicholls's journey. Altogether the narrative is interesting, and contains a good deal of fresh information. There is an excellent map and many attractive illustrations.

Forests and Forestry of Northern Russia and Lands beyond. Compiled by John Croumbie Brown, LL.D. (Edinburgh: Oliver and Boyd, 1884.)

THE forestry of Russia has so recently been the subject of an article in our columns, that we need do little more than refer to this, the latest of the long series of volumes by Dr. Brown on his favourite *Forstwissenschaft* or forest science. It appears to have been compiled *apropos* of the International Exhibition of forest products in Edinburgh, and is intended "to introduce into English forestal literature detailed information on some of the points on which information is supplied to students at the schools of forestry on the Continent." The information contained in the volume has been obtained personally during journeys in Russia, or from the best official sources. There is also, it should be said, much to interest the most general and careless of readers, for Dr. Brown quotes extensively from the best recent writers on the districts of Russia to which his book specially refers.

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.*]

M. Thollon's Views of "Great B" in the Solar Spectrum

THE excellence and power of M. Thollon's prisms have become proverbial in the spectroscopic world. For the sake, therefore, of having his own account of what he has himself seen (NATURE, vol. xxx. p. 520), with physical apparatus of gigantic size, so well planned, so admirably constructed, and manipulated with such matchless skill,—doubtless every reader will make very little objection to any small accompanying inaccuracy in one outside reference.

To me, therefore, as well as probably to every one else, it is a very trifling matter that he should lay to my charge that I have said "Great B" does *not* increase in intensity as the sun approaches the horizon; although in my "Madeira Spectroscopic" book I have actually introduced Plate 5 to show, as compared with Plate 4, that it does so increase very notably.

But the real point of interest, of special importance just now, and perplexity too, is not that there is *some* effect of the telluric character in the "B" lines—but how much? and in what manner does it grow with zenith distance?

Now that residual question does not seem yet to have occupied M. Thollon, or he would have described the different rates at which the dry gas lines of "B" grow with zenith distance compared with the lines of watery vapour; and, as a first and easy result, he would undoubtedly have obtained, as I have with far inferior means, an indication that the water-vapour of the earth's atmosphere is confined to the lower strata only, while the dry gas composing "B" belongs more nearly to the whole atmosphere, high and low. To that too, at least; for some observations of "B" when near the zenith, or looked at through the shortest aërial path possible at the place, showed me so immense an intensity still in its lines, as to lead to the suspicion

that *part* of their producing gas may be even far outside the usually considered limits of everything belonging to the earth.

M. Thollon, indeed, gives a view of the "B" region, "as," he says, "it would appear if observed outside the earth's atmosphere"; and therein he shows every line constituting our magnificent earthly constellation "Great B," absolutely wiped out of existence—a few *ultra*-faint, accidentally intruding solar metallic lines alone excepted. But how has the eminent *savant* obtained that view? Not by ascending in a balloon, or up the sides of a high mountain above all the grosser atmosphere, and seeing that it was so, but merely by observing some small amount of difference of effect, at two slightly different degrees of large zenith distance, viz. 60° and 80°, at the Observatory of Nice.

Two points, however, alone, will never enable a curve to be drawn on their sole authority; and as a curve of effect is what the investigation now requires, M. Thollon's hitherto merely duplex observations will acquire a far greater power of conviction for other men's minds, if he will kindly supplement them with others at 20° Z.D., or as near to it as the latitude of Nice will allow him at time of summer solstice. Still more would he make us all his debtors if he would repeat those three angular directions at three successive stations at greater hypsometric altitudes; duly remembering that while every one knows that water-vapour and oxygen (the gaseous parentage of "B" according to the grand experiments of M. Egoroff) do exist in the earth's atmosphere, that does not, by itself, therefore render them impossible in greater or less quantity to the outer region of the sun's envelopes; or, in a highly attenuated degree, to the 92,000,000 of miles of space between. C. PIAZZI-SMYTH

15, Royal Terrace, Edinburgh, September 27

Shifting of the Earth's Axis

WITH reference to the letter of Mr. W. M. Flinders Petrie (NATURE, September 25, p. 512), I would remark that there has been no sensible change in the latitude of Greenwich (as found by observations of circumpolar stars) during the last forty-seven years, a period nearly twice as long as that covered by the Pulkowa observations which M. Nyrén has discussed. In a paper on the "Systematic Errors of the Greenwich North Polar Distances" (*Mem. R.A.S.* vol. xlv.), I have exhibited the results for the co-latitude of the centre of the Greenwich transit-circle for each year and for groups of years from 1836 to 1877 reduced to the same refractions throughout (Bessel's), and corrected where necessary for index-error of the thermometer, and the accordance of the individual results is as close as can be expected, when allowance is made for the systematic errors to which all observations are liable, but which are usually ignored in estimating theoretically the probable errors of mean results. It may suffice if I here give the results for co-latitude for three periods of years:—

1836-49	mean co-latitude 38° 31′	21″·85
1851-65		21″·87
1866-83		21″·85

The first and last results are identical and are absolutely inconsistent with Mr. Petrie's supposed increase of the Greenwich co-latitude of 1″ or more in a century.

W. H. M. CHRISTIE

Royal Observatory, Greenwich, S.E., September 27

The Sky-Glows

FROM the great purity of the sky this evening, and from the flatness of the horizon westwards, on the line of the Great Northern Railway between Huntingdon and Hitchin, the sunset glow was of a very beautiful description. At five minutes before six (watch-time, three or four minutes slow) the sun set; and it was no sooner hidden than a parhelion-like patch of white light, 6° or 8° in diameter, brighter than the rest of the sky, occupied a place 10° or 15° above the sunset point of the horizon, and continued shining there with pearly brightness for about ten minutes. The horizon-line became edged at the same time with bright red, melting abruptly away upwards into orange, and higher up into a field of yellow light round the lucid spot. At 6.5 this spot's white light began to acquire a rosy tinge, and during the next ten minutes, until 6.15, it became intensely rose-coloured, preserving its definite place unchanged in the upper expanse of yellow; a vivid golden oriole-yellow stripe some degrees broad divided it from the red fringe along the horizon, the dazzling gold colour shading exquisitely into the fiery red below and rosy red above, and deriving itself from the latter a bronze-like greenish cast in its bright golden hue by contrast.

By 6.15 the rosiness of the bright spot had extended upwards and outwards from its centre, and was now blended in its colour and confines with the yellow band and red fringe below it, until the whole presented a conflagration or red aurora-like outburst of light in the west, 20° or 25° high, and extending 45° or 50° in base along the horizon.

The yellow belt was fading out of this glory, and the brightness and rosiness of its upper part was fast disappearing, when at 6.15 there appeared, with extreme quickness in the brighter base, dark intervals dividing it into upward radiating diverging beams of light, which rapidly acquired such fixed breadths and distinctness that I easily counted six or eight separate beams nearly equidistant from each other, and of equal lengths and strengths, marking out plainly by their divergence the sun's place, and the considerable depth to which it had already sunk below the horizon. The two outer ones only of the beams, on the northern side, were a little confused together, and marred the symmetry which the whole presented, but the full number of their display was several times counted over during the ten minutes—until 6.25—that they continued visible. They were about 15° long from their bases, and extended across and usurped to themselves the light of what had been the golden-yellow belt; but they gradually shortened and became dull red when at the latter hour the horizon assumed the red appearance which it usually presents some time after sunset. The above striking phases of the glow,—the white spot, the rose-red one, and the streamers,—occupied just ten minutes each, and the unusual aspect of the sky ceased entirely just thirty minutes after sunset.

The patch of whitish light observed this evening had all the appearance of a true, but extended and diffused, mock sun of some description; and I have noticed the peculiarity before, in the sunset glows of last winter and spring, whenever I had an opportunity to see the sky and watch their early phase just after sunset; but crystals of ice being then plentiful in cirrus, the evidence of the mock sun's formation by non-aqueous dust in the atmosphere was not so strong as now, when it has recurred after a long continuance of a summer temperature which has been unusually high. It is also singular and curious that the rosy tint began in the white-glow spot, and spread evenly outwards from it as a centre, as the extent and intensity of this remarkable colour grew and increased.

Appearing as the white spot does, when I have seen it, at a pretty fixed height of not less than about 12° from the horizon as soon as the sun has set, it seems difficult to reconcile its presence at such an altitude with a theory of its production by reflection of the sun's horizontal rays from fine films or laminæ of floating glassy dust, unless descending equatorial currents, perhaps, in those extremely stable heights may have a sensible inclination downwards from the west, and may tilt the films' under sides in a direction corresponding with that of the current slightly towards the sun?

With regard to the diverging beams, they are also, perhaps, not quite ordinary, irregularly produced straight lines of radiation; but seemed by their symmetry to be connected, at least in the origin of the shadow-gaps which formed them, with evenly ruled stripes or pleats of the cirrus, and of loftier haze, in this case directed, it seemed, nearly east and west. With such haze-bands and stripes directed rather more south-westerly, or about towards the point of winter sunset, and intersected also with slightly slanting systems of striation, I constantly noticed the sky in Newcastle-on-Tyne, during the prevalence last winter and spring of the repeated sunset glows, to be for weeks and months more or less constantly and uniformly, but in general weakly and dimly, streaked and furrowed over. Either an unusually steady current was prevailing in the upper air; or else a permanent current there, and long lines of aerial disturbances troubling its streams were made more visible and conspicuous than ordinary, by exceptional radiation, or some other unusual refrigerating and haze-engendering cause, depriving the upper air of its transparency, during the time of the sky's presenting such unusual appearances in what Quetelet named and considered to be the "stable" or untempestuous upper regions of the atmosphere.

Whatever may be the explanation of the streamers and of the white glare-spot, observations may perhaps be made of them under even more favourable conditions than occurred this evening, and they would then possibly give a little help towards arriving at some further conclusions both as regards the crystalline or other nature of the haze-causing substance, and as to the

manner and direction of the motions of the extremely lofty air-currents in which the finely-divided material is suspended.

A. S. HERSCHEL

Collingwood, Hawkhurst, September 29

ON September 27, being on the river about 6 p.m., I noticed the beautiful colour of the sky, which lasted for three-quarters of an hour after sunset. The day had been very cloudy, but not much rain had fallen, and about 4.30 p.m. the sky cleared and the sun shone out. My attention was drawn to the appearance of the sky about 6.15, after the sun had set. Great masses of red appeared in the west on a background of gold and primrose; above this the sky shaded from green into blue; the red colour extended upwards for about 40°, and appeared of various shades, deep red, magenta, and rose colour, the various small clouds which were floating about being pink. This red light gradually broadened out and died away, giving place to deep orange and gold, the latter colour lasting till 6.45.

The water was as gorgeous as the sky above, the reflections of the trees being bright red and purple on a floor of gold. I may add that the red light from the sky was so strong that a rosy hue was thrown on some trees and everything around.

Hurley Mill, September 28 T. M. BROWNE

September Stream of Krakatoa Smoke at Strong's Island

AFTER long delay, owing to the wrecking at Strong's Island of the *Morning Star*, I feel very fortunate in coming into possession at last of a most important record of fact, which I hasten to publish, in the form of an extract from the journal of Miss Cathcart, the young lady missionary labouring at Strong's Island with Rev. Dr. and Mrs. Pease, and well known in Honolulu. It is as follows:—

"*September* 8.—Yesterday there was a very peculiar appearance of the sun. The sky was somewhat cloudy, but not so as to obscure the sun, which was of a silver blue colour, and not so bright but what we could look at it without any trouble. The shadow was the same as in an eclipse. There was no bright sunshine all day."

Although the journal contains no further record on the subject, nor any mention of the red glows which must have followed, it is so precise as to date and as to the phenomena observed as to be of the greatest value in continuing the history of the equatorial smoke-stream from Krakatoa beyond Honolulu and Fanning's Island, to which it had been continuously traced on its long route *vid* the Seychelles, Cape Coast Castle, Trinidad, and Panama. It was observed by the barque *Southard Hurlburt* some 2000 miles east-south-east of Honolulu on September 3, at Fanning's Island on September 4, and at Honolulu in conspicuous brilliancy on the evening of the 5th. Mr. Frank Atwater, landing at Maalaea, Maui, on the morning of the 5th, observed a wonderful red glow, and marvelled much (having just arrived) if such were the sunrises in these islands. The same morning passengers on the *Zealandia* steaming southwards towards the Line were awakened by *blue* sunlight streaming into their berths. Mr. F. L. Clarke has supplied a report, somewhat imperfect as to date, of an obscured and coppery sun seen at the Gilbert Islands on or about September 7. This would be September 6 in our reckoning, the Gilbert Islands being west of the meridian of 180°.

Now we have the very precise date given by Miss Cathcart, of September 7 (6th) at Strong's Island, or just one day later than at Honolulu, and thirty-six hours later than the late afternoon coppery and lurid obscuration seen at Fanning's Island. Strong's Island is about 2320 miles nearly due west of Fanning's Island. This gives a rate of progress of the smoke-stream of sixty-four miles an hour. It seems proper to reckon time from Fanning's Island rather than from the Hawaiian Islands, as the latter were evidently north of the central course of the stream, and perceived its atmospheric effects half a day later than the former, although nearly on the same meridian.

It is to be specially noted also that the phenomena were characterised by the peculiarities seen at Fanning's Island, as well as at Panama, rather than those seen at Honolulu. Here the obscuration of the sun was so slight as not to have been noticed during the day, nor was any change in its colour observed, except by Mr. and Mrs. H. M. Whitney, who saw its disk *green* at setting on the 5th. At Strong's Island, as well as at Fanning's Island, Panama, Trinidad, and eastward, the sun was heavily obscured, and its light changed to green at low altitudes, and blue when high up. This proves that the heavier thickness of the smoke-stream did not extend so far north as Honolulu, but was confined to a narrow belt near the equator. Fanning's Island is in lat. 2° 40′ N., long. 159° W. Strong's Island is in lat. 5° N., long. 162° 30′ E. The *Zealandia* was perhaps 5° N. when the blue sun was observed. Honolulu is in lat. 22° 17′ N., and received only the clouds fraying off from the edge of the smoke-belt as it swept by to the southward.

The sun's rays were so greatly obscured by the density of the smoke strata in the main belt that they seem there to have failed to produce the marvellous twilight effects which were so conspicuous in Honolulu. All along the line from Seychelles to Strong's Island, we hear of lurid appearances, green sun, blue light, great obscuration, sun easily observed with the naked eye, but hardly anywhere a word about twilight effects, or red glows; while at Honolulu, under the thinner side clouds of the stream, the colour effects in the twilight were amazing.

The topic is an endless one, and I will not prolong. Many ask what is the cause of frequent revivals of the red glows, such as the very fine one of last evening, August 19. It seems merely to show an irregular distribution of the vast clouds of thin Krakatoa haze still lingering in the upper atmosphere. They drift about, giving us sometimes more, sometimes less, of their presence. It is also not unlikely that in varying hygrometric conditions the minute dust-particles become nuclei for ice crystals of varying size. This would greatly vary their reflecting power. This accords with some observations of Mr. C. J. Lyons, showing that the amount of red glow varies according to the prevalence of certain winds. S. E. BISHOP

Hawaiian Government Survey, Honolulu, August 20

Biology *v.* Botany

ACCORDING to the regulations of the Cambridge Local Examinations, 1883, junior students can alone take botany, while senior students must take elementary biology instead. What has been the result? Taking the Regent's Park centre as a typical example, for it is a single school of several hundred girls, and sends up probably more than any other school in England, we find that from 1872 to 1882, inclusive, 273 senior students entered, and 191, or 70 per cent. passed in botany. In 1883, however, *none were sent up at all*. If we ask, What is the object of teaching science in schools? the answer is obviously for its educational value. Now this can only be acquired by practical study. Botany is eminently qualified for affording this use, whereas zoology is not. The lady principal of the school in question will not entertain the idea of teaching any branch of science if it cannot be taught practically, and very pertinently asks, "How can I get two to three hundred frogs, and make my girls dissect them? In the first place, the parents would not allow it." Consequently biology becomes a dead letter, and botany is discountenanced by the Syndicate for the elder girls.

On inquiring of a member of the Syndicate, I am informed that the general idea is that the juniors should study botany from this educational point of view, but seniors are of such an age that mere "object-lessons" are no longer necessary, but training in scientific thought is called for. Now, in the first place, it must be borne in mind that, from the pressure of other subjects, it is not generally, if ever, easy to teach science at all adequately in schools; and, secondly, the small amount of botany that can only possibly be taught, even to the elder pupils, is little more than practical descriptions, a certain acquaintance with the leading families of plants, and the general principles of physiology and histology. There is not the time to do more. As an examiner for the College of Preceptors for many years, and having to look over papers from schools, &c., from all parts of England, I can testify to the fact that the standard of botanical teaching is decidedly low. Of course there are exceptions, but the majority, who get less than half marks, show little more than a smattering of the subject. Instead, therefore, of insisting on elder pupils advancing to biology, my own feeling is that it would be decidedly better to encourage seniors to continue the study of botany alone, but more thoroughly. The idea of calling such botany an "object-lesson" will sound somewhat ludicrous to my fellow teachers, who know what teaching practical botany thoroughly really means!

The remedy, therefore, seems obvious. Let the seniors as before pass in botany alone, but of a higher standard if you

will; and leave biology as it is for any who may wish to take up that subject. At present the effect can only be to quash the teaching entirely beyond its first and most elementary stage.

There are not wanting signs elsewhere of the evil effects of the younger school of botanists not recognising the importance of first training students in a thorough course of practical and systematic botany before proceeding to laboratory work. In an examination lately held for a post at Kew, I am informed that two gentlemen who had been trained at Cambridge competed with a gardener for the post. The gardener secured it. *Verb. sap.*

GEORGE HENSLOW

Animal Intelligence

HAVING frequently observed in your columns accounts of remarkable instances of reasoning power in animals, I am tempted to send you the following notes, which may perhaps be not without interest to the readers of NATURE.

A young canary belonging to our family is in the habit of receiving small pieces of biscuit, cake, or such like from the tea-table. The hardness of the biscuit has ever been a source of great annoyance to Dicky. One day, however, after an expectant and close examination of the tea-table, he was offered a piece of hard biscuit. Without making the least attempt to break it, he lifted it from the floor of his cage, and taking it to his water-trough, gently dropped it in, following up the action by patiently stirring it round and round with his beak, until it was in a condition to be eaten. He then carefully removed it and devoured it without any trouble. He now puts every *hard* substance which he deems eatable into the water. He endeavoured to soften sweets in the same way, but finding that the sweet became gradually smaller and smaller, he hastily abstracted it, and has never since put anything of that nature into the water.

An equally interesting case of reasoning power was lately exhibited by our cat. Pussy had lately become the mother of a family of kittens, and was naturally indisposed after the occurrence. She wandered about through the house in a strange manner, as if seeking for something, always, however, keeping within near range of the coal bunkers when they were likely to be required. With a view to finding out what she wanted, the bunkers were left open. The cat immediately entered, and commenced searching diligently among the coals, until she found a piece covered with pyrites. This she proceeded to lick vigorously, returning to the bunker and repeating the operation at regular intervals. On ground sulphur being offered her, she at once forsook the pyrites for that, and ere long, by use of that medicine, regained her usual health.

R. J. HARVEY GIBSON

Zoological Laboratory, University College, Liverpool,
September 29

IN the notes on Australian ants forwarded by me by the last mail I forget whether any mention was made respecting an idea that has struck me several times, as to the method in which the antennæ are employed by ants as a means of communicating with each other. That ants utter no audible sound is pretty plainly proved by experiments made with the microphone. It is said that the Ambillidæ give a kind of sharp cry when captured, but the statement requires to be verified. Ordinary ants may be generally spoken of as destitute of any means whereby to utter articulate speech. Beyond the fact that they do not appear to be able to speak, so as to be heard by human ears, the tests resorted to by Sir John Lubbock would go to show that it is extremely doubtful whether ants possess the sense of hearing at all. This, however, does not preclude the possibility, or even the probability, of their being in full power of a means by which they are able to converse. It will be remembered that the antennæ are divided into two separate portions, the *scape* and the *flabellum*. The latter is subdivided into about ten separate segments. Now in this arrangement, by adopting a preconcerted system of signals, all the words of an English dictionary might be expressed.

Let us say that A meets B, and, according to the vocabulary of Formicaria, that a touch with the tip of the antenna of A on the terminal segment of the antenna of B signifies any particular word. A similar touch made on the second segment of the antenna of B indicates another word, and so on. Here there is a means of expressing at least ten different words by taking from the point of the flabellum to its base. If the second point of the flabellum of A is employed as a touching organ, the number of signs that might be conveyed from the one ant to the other would be twenty. If all the segments were thus utilised, a hundred different signs might be interchanged. This is for one antenna only. By utilising the pair this number would be doubled, and by multiplying the number of touches, to express words or plurals of words, also, and by crossing the antennæ so that the right antenna of A touched the left of B, and *vice versâ*, all clearly distinct signals, the vocabulary of these little people would be extended almost *ad infinitum*. Say that the one touch of a segment of the flabellum meant an ant, two touches a pair of ants, and three a multitude; here there exists a means by which complicated ideas might be communicated in a manner somewhat similar to that adopted by the Chinese, by whom a particular sign means a woman, two mischief, and three marital unfaithfulness; or, as in the language of the Australian natives, who employ the term "Yarra" as signifying "flowing," and "Yarra-Yarra" as "ever-flowing." All this would be pantomime, of course; but those who have witnessed a public exhibition of the skill of well-taught deaf-mutes, are aware of the amount of information that can be imparted by the simple use of the ten digits, just half the number of separate conversational organs at the disposal of ants. Nor do persons and nations, well able to speak audibly, fail to avail themselves of the same kind of speech. A Chinaman utters a certain word, but it may mean half a dozen different things, as he moves his fingers to the right or to the left, up or down, or describes some imaginary diagrams in the air.

The above views may seem altogether visionary at first sight, but we have been told so many remarkable stories relative to the instincts displayed by the singularly intelligent creatures under consideration, that no persevering student of their habits will be inclined to say that the use by them of some such code of signals is altogether beyond the range of possibility, even of probability.

It might be as well if naturalists, when watching the meeting of ants, would notice carefully whether the observed touches vary in any particular, and whether any noticeable results followed after, and appeared to be connected with, the variations.

THOMAS HARRISON

244, Victoria Parade, East Melbourne, Victoria,
July 16

Meteors

I HAVE to record a brilliant series of meteors seen last night (Sunday, July 20) by myself and others. I will describe that seen by myself, as, amid the many splendid meteors I have observed during my sixty years of life, I have never seen one more magnificent. I was walking up and down my "quarter-deck," the carriage-drive in front of my house, which faces due north and south, admiring the glorious tints of the dying day, for we have been having, on a reduced scale, the grand sunsets about which I have already written. I was looking due north, and saw a huge fireball suddenly appear about half way between the horizon and the zenith. It moved slowly and horizontally, leaving a broad trail of red light behind it, as well defined as that emitted by a rocket. The meteor itself was about half the size of a full moon, white, and of the most intense and dazzling brilliancy. It travelled so slowly that I had time to call out, *several* times, to my wife, "Look at that glorious meteor," and she had time to turn round and see it. At about north-north-west it suddenly broke up into six, if not *seven* pieces, but at this moment its light was so intense that I could not be quite certain; six, however, I counted *distinctly*. They did not *fall*, but trailed on in a line after the larger mass, which did not seem diminished by the rupture, and finally, at north-west, they all disappeared. On taking out my watch I found it was just two minutes past six, and as we are a month past our shortest day, you can fancy there was plenty of daylight left to dim its splendour. But it was a magnificent sight, and its intense brilliancy surpassed anything I have seen before.

At 6.30 two friends walked up to dinner. I asked if they had seen the meteor. They said, "Yes, how splendid it was!" I asked, "Could you count the number of pieces into which it broke?" They looked at each other in amazement. "It did not break!" "In what direction did it pass?" was my next question. "From west to east," said one of them; "if you were standing here you could not have seen it; it was low down on the southern horizon, behind your house." I then

found on comparing notes that this one, which they both said was large and extremely brilliant, had appeared about *twenty-five minutes past six*.

At night we attended the Governor's last "reception," prior to his leaving the colony. He was handing my wife to her carriage—I was unfortunately in the house—when another fine meteor illumined the sky. It must have been in the west, or, from the position of the carriage and the buildings, my wife could not have seen it. She says it fell straight down from the zenith, and broke into several pieces. This occurred at 10 45; I had just previously looked at my watch. I also heard of other smaller, though bright, meteors, but did not see them myself. What are we doing, Mr. Editor? Are we going through the tail of a comet? or is cosmic dust igniting? or are these "dire and bloody" portents? Whatever they are, I record them, in the hope that others may have seen and noted them.

British Consulate, Noumea, July 21 E. L. LAYARD

The Milleporidæ

SPECIAL interest is attached to any direct evidence as to the nature of the reproductive organs in the Milleporidæ, the more especially as no traces whatever of such organs have hitherto been discovered. In the absence of any direct evidence it has been concluded that, from the apparent absence of ampullæ, the gonophores probably develop free of the cœnosteum; and this seemed partly borne out by the general resemblance between the zooids of the Milleporidæ and those of the gymnoblastic Hydroids.

On some dry specimens, however, of a new species of Millepora (*Millepora murrayi*, characterised by its extremely laminated and coalescent fronds, much and palmately divided at their extremities, and by its minute gastropores, ·25 mm. wide, and its still more minute dactylopores and even surface) from the Philippines, there occur, irregularly and numerously distributed among the young branchlets of the cœnosteum, large receptacles, which, though the absence of the soft parts prevents any absolute confirmation thereof, can leave no doubt as to the true ampullate nature of the generative organs in this family. These receptacles occur either closely, or widely apart, as circular cavities in the superficial reticulations of the cœnosteum, and are covered above by a very thin and porous layer, which is often broken away. When it is thus laid open, the cavity is seen to be about ·75 mm. in diameter. The receptacles are seen on the surface as white, circular, scarcely raised areas about ·5 mm. in diameter, with a small pore in the centre; and they are generally rather numerously placed on one or both faces of the palmated branchlets.

By the discovery of the ampullæ in the Milleporidæ, a complete confirmation is given to the relationship which Prof. Moseley has shown to exist between this family and the Stylasteridæ; and it is seen that the two families are even more closely related than had been imagined. The presence of such a structure seems to bring the Milleporidæ into relationship rather with the calyptoblastic than with the gymnoblastic Hydroids, in spite of the general resemblance of its zooids with the latter. JOHN J. QUELCH

Natural History Museum, South Kensington

To Find the Cube of any Number by Construction

THE following graphical construction for finding the cube of a number may interest more than the mere mathematician:—

Take a triangle $A B C$, in which suppose A to be the vertical angle and B greater than C. Draw the perpendiculars $A D$, $B E$, $C F$, thus obtaining the pedal triangle $D E F$; take H the middle point of the perpendicular $E G$ on $D F$. Then $\tan C D H = \tan^3 C D E = \tan^3 A$. If then we take a triangle with vertical angle A such that $\tan A = n$, we see that $\tan C D H = n^3$.

The proof of the above result is quite elementary.

September 22 R. TUCKER

The Failure of the Parsley Crop

WOULD you permit me to ask some subscribers to your paper if it be possible to account for the total failure of the crop of parsley this and last year. Is it owing to any known insect or what? The parsley comes up well, grows to about one inch in height, then begins to dwindle and get yellow, and the whole summer remains about half an inch high, the only green part being the crown. All the market gardeners are in the same position as myself, only one having a crop, and this was sown in freshly cultivated earth. I have carefully examined leaves and roots under the microscope, but can discover no cause for this disease. Have any of your subscribers been troubled in the same manner, and can any one suggest a remedy? W. H. C. B.

Cheltenham, September 23

Wasps as Fly-Killers

YOUR correspondent at p. 385, vol. xxx., may be informed that in this part of the world wasps enter dwellings by the open windows in summer-time, and hunt house-flies unmercifully, leaving the dead flies in hundreds on the floors, ready to be swept into a dustpan. This occurs only in the country, and where wasps' nests are near by. Westwood quotes from St. John's "Letters to an American Farmer" that: "The Americans, aware of their (wasps') service in destroying flies, sometimes suspend a hornets' nest in their parlours" (Introduction to "Modern Classification of Insects," ii. p. 246, foot-note).

GEORGE LAWSON

Dalhousie College, Halifax, Nova Scotia, September 8

GEORGE BENTHAM

WE recently announced the death of the veteran botanist, George Bentham, when within a few days of his eighty-fourth birthday. His life, from a very early age, was one of incessant mental activity, and of much change and vicissitude during its three or four first decades. Through his birth, connections, and various residences on the continent of Europe, as well as in England, he became acquainted with many men famous in literature, science, and art, and his career is rendered especially notable from its intimate association with his uncle Jeremy, the jurist, in the arrangement of whose papers and preparation of whose works for the press he was actively engaged for not a few years, and with whom he resided on the most intimate terms as companion and secretary till the death of that relative in 1832. This and the scientific value now attached to the "pedigree" have suggested the expediency of entering with some detail into the family history and early life of Mr. Bentham (for most of which we are indebted to information imparted by himself) before detailing his botanical career and writings.

About the year 1750 Jeremiah Bentham, an attorney or solicitor, one of a family of scriveners who, as fathers and sons, had inhabited the Minories since the beginning of the seventeenth century, migrated to the West End of London, purchasing property in Queen's Square Place and Petty France (now York Street, on the south side of Birdcage Walk, St. James's Park). He had two sons: the elder, Jeremy, the well-known writer on Jurisprudence, the younger, Samuel (subsequently Sir Samuel), father to George, the botanist. Samuel devoted himself to the study of naval architecture, and at the age of twenty-two visited the arsenals of the Baltic for the purpose of improving himself. From thence he travelled far into Siberia, and became intimate with Prince Potenkin, who induced him to enter into the service of the Empress Catherine, at first in a civil, and afterwards in a military, capacity. In the latter he took a distinguished part in a naval action against the Turks on the Black Sea. For this he received the Cross of St. George, and was given the command of a regiment quartered in Siberia, which enabled him to penetrate eastward to the frontier of China. After ten years of absence he returned to England, and was shortly afterwards promoted to the rank of general. The death of Catherine followed soon after, when he was offered employment in England by his friend Earl Spencer, then First Lord of the Admiralty, who was anxious to avail himself of Gen. Bentham's ingenuity and experience in

improving the civil branch of our naval system. This he accepted, resigning the Russian service, and attained the post of Inspector-General of Naval Works. His son has been heard to say that amongst other improvements introduced by Gen. Bentham into the dockyard were the steam sawmills and the machinery for the eccentric turning of blocks, through his employment of the late Isambard Mark Brunel, whom he brought over to England.

In 1796 Gen. Bentham married the eldest daughter of Dr. George Fordyce, F.R.S., the well-known physician and author. Mrs. Bentham was a woman of great ability and energy; she had actively aided her father in the preparation of his works, and with still greater perseverance she devoted herself to assisting her husband in his arduous labours, drawing up as well as writing out his voluminous reports to the Admiralty, and accompanying him on his visits of inspection to the dockyard, which were often of several months' duration. Up to the age of eighty she wrote a most beautiful hand, and it is within the recollection of readers of this article that letters in the *Times*, under her signature, when she was considerably over ninety years of age, appeared during the Crimean War, urging the introduction of improvements in our war material, especially great guns, which her late husband had suggested.

It was during one of the annual inspections of the Portsmouth Dockyard that George was born, at Stoke, then a village near Portsmouth, and now absorbed in that town. He was the second son, and had three sisters, one of them older than himself. All were forward children: on their fourth birthdays the two elder sisters made the clothes they wore on those days and wrote out a list of their possessions; and before he was five years old, George wrote copies, enjoyed reading Miss Edgeworth's "Easy Lessons" with his brother, and began to study Latin. The whole family were taught reading by the words, not letters or syllables.

In 1805 Gen. Bentham was sent by the Admiralty on a mission to St. Petersburg, having for its object the building in Russia of ships for our navy, and he took his family with him. There they remained for two years, during which time the education of the children was intrusted to a talented Russian lady, who could speak no English; and the young people, showing a remarkable facility for the acquisition of languages, were able before leaving to converse fluently in Russian, French, and German. Latin was acquired under a Russian priest, and, at six years of age, music, to which George subsequently became passionately attached, was commenced.

War between England and Russia breaking out in 1807, Gen. Bentham was recalled. The homeward route was by Revel and Sweden, and the voyages were notable. At Revel they embarked for Stockholm in a Russian frigate, a bad sailer, with a crew hardly any of whom had before been at sea; and, after driving backwards and forwards in the Baltic under continuous gales, they landed on the fourteenth day at Carlscrona! In Sweden they were detained several weeks, long enough for the two brothers and their elder sister, by dint of perseverance and hard study, to learn enough of Swedish to converse in that language and read it with tolerable ease. From Gothenburg they sailed for Harwich in a wretched craft, and, after beating about the North Sea in a succession of tempests, arrived on the fourteenth night, when the crew took the boats and hastened ashore, leaving the Benthams till the following midday with no other food but rejected bits of biscuit picked up wherever they could be found.

In England the family settled at Hampstead, whence the father went daily to his offices at the Admiralty and Somerset House, whilst George and his brother pursued their studies. These, then and ever afterwards, were conducted by private tutors, and it was a life-long source of regret to George that he had never been at school or college. This, in his opinion (and not his alone), accounted for an habitual shyness and reserve that often caused him to be misunderstood, and credited with motives or sentiments that were foreign to his disposition and character. Much of his time was spent at Berry Lodge, a house and property which his father had bought between Gosport and Alverstoke, where the summer months were passed, and which still belongs to the family. It was from here that he was once taken by his father on a visit to Lady Spencer at Ryde, and met at her house John Stuart Mill—then on a visit there—a boy of six, in a scarlet jacket and nankeen trousers buttoned over it, and who was then considered a prodigy. Bentham has described him as wonderfully precocious, a Greek and Latin scholar, historian, and logician, fond of showing off, and discussing with Lady Spencer the relative merits of her ancestor the Duke of Marlborough and the Duke of Wellington, he taking the part of the latter.

The year 1814 opened upon a period of great excitement throughout the Continent; the invasion of Russia by Napoleon and the burning of Moscow were naturally matters of intense interest to the Bentham family. The boy George, then only thirteen, now budded into an author, commencing with his brother and sister the translation of a series of articles from a Russian paper, detailing the operations of the armies, which were contributed to a London magazine of ephemeral duration. He gloried in the reverses and final abdication of Napoleon, and was presented to the Emperor of Russia by his father on the visit of that monarch to the naval establishment at Portsmouth.

Peace being proclaimed, the Bentham family went to France, and prepared for a long residence in that country; they resided first at Tours, then at Saumur and Paris, during the eventful period that extended from the return of Napoleon to his final overthrow. Young Bentham kept full journals of all that passed, interspersed with anecdotes relating to the forced exile of Louis, the defeat of the Emperor, the restoration of the Bourbons, the conduct of the allies, the execution of Ney and Labedoyère, the condition of the city of Paris, and the prominent part taken in the politics of the day by Walter Savage Landor, who was intimate with his family. Moreover, he seems to have been able at this early age to enjoy and even take his part in the society of the eminent men of the time and the *salons* of the leaders in literature and science, the Duc de Richelieu, Talleyrand, the Comte de Damas, Jean Baptiste Say, the aged Mme. Andelan (the daughter of Helvétius), were amongst the intimate friends of the family; as was Baron Humboldt, who took warmly to the lad, encouraging especially his taste for geographical science, giving him introductions to libraries and to individuals who could aid him in the preparation of a work which he had begun on the data of physical geography.

In 1816 Gen. Bentham organised what may be called a caravan tour of France for himself and family, having for its objects partly unceremonious visits to his many friends in the provinces, and partly the leisurely inspection of the great towns and other objects of interest. The *cortège* consisted of a two-horse coach fitted up as a sleeping-apartment, a long, two-wheeled, one-horse spring van for himself and Mrs. Bentham, furnished with a library and piano, and another, also furnished, for his daughters and their governess. The plan followed was to travel by day from one place of interest to another, bivouacking at night by the road, or in the garden of a friend, or in the precincts of the prefectures, to which latter he had credentials from the authorities in the capital. In this way he visited Orleans, Tours, Angoulême, Bordeaux, Toulouse, Montpellier, and finally Montauban, where a lengthened stay was made in a country-house hired for the purpose. From Montauban (the *cortège* having broken down in some way) they proceeded, still by private conveyances, to

Carcassonne, Narbonne, Nimes, Tarascon, Marseilles, Toulon, and Hyères.

It was during this tour, when at Angoulême, that Bentham's attention was first turned to botany, and it fell out on this wise:—His mother, who was fond of plants, and a great friend of Aiton at Kew, had purchased a copy of De Candolle's "Flore Française," which was then just published. Young Bentham took it up accidentally, and was struck with the analytical tables for the determination of the affinities and names of plants, which exactly fitted in with the methodising, analysing, and tabulating ideas which he had derived from his Uncle Jeremy's works, and had endeavoured to apply to his own geographical tables. He at once went into the back-yard of the house, and, gathering the first plant he saw, he spent the whole morning studying its structure with the aid of the introductory chapter of the "Flore," which treated of elementary botany, and succeeded in referring it to its natural order, genus, and species. The plant, *Salvia pratensis*, was not an easy one for a beginner, owing to the irregularity of the flower and abnormal character of the ovary and stamens. His success led him to pursue the diversion of naming every plant he met with in future.

At Montauban, near Tours, where the family resided for many months, Bentham spent what he always regarded as the happiest period of his life; he was entered as a student of the Faculté de Théologie, at Tours, followed with ardour the courses of mathematics, Hebrew, and comparative philology (the latter a favourite study in after-life), and at home occupied his time with music, Spanish, drawing, and botany, whilst, during the holidays, dancing was his delight; it was a favourite boast that at Montauban he attended thirty-four balls between Twelfth-night and Mardi-gras, of which thirteen were consecutive, and lasted from nine at night to the same hour on the following day.

The appearance of the "Dictionnaire d'Histoire Naturelle," a course of lectures under Benedict Prevost, and De Candolle's general works on the structure and classification of plants, first opened his mind to scientific botany, and induced him to take up the study of exotic plants, to which he devoted himself till 1820, when he took to the amusement of shooting and stuffing birds. At this period, too, John Stuart Mill resided in his father's family for seven or eight months, and it was probably due to this that Bentham was diverted to the study of philosophy, and at the age of twenty began a translation into French of his uncle's "Chrestomathia," which was published in Paris some years afterwards. Here, too, he began the study of Lamarck's works, with the "Système analytique des Connaissances positive de l'Homme," only to give it up in disgust on reading "Dieu créa d'abord la matière," followed by the statement that nature was the second thing created, and this produced everything else. Sliding down from great things to small, a fit of entomology supervened, and he commenced tabulating observations on insect life as he had his geographical and philosophical facts and ideas.

The next phase of Bentham's Protean life was that of a practical estate-manager and farmer, his father having bought a property of 2000 acres, that of Restinalières, near Montpellier, and given over the management of it to his now only son, for he had lost his eldest through an accident some years before. Into this work Bentham threw himself with ardour, and now his methodical habits, close application, and familiarity with French country life stood him in good stead. The farms and vineyards rapidly improved, and were very profitable. Still he found time for his favourite pursuits, his holidays were spent in botanical excursions to the Pyrenees and Cevennes, and his spare hours at home in logic and the preparation of a French edition of his uncle's essay on Nomenclature and Classification. Here, too, he wrote his own first work of importance, "Essai sur la Nomenclature et Classification des Arts et Sciences," which was published in Paris, and established his position in France as an acute analyser, clear expositor, and cautious reasoner.

In 1823 Bentham was sent to England for the purpose of purchasing agricultural implements and obtaining information as to improved methods of farming that might be introduced into the Montpellier estate. On arriving in London he was asked by his uncle to visit him, bringing his translation of the "Chrestomathia." This invitation, the attractions of English scientific and literary society, and the fact that provincial jealousies threw every obstacle in the way of the introduction of improvements into the Restinalières estate, led ultimately to the abandonment by his father of the latter (in 1826), and the return of the Bentham family to England.

On his arrival in London he was at once received into the best literary and scientific society; he attended the breakfasts and receptions of Sir Joseph Banks, and studied in his library and herbarium, and that of the Linnean and Horticultural Societies, and formed life-long friendships with Brown, Lambert, Don, Sabine, Menzies, &c. During a tour through England and Scotland, taking with him letters of introduction to the leading botanists there, he became acquainted with Sir James Smith, Dawson Turner, Graham, Greville, Hooker, and many others. It was during this tour that he formed a friendship with the late Dr. Arnott (subsequently Professor of Botany in Glasgow), with whom he made, in 1824, an extended journey into the Pyrenees, which resulted in his first botanical work, "Catalogue des Plantes indigènes des Pyrenées et de Bas-Languedoc, avec des Notes et Observations" (Paris, 1826).

On the settlement of the family in London a new career was opened to Bentham, his uncle Jeremy having invited him to devote much of his time to aiding him in the arrangement and preparation of his MSS. for the press, accompanying the invitation with assurances that he would provide for him at his death. The proposal of aiding his uncle was congenial to him, but not the accompanying one, for he was now desirous of seeking a serious profession that would lead to independence; and after many embarrassing interviews on the subject with his uncle it was arranged that he should enter Lincoln's Inn and study law, whilst devoting some morning hours to his uncle, besides dining with him twice a week and writing for him afterwards from 8 to 11 p.m. In one shape or another this arrangement of working with and for his uncle lasted till the death of the latter in 1832; when, owing to the many foolish and fruitless speculations of the great jurist, the extravagant sums spent by his executors on the posthumous publication of his works, and some irregularity in his will, Bentham found himself in possession of the house in Queen Square Place, but with less property than he should have received. His father's death, however, in the previous year, had rendered him in a measure independent.

From 1826 to 1832 Bentham's life was one of incessant activity. Besides his irksome labours for his uncle, in whose ideas he did not at all participate, and many of whose acts he regretted, he had the editing and often rewriting of his father's (now Sir Samuel Bentham's) voluminous papers on the management of the navy and the administration of the dockyards. His legal studies were sacrificed to logic and jurisprudence; the fruits of the former being the publication of his "Outlines of a New System of Logic, with a Criticism of Dr. Whateley's Elements of Logic" (London, 1827), in which the doctrine of the quantification of the predicate is for the first time clearly set forth. This remarkable work fell still-born from the press; only sixty copies were sold, when the publishers became bankrupt, and the stock was seized and went for waste paper. It was not till 1850 that the fact of its containing a discovery was recognised (*Athenæum*, December 31, 1850); this led to a sharp dispute as to Sir

William Hamilton's claims to the same, and which was ended by a verdict of Herbert Spencer's in the *Contemporary Review* (May 1873) in favour of Bentham.

In jurisprudence two subjects deeply engaged his attention—one was codification, in which he entirely disagreed with his uncle, and his paper on which attracted the attention of Brougham, Hume, and O'Connell; the other was the laws affecting larceny, his suggestions on which he submitted to Sir Robert Peel, *apropos* of his Bill for the consolidation of the criminal law. Of this Peel thought so highly that he wrote a complimentary letter to its author, informing him that his remarks should be fully considered and submitted to Sir John Richardson, to whom the Bill was referred. Brougham also (to whom his uncle showed the paper) wrote a letter of eighteen pages of remarks on it. These and a pamphlet on the "Law of Real Property" are Bentham's chief contributions in his adopted profession. Of practice he had very little; he got his first brief in 1832, and, as junior counsel, bewigged and begowned, followed his leader when called for; but, being overcome with nervousness, he cut short his argument, and had the mortification of hearing the counsel for the opposite side say that "a more preposterous speech it had not been his fortune to hear during a long course of practice"

In botany Bentham was more at home than in the courts. In 1828 his herbarium arrived from France, and in the same year he was elected a Fellow of the Linnean Society, and joined with delight its reunions, attending its meetings punctually, its anniversary dinners, and those of its club. The return of Wallich from India with the enormous collections of the East India Company which first made known the flora of the Himalayas, Burmah, and many other parts of that vast empire, gave him occupation in the study and publication of various intricate genera and natural orders of plants. Of these writings, his "Labiatarum, Genera and Species" was the most important; this large family having been in a state of utter chaos before Bentham brought his remarkable powers of generalisation and description to bear upon it.

In 1829 Bentham finally gave up the law for botany, and amongst other labours accepted the honorary secretaryship of the Horticultural Society, which was in a perilous condition of debt and dissension. From these he extricated it with perfect success, and, aided by his friend Lindley, the assistant secretary, raised it to a flourishing condition financially and scientifically, and which it has never since approached.

In 1833 he married the daughter of the late Right Hon. Sir Harford Brydges of Boultibrooke, formerly Ambassador at the Court of Persia, and in 1834 removed to his late uncle's house in Queen Square Place, the site of which is now occupied by the "Bentham wing" of the "Queen Anne's Mansions." There he resided till 1842, when, with the view of providing better accommodation for his now extensive herbarium and library, and devoting himself more exclusively to science, he removed to Pontrilas House in Herefordshire, where he revised the *Labiatæ*, and elaborated the great families of *Scrophularineæ*, *Polygoneæ*, and others for his friend Alphonse de Candolle's continuation of the "Prodromus Systematis Naturalis Regni Vegetabilis."

In 1854, finding that the expenses of his collections and books were exceeding his means, he determined on presenting the whole to the Royal Gardens at Kew (they were valued at 6000*l*.), and returning to London; at the same time he entertained the idea of abandoning botany, with characteristic modesty regarding himself as an amateur who had hitherto pursued the science rather as an intellectual exercise in systematising, than as a scientific botanist, who, in his opinion, should unite a competent knowledge of anatomy, physiology, and of Cryptogamic plants, to skill as a classifier and describer of Phanerogams. He yielded, however, to the entreaties of his friends, the late Sir W. Hooker and Dr. Lindley, coupled with the offer from the former of access to his own private library and herbarium, and a room in Kew where his own was placed, backed by the request that he would inaugurate the series of colonial floras that was planned at Kew, by elaborating that of Hong Kong. Consequently, in 1855 he again took up his residence in London, first at Victoria Street, and latterly at 25, Wilton Place, and for the remainder of his life, till disabled by age, he almost daily throughout the year, except during autumn excursions to the Continent or visits to friends in Herefordshire, repaired to Kew and occupied himself exclusively with descriptive botany from 10 a.m. till 4 p.m.

The Hong Kong flora finished, Bentham took up that of Australia, and, aided by the observations, collections, and numerous discoveries of his active and able correspondent, Baron Mueller, of Victoria, he, single-handed, completed it in 1867 in seven octavo volumes, containing about 7000 species, the most extensive exotic flora ever brought to a conclusion. Meanwhile, the plan of a general work on Phanerogamic plants had been on various occasions discussed by Dr. Hooker and himself; at first it was proposed to confine it to carpology, but it finally assumed shape in a critical study and description of the genera of plants, founded on all available characters, for which his herbarium and the Hookerian offered unrivalled resources. This work, entitled "Genera Plantarum ad Exemplaria, imprimis in Herbariis Kewensibus servata, definita," was commenced in 1862 and concluded in 1883, the greater portion of it being the product of Bentham's indefatigable industry.

The only material break in Bentham's work at Kew was his acceptance of the presidency of the Linnean Society, which he held from 1863 to 1874, and to the duties and interests of which he devoted his time, his energies, and his purse, with characteristic singleness of purpose. He combined with the duties of President those of Secretary, Treasurer, and Editor of the botanical parts of the *Transactions* and *Journals*, spending a part or the whole of one day a week in the Society's rooms during the eleven years of his presidency. On the final transference of the Society's collections, library, and portraits from the rooms in old Burlington House to those they now occupy, he arranged the whole himself, classifying the books, and literally with his own hands placing them on the shelves they now occupy. His presidential addresses were remarkable for their grasp and wide range, and those who knew him only as a systematist and descriptive writer were surprised to find the great powers of analysis and the sound judgment he displayed in discussing evolution and its bearings, the writings of Haeckel, geographical distribution, the condition and prospects of fossil botany, deep-sea life, abiogenesis, methods of biological study, and the histories and labours of the Natural History Societies and their journals, and the scientific periodicals of every civilised quarter of the globe.

On the conclusion of the "Genera Plantarum" in the spring of 1883, his strength, which had for some years shown signs of diminution, suddenly gave way, and, after several ineffectual attempts to resume his studies, his visits to Kew ended, and, lingering on under increasing debility, he died of old age on September 10 last, when within a few days of his eighty-fifth year, leaving no family, and directions that his funeral was to be a strictly private one.

The above sketch conveys no idea of the prodigious amount of systematic and descriptive work in Phanerogamic botany that Bentham accomplished. In the "Genera Plantarum" there is hardly an order of any importance that he did not more or less remodel. His labours on the Compositæ, Gramineæ, Cyperaceæ, and Orchideæ are especially noticeable, and he contributed

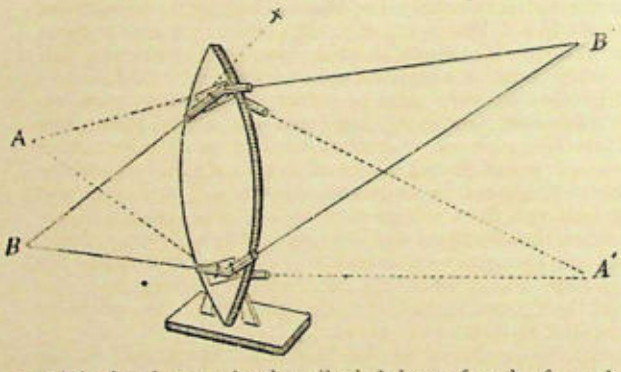
masterly essays upon these and others to the Linnean Society. His treatises on the Leguminosæ are no less exhaustive and valuable; and there is not a temperate or tropical region of the globe whose floras have not been largely elucidated by him. It may safely be affirmed that for variety and extent of good work of the kind he had no superior. The distinctive qualities of his descriptions are—scientific accuracy, good arrangement, precision of language, lucidity, and the discarding of what is superfluous. In these respects he has had no superior since the days of Linnæus and Robert Brown, and he has left no equal except Asa Gray.

Of his amiable disposition, and his sterling qualities of head and heart, it is impossible to speak too highly: though cold in manner and excessively shy in disposition, he was the kindest of helpmates and most disinterested of labourers for others.

Of recognition by foreign Academies Bentham had his full share, including that of Corresponding Member of the Institute of France. His election into the Royal Society was not till late (1862). It should have been in 1829, when he was proposed by R. Brown, and at his recommendation withdrawn, along with other scientific candidates, who thus showed their dissatisfaction at the Society's election of a Royal Duke to the President's chair. He, however, received the Royal Medal of the Society, and in 1878, on the completion of the Australian flora, the Secretary of State for the Colonies, unsolicited, recommended him to Her Majesty for the Companionship of the Order of St. Michael and St. George.

A MODEL LENS FOR USE IN CLASS DEMONSTRATIONS

IN using diagrams or models as aids in teaching, this question constantly arises—How far may we represent Nature diagrammatically without producing in the mind of a student one-sided and false impressions? I have myself endeavoured to follow this rule: that, if a complicated object or phenomenon is to be studied, we may simplify this, and bring out many salient features, with a diagrammatic representation; this must, however, only be looked upon as a stepping-stone to a more complete study of the object or phenomenon itself. The



model of a lens to be described I have found of much service in lecturing, antecedent to a demonstration of the passage of luminous rays through actual lenses.

This model may be constructed out of the simplest materials, and should cost but two or three shillings. It consists of a piece of deal board cut in the shape of the cross-section of a biconvex lens, and fixed to a stand of wood (see diagram). Four small squares of board, *x*, are fixed in the positions indicated, two on either side of the lens. Glass tubes bent at obtuse angles are fixed to these by staples, and can rotate with them on the screws by means of which the squares are fixed to the lens. Two pieces of string to represent visual rays are then passed through the tubes A A′ and B B′. The theory of the use of this model will be at once apparent. A ray of light passing through a lens of a given curvature and density will practically (this is not absolutely true) be bent at a given angle, whatever be the direction of the ray, so long as it passes through the same part of the lens. In the model this constant degree of bending is given to the string—representing the ray of light—by the bent tubes. These, rotating on the lens, allow one diagrammatically to represent the rays passing through it in any desired direction.

Taking the string B B′, for example, and holding it at these two points in the two hands, and keeping the string taut, it will be found that in shifting the point B—representing a luminous point—in any direction, B′ will shift until it occupies the position of the corresponding focus. By shifting the string it is possible to demonstrate the focal points of parallel, diverging, and converging rays, either parallel to the axis of the lens, or on secondary axes. Then, by using at the same time the string fixed to the other side of the lens A A′, the formation of an image may be shown. Grasping with the two hands A and B, an assistant holding A′ and B′, it will be seen how by this lens an inverted image is produced. Bring the points A and B nearer the lens, keeping them, however, at the same distance apart, and the points A′ and B′ will recede from the lens and from each other, showing how the image of the nearer object is formed farther away from the lens, and is larger in size. On the other hand, if A and B be pulled away from the lens, A′ and B′ approximate to it and to one another.

In working the model the squares should rotate easily, and the strings must always be held taut. For lecture-room purposes the lens should be about two feet high, and the strings may be coloured. On the same principle I have constructed models of other lenses or lens combinations.

JOHN B. HAYCRAFT
Physiological Laboratory, Mason College,
Birmingham

THE ELECTRICAL EXHIBITION AT PHILADELPHIA

[FROM A CORRESPONDENT]

TO one who has visited the various electrical exhibitions held in recent years in the chief European cities, the Exhibition now open in the city of Philadelphia might seem a little disappointing from the absence of novelty in the exhibits, though replete with objects of interest for all to whom this class of show is not familiar. As might be expected, the strong point of the Philadelphia show is electric lighting; and the building—a temporary structure erected close to the depot of the Pennsylvania Railroad Company on the west bank of the Schuylkill—presents both interiorly and exteriorly a blaze of light. The array of dynamo-machines is remarkably complete. Edison leads the way with a variety of machines, including one "Jumbo," of the same type as, but rather smaller than, the pair of machines in use at the Holborn Viaduct lighting station. There are also a large number of Weston's machines, and a very valuable exhibit by the Thomson-Houston Company. The machines of the latter company are quite unique amongst dynamos; one of them can maintain sixty arc lights on one circuit, though there are but three coils on its armature. Other dynamos are shown by Ball, Hockhausen, Van Depoele, and McTighe. There are several excellent arc lamps, possessing novelty, however, in matters of detail only. A great show of incandescent lamps is made by the Edison Company, and also by the Weston Company. The latter has some remarkable lamps with filaments sixteen inches in length prepared from a new parchment-like substance, of which samples are shown. These lamps are from 100 to 200 reputed candle power.

Electric motors are exhibited by several inventors.

The little Griscom motor and the Cleveland motor are of course present, driving sewing-machines and fans. Edison contributes also some small motors of excellent finish. Amongst larger machines there is one by Daft and one by Elihu Thomson. But by far the most important of all exhibits of this class is that of Mr. F. J. Sprague, which shows a very great advance on anything hitherto accomplished. Mr. Sprague appears to have succeeded in producing a motor which runs at a uniform speed whatever its load. It is employed in driving a small loom.

In telephones there is not much new. The Clay Telephone Company exhibits its system, with a remarkably simple and efficient receiving instrument. Beyond this there is absolutely nothing new. The chief interest centres on the historic exhibitions of Elisha Gray, Graham Bell, A. E. Dolbear, and Van der Weyde. The remarkable telephones of Daniel Drawbaugh are not yet exhibited to public gaze on account of pending legal proceedings.

In telegraphy the sole novelty is the marvellous multiplex telegraph of Delaney, based upon the principle of La Cour's "phonic wheel," and capable of transmitting seventy separate messages simultaneously through a single wire.

Passing on to other exhibits, it should be mentioned how Messrs. J. W. Queen and Co. display a very large collection of imported apparatus, including the finest instruments of Elliott Brothers, Carpentier, Breguet, Hartmann, and Edelmann. Some excellent measuring-instruments by the Electric Apparatus Company of Troy, N.Y., are also shown. A collection of a curious and instructive nature was exhibited by the U.S. Patent Office, consisting of the historic models sent by inventors. Here may be seen the original Edison telephone, the original Brush dynamo, the original Edison lamp, and many other similar objects, including many old forms of electric motor dating from the years 1840-50. A special effort has also been made to get together a complete modern library of books bearing on the science of electricity. Some six thousand volumes have in this manner been procured, and form a valuable collection.

The Franklin Institute of Philadelphia, which has organised this Exhibition, must be congratulated on the energy and enterprise which it has put forth. It would be impossible to get together a collection of apparatus more thoroughly representative of the solid progress made in electro-technics on the American continent. Though the Exhibition is yet far from complete, it has become much more so since its opening on September 2. It will remain open until October 11.

A NEW APPLICATION OF INDIA-RUBBER[1]

IF iron takes the lead among articles of modern industry in the extent and number of its applications, it yet falls short of india-rubber in their variety. This latter article, indeed, promises soon to attain a universal diffusion. Its industrial career, though little more than just begun, already outstrips that of most substances that were first in the field.

The mere enumeration of its qualities would suffice to account for the diversity of its applications. It possesses so great an elasticity that by this quality alone it adapts itself to a thousand different uses—brace-bands, garters, sides of boots, &c.

Observe how, if not the lightest, india-rubber is at least the most powerful reservoir of mechanical energy known. It lends itself most readily to the restitution, under the form of mechanical labour, of the energy imparted to it by tension, and this restitution may be effected with remarkable quickness. It is owing to the relative lightness of india-rubber considered as an accumulator of energy, and, above all, to its power, that the exactness of the principle of "heavier than air" may be demonstrated on a small scale.

From an electrical point of view, india-rubber acts as a better insulator than gutta-percha, and is, indeed, one of the best insulating bodies known. At the same time that its specific inductive capacity is weaker than that of gutta-percha, it does not become plastic at a moderate temperature. These properties render it an excellent insulator in electrical applications: submarine and subterranean telegraphy, electric light, transmission of force, &c. While it insulates better than gutta-percha, the conductor, where india-rubber is used, does not run the risk of being put out of centre, as is the case sometimes with gutta-percha.

India-rubber is known to oxidise under exposure to air and light; above all, under alternations of dryness and damp. By subjecting it, however, to a special operation, called vulcanisation, a product is obtained which maintains its flexibility at low temperatures, resists heat much better, does not oxidise in air, and absorbs less water. It is especially under the form of vulcanised india-rubber that its applications are numerous.

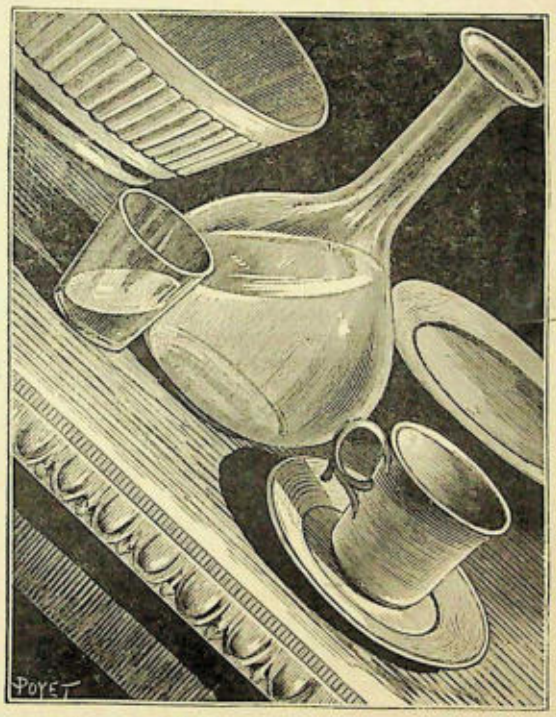


FIG. 1.—Position in which household utensils furnished with india-rubber may be placed without falling.

There is, finally, a third form of india-rubber, no less useful, that of ebonite, or hardened india-rubber, a form which combines with its lightness and great electrical resistance, the further advantage of resisting acids, and which is therefore exclusively employed when vessels for the electric pile or other reservoirs of a light and not readily brittle character are wanted. Like a new Proteus, india-rubber is thus seen to adjust itself to the ever more numerous and pressing demands of modern industry.

To turn now to the new, curious, and original application an idea of which it is the object of this notice to convey. The aim of the inventor, whose name unfortunately has not reached us, has been to take advantage of the great mutual adherence of a soft and a hard body. It is by the utilisation of this relation that the inventor has originated quite a series of household objects in earthen-

[1] From *La Nature*.

ware, porcelain, glass, &c., which manifest a remarkable adherence to the body supporting them, and this result he has obtained by the very simple expedient of securing to the lower part of all kinds of goblet objects (Fig. 2) a groove, A A, in the form of a swallow-tail, into which is lodged a band of red india-rubber, a variety of vulcanised india-rubber, forming, when deposited, a kind of circular cushion. Objects furnished in this manner are almost incapable of falling from their places. They may be placed on a wooden table, and the table be inclined (Fig. 1) from 45 to 50 or even 60 degrees without upsetting any of them. The most direct and immediate use offered by the properties which a vessel so provided with india-rubber thus acquires is evidently in the shipping service. At the Fisheries Exhibition of last year in London, and at the Health Exhibition of this year, the inventor has displayed a little barque, the bridge of which is entirely covered with dishes, plates, &c., all furnished in the manner described, and the barque, floating in a basin, may be

Fig. 2.—Arrangement of the india-rubber covering in a swallow-tail groove A A, provided at the base of the object.

tossed to and fro in every direction without displacing a single piece.

All who have been on long voyages at sea know the disagreeable and painful impression produced by the screen of cord laid along the table to prevent the glasses and bottles from falling.

As an accessory advantage possessed by the undisplaceable india-rubber dishes may be reckoned the less noise they occasion, and the less risk of breaking they run on being clapped down carelessly or hastily on the table. Washhand basins and water-pots may likewise be advantageously constructed with the india-rubber band.

Invalids in bed, and compelled to eat from a board placed more or less horizontally across the bed, and children, so apt to upset glasses and bottles, will both find their advantage in the undisplaceable contrivance. We have thus a simple, ingenious, and useful application of india-rubber, which we thought it incumbent on us to place before our readers.

NOTES

In the Daily Weather Report of the Meteorological Office for Friday last, there appears a note of some importance on the temperature of the Gulf Stream. A comparison has been made between returns from 28 ships, containing 116 recent observations, with the data in the charts of the Atlantic sea-surface temperature (recently published by the Office), of the area which lies, roughly speaking, between the latitudes of the North of Ireland and of Bordeaux respectively, and extending half way across the Atlantic. It appears from this comparison that during the past summer the ocean temperature in the course of the Gulf Stream was abnormally high, in June the whole of the above-mentioned area being about 3° above the mean, in July the half of the area nearest to the British Isles being about 1°·5 and in August about 1° higher than the mean. It is to be hoped that similar comparisons will from time to time be given by the Meteorological Office, so that the point may be investigated which was long ago suggested by the late General Sabine, as to there being possibly a connection between the temperature of the tropical and sub-tropical waters of the Atlantic and the weather of Europe which followed, and to which we drew attention some years ago (NATURE, vol. xxi. p. 142).

Sir William Thomson lectured on Monday night, under the auspices of the Franklin Institute, at the Academy of Music, Philadelphia, on the "Wave Theory of Light," to a large audience.

Gen. Pitt-Rivers, as Inspector of Ancient Monuments, has issued a very careful and detailed report on his excavations in the Pen Pits, near Penselwood, Somerset. These pits are on the borders of Wilts, Somerset, and Dorset, and consist of a number of hollows in the surface of the ground of various forms and sizes, without order or regularity in their distribution. They cover a tract of high land of greensand formation, the area thus originally covered having been estimated at 700 acres. Various conjectures have been made by antiquaries as to their use, some maintaining that the pits are the remains of a great British city, or formidable series of fortifications; if so, as Gen. Pitt-Rivers points out, it would upset all our conclusions as to the social and political condition of the Britons, and of the extent of the pre-Roman population of these islands. Last autumn Gen. Pitt-Rivers carried out a series of excavations, cutting a section right across the pits in the parts most likely to yield remains of any possible inhabitants. Not a bit of pottery the size of a pea, he tells us, was found, and no indication whatever that these pits have ever been used as habitations. Ample evidence, however, was found that the pits were used as quarries, from which the inhabitants obtained grind-stones or quern-stones. The remains of quern-stones were found, all bearing marks of having been tool-dressed, and in the villages around many such stones are met with, all of them stated to have been obtained from the pits. It is to be hoped that the very careful piece of work thus performed by Gen. Pitt-Rivers, and his report, will set the question permanently at rest. Several plates of sections, plans, &c., accompany the report.

A Commission of five French medical men have reported on their investigations as to the real nature and action of the cholera poison. The substance of their report as it appears in the *Times* is as follows:—"The initial lesion of cholera takes place in the blood. It essentially consists in the softening of the hæmoglobin, which makes some globules lose first their clear shape, the fixity of their form, and the faculty of being indented. Those globules adhere together, lengthen out—*en olive*—stick together, and in fulminating cases especially some are seen which are quite abnormal, while others appear quite healthy. The entire loss of elasticity of the globule (which is shown by the preservation of the elliptic form when it has been stretched out) is, in our view, a certain sign of the patient's death. To stretch out a globule you have merely to alter the inclination of a plate on which a sanguineous current has been established in the field of the microscope. The fluid column stops at one point, whereas the rest continues to flow. An elongation of the intermediary globules results, and then a rupture of the column. In the gap thus formed are some scattered globules. If these revert to their primitive form, the patient may recover. If they keep the elliptic form, we have seen death follow in every case, even if the patient's symptoms were not serious at the time of the examination of the blood."

Education in British Burmah appears to be in a sad condition. According to a correspondent of *Allen's India Mail*, the province has not yet produced any student capable of attaining the B.A. degree, and only five or six have succeeded in passing the first examination in Arts. There is no local school of medicine, and such native medicine as exists is a compound of empiricism and a belief in charms and enchantments; while the principal legal authority has repeatedly deplored the gross

ignorance of law exhibited by both advocates and judges. The Viceroy himself complained of the slowness of the official department in respect to female education. A change, however, appears to have been made by the Government of India, which has authorised the establishment of a College, though not yet of a University. Until 1881 the control of education in British Burmah was purely administrative, being vested in a Government department; but Lord Ripon decided to create a controlling body something like the London School Board, except that its members will be nominated, not elected. The rights of the missionaries, who appear to have been the pioneers of education in the province, as well as of the Burmese themselves, were recognised, and they are represented on the new governing body. The labours of the Board so far have been very successful. It created a law school and a free library; it has organised and simplified all public examinations, and has promoted a movement amongst the wealthy natives for endowing scholarships for the higher branches of education and for the promotion of learning generally. This is all very promising; but, according to the correspondent whom we have quoted, there is a slight rift in the lute in the shape of the hostility of the local officials to the acts and even to the existence of the Board. Bureaucratic prejudice, however, can hardly hinder effectually the work of a council established on such a broad basis as this one is, backed as it also is by the authority of the Government of India.

THE Health Exhibition in connection with the Autumn Congress of the Sanitary Institute of Great Britain was opened at Dublin on Tuesday by the Lord Mayor. The inaugural address to the members of the Institute was delivered in the evening by the President, Sir Robert Rawlinson. He observed that in our own days one of the greatest works to be accomplished is to stem the torrent of sanitary ignorance now working so much mischief. Quarantine, as now practised, works at enormous money cost as well as incalculable inconvenience, and produces much misery without preventing the effects intended to be warded off. Sir Robert Rawlinson referred to the conditions under which cholera has so long afflicted India and China, partly arising from bad or insufficient food, impure water, and defective sanitary arrangements. Turning to England, he spoke of its temperate climate, pure atmosphere, and soil almost entirely free from malaria; but we have much to be ashamed of, and much to amend, in our social economy. Commenting on cholera generally, he said that occasionally it is epidemic we know. That it is contagious in the sense imagined by the ignorant experience does not prove. The President then pointed out the connection between disease and the want of good sanitary arrangements in various countries, and showed the importance of pure air, good food, pure water supply, and efficient drainage and sewerage, putting forward practical suggestions for sanitary engineers.

MAJOR SERPA PINTO, the Portuguese traveller, will leave Mozambique very shortly at the head of an expedition in order to explore the country between Mozambique and Lake Nyassa. The route to be taken is kept secret, but it is rumoured that he will proceed to the Congo, *viâ* Lake Tanganyika. The expedition, which is now being fitted out, will be on a large scale. It will comprise one hundred Inhambane Zulus as a body-guard, and two hundred and fifty carriers, and will be accompanied by a Portuguese naval lieutenant and an English photographic artist.

THE death is announced from Bangkok of Mr. Henry Alabaster, the most eminent European servant of the Siamese Government. Besides various political services, Mr. Alabaster, who had been at one time in the British Consular Service, played an important part in the great advances recently made by Siam. He introduced and established the telegraph and telephone in the country, collected a valuable European library for the palace, and originated the museum and the botanic gardens at Bangkok.

INTELLIGENCE has been received at Mozambique of the death, on August 16, of Capt. Foot, British Consul in the districts adjacent to Lake Nyassa. Capt. Foot has done some good exploring work in the Nyassa region.

THE Annual Exhibition of the Photographic Society opens at the Gallery in Pall Mall on Monday next.

A RED glow, similar to those of last year, was seen in the western sky at Berlin on September 13 at 6.45 p.m., viz. half an hour after sunset. It reached to a height of about 20° above the horizon, the colour being red to violet, which changed into a deep yellow near the horizon. Some measurements of the visible diameter was made by an observer, who discovered that the glow was limited by a spherical segment 20° in height, and with an extension towards the horizon of 35°. The centre of the segment coincided exactly with that of the sun below the horizon, which was then 78° west of the true north.

THE first news has been received from Lieut. Wissmann, leader of the expedition for the exploration of the Kasai. In a letter from Malange, dated August 25, he writes: "I am at last so far that I can say I leave this place to-morrow." Till then he had been merely making preparations.

A RECENT issue of the *Ceylon Government Gazette* contains a correspondence on the "grub" which ravages the coffee plantations of the island. The principal, and in fact only important, document in the publication is a lengthy report by Mr. McLachlan on the subject. Some forty species of beetles were submitted to him, but special interest centred in twenty of these, all or nearly all of which were allied to the *Melolontha vulgaris*, or common European cockchafer. Mr. McLachlan assumes that no undergrowth of grass or other herbaceous plants is allowed in the plantations, for the grubs of the European cockchafer and its allies feed on the roots of such plants, and not as a rule on those of trees and shrubs. But the larvæ would make their way from the roots of the weeds to those of the coffee plant. Whether hardening the surface of the ground around the plant so as to render it difficult for the female to deposit her eggs would be of any efficacy, is a point for the planters to decide for themselves in view of the welfare of the plant at the time. Mr. McLachlan professes himself unable to suggest any chemical poison for the grub, although he thinks that dilute kerosene oil might be tried. He advises, "above all things," to encourage insectivorous birds to the fullest possible extent, and adds that a flock of crows probably destroy more grubs in an hour than would be possible by any artificial means in a week; the systematic catching of the perfect insect or larva is also suggested as beneficial, and hand-picking should be resorted to where labour is cheap. Finally, he thinks it highly desirable that the Planters' Association or the Ceylon Government should establish an experimental plantation of a few acres, in which the natural history of the various kinds of grub, and the effect of the various supposed or real remedies, could be carefully watched.

A NEW development of telegraphy has been instituted by Michela in Italy: he has constructed a machine by which signs corresponding to various sounds can be telegraphed; thus we have practically a telegraphic shorthand to which the name "steno-telegraphy" is given. Michela's apparatus has now been in regular use for some period in telegraphing the debates of the Italian Senate. The transmitting apparatus briefly consists of two series of ten keys, each of which corresponds to some particular sound. Each key acts in reality like a Morse key, and thus transmits a current to the receiving instrument. The

receiving instrument consists of a combination of twenty Morse receivers, to each of which is attached a style which marks on the receiving paper its proper sign, thus producing a stenographic message. Great speed in transmitting is claimed for this method, and the following figures are given as comparative :—

Morse simple	500	words per hour
Hughes simple	1,200	,, ,,
Wheatstone	1,800	,, ,,
Steno-telegraphic	10,000	,, ,,

A MEDICAL student, M. J. Olsen, who has been engaged during the summer in studying the fungoid flora in the neighbourhood of Bergen (Norway), has found on Ask Island a specimen of the remarkable *Tricholoma colossum*. It is the first time it has been found in Norway, and it has only once been found in Sweden. The stem is 2½ inches in diameter. Prof. Elis Fries in describing this variety says : "I discovered this unique variety for the first time among branches of spruce lying on the ground in a place near the Tem Lake in Småland (Sweden). It is the largest and finest of the hitherto discovered mushrooms."

THE thirteenth annual *conversazione* of the Chester Society of Natural Science was held in the Town Hall on September 25, and was attended not only by the members, but by a contingent of the Iron and Steel Institute, who have been holding their annual meeting in the Cestrian city. The Kingsley Memorial Medal was awarded to Mr. A. O. Walker, F.L.S., and Kingsley Memorial prizes were given for local natural history collections. It was announced that a prize of 10*l*. would be given in 1885 for the best collection of coal-measure fossil plants from the Society's district, a similar sum in 1886 for the best collection of "Bees and Wasps" from the same area, and in 1887 "for the best Essay on the Physiography of the Society's District, on the lines of Prof. Huxley's Physiography;" the district in question being Flint and Denbigh, with as much of the county of Cheshire as lies west of a line drawn south from Warrington. The exhibition of microscopic objects was, as is usually the case at Chester, exceedingly good, and for teaching purposes they were rendered more useful by the publication by the Society of a little handbook of twenty-eight pages, on Natural History, for use in the annual *conversazioni* and other meetings of the Society. It is drawn up by Mr. C. F. Fish, and appears to be an expansion of the useful programme, on which we commented last year. The information as to the classification and structures of the lower orders of life, both animal and vegetable, appear to be very carefully done, and are very concise. The work could be made much more useful by expanding the geological and physical portions; it is published at a few pence.

DR. GEORG SCHWEINFURTH has left Berlin to return to Egypt, whence he intends to start upon a new scientific exploring tour through the desert.

ON September 18 the meeting of German naturalists was opened at Magdeburg, under the presidency of Dr. Gachde. Over a thousand men of science were present. Strasburg was fixed upon as next year's meeting-place, with Profs. Kussmaul and De Bary as secretaries. Among the addresses delivered we may mention :—On the relation of micro-organisms to the infectious diseases of man, by Prof. Rosenbach (Gottingen); on the importance of German colonisation in Africa, by Dr. Gerhard Rohlfs; various medical addresses by Drs. Schwarz (Cologne), Paetz (Alt-Scherbitz), Finkler (Bonn), and Prior.

THE death is announced near Sydney of James Snowdon Calvert, the last survivor of Leichhardt's Australian exploring expedition.

A TELEPHONE now transmits, by the ordinary telegraph wire, the music from the Brussels Opera House to the Royal Châlet at Ostend. The system, of course, is Van Rysselberghe's, mentioned in our last number.

THE late Dr. Ferd. von Hochstetter's travelling reports, dating from the celebrated *Novara* Expedition (1857–59), are now being published in book form, upon the occasion of the twenty-fifth anniversary of the *Novara's* safe return to Trieste. The book will contain a portrait of the author, a preface by V. von Haardt, and a map of the course of the *Novara*. Hölzel of Vienna is the publisher.

M. CHARLES HUBER, who was travelling in the interior of Arabia in the service of the French Ministre de l'Instruction Publique (formerly together with Prof. Euting of Strasburg) has been murdered near Labegh (Rabegh ?) by Bedouins of the Harl tribe. His Arabian servant Mahmoud has met the same fate.

NEWS has been received from Capt. Adrian Jacobsen, now travelling in Northern Asia, by order of the Berlin Ethnological Museum with a view of making ethnographical collections. Capt. Jacobsen, after leaving St. Petersburg, visited Kasan, Ekaterinburg, and Tomsk, and has already sent home two large cases containing ethnographical objects collected among the uncivilised Russian tribes of the Tscheremiss, and Tschmrasch, and Wotjäks.

REFERRING to our note of last week on Mr. St. Clair's "Note on a Possible Source of Error in Photographing Blood Corpuscles," the author writes to say that "in Dr. Norris's photographs where the colourless disks are well defined, the dark ones are out of focus." But it has not been shown possible to produce the ghosts while the real images are *at all* visible, and until this is done we must adhere to the opinion we have already expressed.

THE additions to the Zoological Society's Gardens during the past week include a Toque Monkey (*Macacus pileatus* ♂) from India, presented by Mrs. Batchelder; a Common Marmoset (*Hapale jacchus* ♂) from Brazil, presented by Mr. W. E. Steinscher; six Great Bats (*Vespertilio noctula*), British, presented by Mr. W. Atkinson; two King Parrakeets (*Aprosmictus scapulatus*), two Cockateels (*Calopsitta novæ-hollandiæ*) from Australia, presented by Mrs. C. Price; two Spanish Terrapins (*Clemmys trijuga*), South European, presented by Mr. W. H. J. Paterson; a Common Viper (*Vipera berus*), British, a Viperine Snake (*Tropidonotus viperinus*) from West Africa, presented by Mr. William Cross; a Common Snake (*Tropidonotus natrix*), a Common Viper (*Vipera berus*), British, presented by Mr. W. H. B. Pain; a White-breasted Kingfisher (*Halcyon smyrnensis*) from India, two Reed Buntings (*Emberiza schœniculus*), a Blackcap (*Sylvia atricapilla*), a Pied Wagtail (*Motacilla lugubris*), British, a Tree Boa (*Corallus hortulanus*) from Cuba, purchased.

OUR ASTRONOMICAL COLUMN

COMET 1884 *b* (BARNARD, JULY 16).—Dr. Berberich of Strasburg, who has investigated the elements of this comet from observations extending to September 14, has found an elliptical orbit, in which the period is only 5¼ years, a result which will perhaps have been rather expected, considering the nature of the parabolic orbits previously calculated, and, as was pointed out by Prof. Weiss, their resemblance to the elements of De Vico's comet of short period observed in 1844. Dr. Berberich's ellipse is as follows :—

Perihelion passage, 1884, August 16·48346 Greenwich M.T.

Longitude of perihelion	306° 7′ 31″·1	Mean Equinox 1884·0
,, ascending node ...	5 3 50·2	
Inclination	5 28 49·6	
Angle of eccentricity	36 3 43·8	
Log. semi-axis major	0·493392	
Period of revolution	2007·9 days or 5·4965 years	

At aphelion in this orbit the comet would be distant from the orbit of Jupiter 0·503, but there is a very much closer approach to the orbit of Mars, at a true anomaly of 37° 13′, corresponding to heliocentric longitude 343° 25′, where the distance of the two orbits is only 0·0088, and it is worthy of note that between April 5 and 10, 1868, both Mars and the comet would pass that point, and if Dr. Berberich's period is approximately correct, there must have been a close approach of the two bodies, possibly a closer one than calculation assigns. The following positions are deduced from the elliptical orbit :—

At Berlin, Midnight

	R.A. h. m. s.	Decl. ° ′	Log. Distance from Earth.
October 5 ...	20 33 51 ...	− 22 30·1 ...	9·8331
9 ...	20 46 54 ...	21 2·5 ...	9·8536
13 ...	20 59 26 ...	19 35·6 ...	9·8746
17 ...	21 11 28 ...	18 10·0 ...	9·8960
21 ...	21 23 4 ...	16 45·9 ...	9·9175
25 ...	21 34 14 ...	15 23·5 ...	9·9391
29 ...	21 45 1 ...	− 14 2·9 ...	9·9608

The comet is rapidly growing fainter, but it is obviously of importance for its theory that observations should be continued as long as possible.

Comet 1884 *c*.—A new comet was discovered by Herr Wolf at Heidelberg on September 17, and was observed at Strasburg on September 20. It was also independently detected by Dr. Copeland at Dun Echt on September 22, the night before the telegraphic notice from Kiel arrived at that Observatory. Prof. Tacchini has favoured us with the following observations made by himself and Prof. Millosevich at the Observatory of the Collegio Romano in Rome :—

	Rome M.T. h. m. s.	R.A. h. m. s.	Decl. ° ′ ″
Sept. 21 ...	9 24 47 ...	21 15 46·00 ...	+ 21 59 22·6
23 ...	7 39 12 ...	21 16 44·33 ...	+ 21 7 48·7

This comet is likely to remain visible for several months, according to the orbits yet calculated, but a somewhat wider extent of observation than is now available will be required to predict its track in the heavens with any degree of certainty.

The Lunar Eclipse on October 4.—We gave last week the times of occultations of two stars during the totality of this eclipse, of which accurate positions are found in our catalogues. A somewhat extensive list of stars liable to occultation has been determined at Pulkowa with sufficient precision for the predictions of the times of immersion and emersion, which have been communicated to various observatories. Several stars rated higher than the ninth magnitude appear on this list, where the *Durchmusterung* magnitudes are followed. Our remark last week should have been explained as referring only to stars of which accurate places are found in the catalogues.

HYDROXYLAMINE AND THE ASSIMILATION OF NITROGEN BY PLANTS

THE researches of V. Meyer and E. Schulze on the action of hydroxylamine salts upon plants (*Berl. Ber.*, xvii. 1554) were undertaken with the *a priori* probability of showing that this base plays an important part in the synthetical activity of the plant ; and although they have not succeeded in establishing the experimental fact, the results obtained are of great interest, and the whole is eminently suggestive of future possibilities. The supply of nitrogen to plants takes the form of nitrates and ammoniacal salts, and these classes of compounds being destitute of synthetical activity, we are driven to assume that the earlier stages of nitrogen assimilation consist in the conversion of these comparatively inert substances into derivatives having the "chemical tension" necessary to synthetic activity. Hydroxylamine and its salts, which occupy in point of oxidation a position intermediate between ammonia and the nitrates, are bodies possessing this character in the highest degree. To use the author's words, "the behaviour of this base towards the organic oxy-compounds is most aggressive : it is indeed astonishing with what facility it converts carbonyl-compounds into azotised derivatives." This is notably the case with the ketones and aldehydes of the fatty series, the products of the union being oximido-derivatives, *e.g.* aldoxime, acetoxime, isonitroso acids ; in these the characteristic $C=NO_2$ group easily undergoes reduction, with formation of the corresponding amido derivatives ; and upon the hypothesis of the formation of hydroxylamine in the plant as the first stage in nitrogen assimilation, it is easy to see in what manner its non-nitrogenous constituents, which for the most part possess the characteristics of aldehydes and ketones, would contribute to the further stages in its elaboration.

To test this hypothesis, in the first instance, the authors instituted parallel experiments on the culture of maize, to which the nitrogen was supplied in the form of ammonium sulphate, hydroxylamine sulphate, and hydrochlorate and potassium nitrate, respectively. The result was, in a word, to show that the hydroxylamine salts act as direct poisons to plant life, as indeed they have already been shown by Bertoni to act towards animal life. Having established this fact, the authors inferred their probable action as antiseptics, and experiment showed that they possess this property in a remarkable degree. This result, as they contend, does not negative the original hypothesis, as the occurrence of the base in the plant would necessarily be transitional.

It seems to us that the antiseptic properties of hydroxylamine are a direct consequence of its synthetical activity ; and further that antiseptics fall into three classes according to their disturbance of one of the three essential conditions of cell life, which are : (1) hydration ; (2) oxidation ; (3) the synthetical activity of aldehydes (Löw and Bokorny), chiefly in the direction of condensation. In illustration of this classification we may cite as typical members of group (1) common salt, (2) sulphurous acid in its various combinations, (3) phenols.

THE BRITISH ASSOCIATION
REPORTS

Second Report of the Committee, consisting of Prof. A. W. Williamson, Chairman, Profs. Sir H. E. Roscoe, Dewar, Frankland, Crum-Brown, Odling, and Armstrong, Messrs. A. Vernon-Harcourt, J. Millar Thomson, V. H. Veley, F. Japp, H. Forster Morley, and H. B. Dixon (Secretary), appointed for the purpose of drawing up a Statement of the Varieties of "Chemical Names" which have come into use, for indicating the causes which have led to their adoption, and for considering what can be done to bring about some Convergence of the Views on Chemical Nomenclature obtaining among English and Foreign Chemists.—The Report is somewhat lengthy, and includes some long tables of varieties of names for common chemical substances. It commences with historical notes on chemical nomenclature. No attempt was made until about 100 years ago to name chemical substances in a way which would indicate their composition ; alchemistic or "culinary" names being given to substances in many cases. Macquer is credited with being the first to introduce generic names like vitriol and nitre to indicate sulphates and nitrates. The term salt was used to indicate almost any substance soluble in water and affecting the sense of taste, and in the eighteenth century acids, salts, and bases began to be distinguished. Rouelle was the first to define a salt from its chemical properties, and distinguish it from acids and bases (see Kopp's "History of Chemistry," iii.). Bergmann and Guyton de Mouveau separately proposed systems of nomenclature, many terms of which are still in use. De Mouveau made the terminations of names of acids uniform, and the names of salts to indicate their composition from bases and acids. In 1787 Lavoisier, De Mouveau, Berthollet, and Fourcroy prepared a scheme of naming compounds which is practically that in common use now, introducing the terminations "ate" and "ic," "ite" and "ous," in acids and salts. But higher and lower oxides are not distinguished by generic names. Berzelius made a more elaborate classification of salts, and added some names. He distinguished the halogen compounds of hydrogen as hydracids, and distinguished clearly between "neutral," "acid," and "basic" salts. The views now held of acids, salts, and bases are practically those of Gerhardt and Laurent, who first recognised the part played by hydrogen in acids and salts. The Report then goes on to consider the tables, which give the number of times a substance has been distinguished by any particular name. Table I. deals with the names of oxides of carbon from 1755 to 1882. By far the greater number of sources give the names carbonic oxide to CO and carbonic acid to CO_2 ; systematic names like carbonous oxide and carbonic oxide only occurring two or three times, the terms carbonic oxide and carbonic anhydride or dioxide being next in frequency. In France and Germany the names oxide de carbon and acide carbonique, Kohlenoxyd and Kohlensäure have been much more frequently used. But in several instances the same names have been used in a different sense ; the term carbonic oxide being some-

times used for CO_2, sometimes for CO. In Table II. the prominence of this "diversity of names for the one thing," and giving the same name to distinct substances, is more frequent. The use of numerical prefixes has also been very irregular; "thus, trisodic phosphate has been called 'triphosphate of soda,' 'diphosphate of soda,' and 'sesquiphosphate of soda'; in all these cases the prefix is intended to indicate the number of molecules of soda to one molecule of phosphoric acid." "In some of the older forms of nomenclature ambiguity was avoided by using the prefix 'bi-' to multiply the acid when in excess over the base, and 'di-' to multiply the base when in excess over the acid; thus, Na_2O2SiO_2, bisilicate of soda, $2Na_2OSiO_2$, disilicate of soda." The Report goes on to say that "the usefulness of any system of nomenclature depends on its permanence." Curiously enough the tables show that where names have been adopted supposed to represent in some way the chemical constitution of bodies, they have not, as a rule, endured; the advance of knowledge necessitating a change of opinion, whilst names not expressing a chemical opinion as to constitution have endured. "As a rule, those names are to be preferred which have shown most vitality and have led to no ambiguity. Where there are two compounds composed of the same elements, the terminations 'ous' and 'ic' should be employed. The prefixes 'proto' and 'deuto,' introduced by Thomas Thomson, were intended to mark the compounds in a series, not the number of atoms in a molecule. Where retained this use only should be made of them." Referring to change of name, instance is made of the oxides of carbon, the names of which have recently to some extent been transposed, the higher one being termed "carbonic oxide," and the lower one, to which the term "carbonic oxide" has long been applied, has had a new name. The sensible conclusion of the Report is to retain names of substances which are in common use, rather than to change them for names indicating constitution, and which might be again found to require alteration in accordance with some new view of the constitution of the substance.

SECTION B—CHEMISTRY

AT the meeting of the Chemical Section at Montreal a new departure was made in the selection by the Organising Committee of two subjects for special discussion. The subjects chosen were: "The Constitution of the Elements," and "Chemical Changes in their Relation to Micro-Organisms."

Discussion on "The Constitution of the Elements"

Prof. Dewar began by referring to Grove's discovery that water suffered decomposition at the temperature of the oxy-hydrogen flame, an experiment which led Sainte-Claire Deville to undertake his researches on dissociation. Deville has shown that in compound substances there is an equilibrium between decomposition and recomposition, this balanced relation changing with the temperature. The experiments of Deville on the temperature of burning gases agree closely with the results obtained by Bunsen, who determined the pressures generated in the explosion of hydrogen and other gases with oxygen. The breaking up of the iodine molecule, effected by Victor Meyer, is a decomposition of elementary matter. Owing to the rapid recomposition, there seems no hope of isolating atomic iodine at low temperatures. The vapours of potassium and sodium have different densities at different temperatures; probably also their molecules consist of two atoms at lower, and of one atom at higher, temperatures. More exact determinations are needed of those substances which exhibit a variable vapour density. The evidence afforded by spectral analysis proves that oxygen and nitrogen have two spectra, and therefore probably different molecules at different temperatures. Hydrogen has a complicated spectrum under certain conditions. Referring to Mr. Lockyer's speculations, he said there was a general basis of similarity in the type of the vibrations of certain allied elements, viz. the triple lines in zinc and cadmium. Mr. Lockyer has proved that the identity of certain "basic" lines of different elements, such as iron and calcium, is not due to impurity, but the greater dispersion of more powerful instruments has shown that the coincidence of these lines is only apparent and not absolute. The differences observed in some of the spectral lines of a single element in the sun might be accounted for not by the decomposition of the "element" into simpler matter but by great differences of level in the luminous vapour. Prout's hypothesis, that the atomic weights of the other elements are multiples of that of hydrogen, has no basis in experimental fact. Stas and Marignac have both returned in their old age to the redetermination of the atomic weights made by them twenty years ago. Stas, avoiding the possible sources of error in his former methods, has lately found 14·055 for the atomic weight of nitrogen; his old determinations gave 14·044. For potassium he now arrives at the number 39·142 instead of 39·137. Marignac gives the following as the atomic weights of zinc and magnesium, 65·33 and 24·37,—numbers very far removed from whole numbers.

Prof. Wolcott Gibbs drew the attention of the Section to the probability that what is generally regarded as a simple molecule, such as sodium chloride, consists in the solid state of several hundreds of atoms, and that the salt undergoes in solution a kind of molecular dissociation. Very complex molecules, such as those acids he had prepared containing many molecules of the oxides of molybdenum, vanadium, barium, &c., are probably derived by substitution from what are called simple molecules, but which are really composed of a great number of atoms.

Prof. Frankland said he ventured to differ from Prof. Dewar in one point. He thought it might not be impossible by a decomposition of compound molecules to prepare isolated iodine atoms.

Sir Lyon Playfair suggested as a useful line of work the determination of the conditions under which such bodies as nitric peroxide would enter into combination with other compounds.

Prof. Tildén pointed out that a large field lay open to workers in thermo-chemistry, on the one hand in determining the temperatures at which chemical action begins, and on the other the heat-changes of chemical combination and solution at different temperatures.

Rev. Father Perry agreed with Prof. Dewar that some differences in the solar lines were due to difference of level of the luminous vapour. But, on the other hand, the widening of solar lines in the umbra of spots cannot be accounted for in this way. The Astronomer-Royal and Mr. Lockyer have been studying the solar spectrum from the line D to F. The Rev. Father Perry (studying D towards B) has found differences in the lines of the same metal in different spots which could not be attributed to difference of level only.

Prof. Dewar, in answer to Father Perry, stated that the widening of certain lines at the red end of the spectrum might have been anticipated from the results of his own work in the crucible. The supposed allotropic spectrum of magnesium is due to a compound of magnesium and hydrogen. The fact that in the upper regions of the solar atmosphere, where hydrogen and magnesium occur in enormous quantities, this allotropic spectrum is not observed presents a difficulty. Perhaps at the mean temperature of the solar atmosphere this compound is dissociated. If so, somewhere nearer the surface or in the spots a condition of temperature should occur in which the compound should be stable. He hoped Father Perry would succeed in observing this spectrum in the umbra of spots. It had been stated that if our elements are compound substances they should be found decomposed at the enormously high temperatures of the sun; but if it is admitted that the elements are compounded of hydrogen, and that dissociation can occur, the compound vapour is diffused through an atmosphere of hydrogen, one of the products of its dissociation, and is therefore precisely under those conditions in which it is most stable.

Discussion on "Chemical Changes in their Relation to Micro-Organisms"

Prof. Frankland, in opening the discussion, distinguished between two kinds of chemical action—(1) that in which substances brought into contact mutually undergo chemical change, and (2) that in which chemical change is effected in one substance by contact with another, which itself apparently suffers no alteration. The following definitions were proposed to distinguish animal and vegetable organisms:—(1) A plant is an organism performing synthetical functions, or one in which these functions greatly predominate; it transforms actual into potential energy. (2) An animal is an organism performing analytical functions, or one in which these functions greatly predominate; it transforms potential into actual energy. All micro-organisms appear to belong to the second class. Oxidation is the essential condition of life. There are, however, many other chemical transformations in which potential becomes actual energy, and which therefore can support life. After de-

scribing the chemical changes produced by a large number of micro-organisms, the author concluded that there is no break in the continuity of chemical functions between micro-organisms and the higher forms of animal life. It is true there are apparently certain sharp distinctions between them. The enormous fecundity of micro-organisms and their tremendous appetites seem to separate them from the higher orders of animals. But this distinction is only comparative. It must be borne in mind that an animal like a sheep converts much of its food into carbonic acid, hippuric acid, and water, thus utilising nearly the whole of the potential energy, while the micro-organism as a rule utilises only a small portion. Those micro-organisms which have been chemically studied produce, like the higher animals, perfectly definite chemical changes. The position of these organisms in Nature is only just beginning to be appreciated. It may safely be predicted that there is no danger of their being spoiled by the petting of sentimentalists, yet these lowly organisms will receive much more attention in the future than they have done in the past.

Principal Dallinger referred to the attempted distinction between the lower animal and vegetable forms. In following out the life-history of certain monads he used a nutritive fluid containing no albuminoid substances, but only mineral salts and tartrate of ammonium. Organisms classed by Prof. Huxley as animal were found to live in this mineral fluid. Bacteria of forms which cannot be distinguished by the microscope have very different physiological functions. These Bacteria can be modified physiologically, but not at all readily morphologically; by a slow change it is possible to completely reverse the conditions of the environment of the Bacterium without changing its form. It is most important to study the physiology of Bacteria.

Dr. Macalister pointed out that the experiments made on the conversion of the Bacillus of the hay infusion into the *Bacillus anthracis* had not been confirmed by more exact experiments. The germs of the *Bacillus anthracis* readily diffused themselves through the air of the laboratory, and without the very greatest care it was impossible to avoid contamination of the liquids with stray germs.

Prof. Dewar referred to the extraordinary behaviour of very small quantities of peroxide of hydrogen on putrescible liquids. One-hundredth of a per cent. of the peroxide perfectly preserved many liquids, keeping them quite clear and without a trace of any Bacteria. The conversion of sugar into anhydrous alcohol and carbonic acid seemed to be unaccompanied by a thermal change, so that an important question arises, Where does the power which effects the change come from? Possibly, like chlorophyll, the Bacteria absorb rays of radiant heat and light. Dr. Engelman has studied the distribution of radiant energy in the spectrum of the sun and flames by the activity of the Bacteria submitted to different parts of the spectrum.

Sir Lyon Playfair regarded it as curious that the products formed in the growth of the higher animals—namely, carbonic acid and urea—should be so much simpler than the products formed by lower organisms.

Complex Inorganic Acids, by Prof. Wolcott Gibbs.—This research may be regarded as a series of generalisations of the class of silico-tungstates discovered by Marignac in 1861, and of the analogous class of phospho-molybdates studied by Deville. Scheibler has described two distinct series of phospho-tungstates; the author finds there are at least ten, the highest having the formula $24WO_3.P_2O_5.6H_2O$, the lowest the formula $6WO_3.P_2O_5.6H_2O$, and that the phospho-molybdates are at least equally numerous, and have a similar range. Corresponding compounds containing arsenic oxide also exist. To generalise these results the author replaced phosphoric oxide by vanadic oxide and antimonic oxide, so as to form vanadio-tungstates and antimonio-tungstates, and the corresponding compounds of molybdenum. Many of these salts are very beautiful. Probably the greater number of oxides of the type R_2O_5 form similar compounds. A second series of complex acids contain *two* molecules of the type R_2O_5, so that we have various phospho-vanadio-tungstates and phospho-vanadio-molybdates. The generalisation of the term WO_3 or MoO_3 appears also possible, as the author has prepared compounds in which sulphur and selenium replace oxygen in WO_3 or MoO_3. Again, the author finds that phosphorous and hypophosphorous acids enter into similar combinations with tungstic and molybdic acids, and he has also prepared compounds in which the methyl, ethyl, and phenyl derivatives of phosphorous and hypophosphorous acids occur. An attempt to prepare complex acids containing pyro-phosphoric acid failed, as that acid quickly changed to the ortho-acid; but with meta-phosphoric acid the author succeeded in preparing several new compounds. The author has further shown that the group R_2O_5 may be replaced by R'_2O_3, $R'Cl_2$—R' being a metal of the platinum group—and that the chlorine can be replaced by bromine or iodine. The type of silico-tungstates is also capable of generalisation, silica being replaced by a large number of similar oxides, as, for instance, the oxides of selenium, tellurium, platinum, &c. As an instance of the extreme complexity of some of these compound acids, the author gave the body $60WO_3.3P_2O_5.V_2O_5.VO_2.18BaO + 150Ag$. This body has the enormous molecular weight of 20,066. In conclusion the author stated that in formulating certain compounds containing V_2O_5 he found much similar expressions resulted when a part of the V_2O_5 was supposed to have the structure $(V_2O_2)O_3$, (V_2O_2) replacing W or Mo.

On the Incomplete Combustion of Gases, by H. B. Dixon.—The author gave a *résumé* of the work he had done in continuation of the researches of Bunsen, E. von Meyer, Horstmann, and other chemists, on the division of oxygen when exploded with excess of hydrogen and carbonic oxide. The following are the general conclusions arrived at:—(1) No alteration *per saltum* occurs in the ratio of the products of combustion. The experiments made completely confirm Horstmann's conclusion: Bunsen's earlier experiments are vitiated by the presence of aqueous vapour in the eudiometer. (2) A dry mixture of carbonic oxide and oxygen does not explode when an electric spark is passed through it. The union of carbonic oxygen is effected indirectly by steam. A mere trace of steam renders the admixture of carbonic oxide and oxygen explosive. The steam undergoes a series of alternate reductions and oxidations acting as a "carrier of oxygen" to the carbonic oxide. With a very small quantity of steam the oxidation of carbonic oxide takes place slowly; as the quantity of steam is increased the rapidity of explosion increases. (3) When a mixture of dry carbonic oxide and hydrogen is exploded with a quantity of oxygen insufficient for complete combustion, the ratio of the carbonic acid to the steam formed depends upon the shape of the vessel and the pressure under which the gases are fired. By continually increasing the initial pressure a point is reached where no further increase in the pressure affects the products of the reaction. At and above this critical pressure the result was found to be independent of the length of the column of gases exploded. The larger the quantity of oxygen used, the lower the "critical pressure" was found to be. (4) When dry mixtures of carbonic oxide and hydrogen in varying proportions are exploded above their critical pressures with oxygen insufficient for complete combustion, an equilibrium is established between two opposite chemical changes represented by the equations:—

$$(I.)\ CO + H_2O = CO_2 + H_2.$$
$$(II.)\ CO_2 + H_2 = CO + H_2O.$$

At the end of the reaction the product of the carbonic oxide and steam molecules is equal to the product of the carbonic acid and hydrogen molecules multiplied by a coefficient of affinity. This result agrees with Horstmann's conclusion. But Horstmann considers the coefficient to vary with the relative mass of oxygen taken. (5) A small difference in the initial temperature at which the gases are fired makes a considerable difference in the products of the reaction. This difference is due to the condensation of steam by the sides of the vessel during the explosion, and its consequent removal from the sphere of action during the chemical change. When the gases are exploded at an initial temperature, sufficiently high to prevent any condensation of steam during the progress of the reaction, the coefficient of affinity is found to be constant whatever the quantity of oxygen used—provided only the quantity of hydrogen is more than double the quantity of oxygen. (6) The presence of an inert gas, such as nitrogen, by diminishing the intensity of the reaction, favours the formation of carbonic acid in preference to steam. When the hydrogen taken is less than double the oxygen, the excess of oxygen cannot react with any of the three other gases present—carbonic oxide, carbonic acid, and steam, but has to wait until an equal volume of steam is reduced to hydrogen by the carbonic oxide. The excess of inert oxygen has the same effect as inert nitrogen in favouring the formation of carbonic acid. The variations in the coefficient of affinity found by Horstmann with different quantities of oxygen are due partly to this cause, but chiefly to the varying amounts of steam condensed by the cold eudiometer during the reaction in different experiments. (7) As a general

result of these experiments it is shown that, when a mixture of dry carbonic oxide and hydrogen is exploded with oxygen insufficient for complete combustion, at a temperature at which no condensation of steam can take place during the reaction, and at a temperature greater than the critical pressure, an equilibrium between two opposite chemical changes is established which is independent of the mass of oxygen taken, so long as this quantity is less than half the hydrogen. Within these limits the law of mass is completely verified for the gaseous system composed of carbonic oxide, carbonic acid, hydrogen, and steam at a high temperature.

On Magnetic Rotation of Compounds in Relation to their Chemical Composition, by W. H. Perkin, Ph.D., F.R.S.—The author gave a *résumé* of his researches on the magnetic rotary polarisation of compounds in relation to their chemical composition. After referring to the remarkable discovery of Faraday in relation to this subject, and the results obtained by more recent workers in this field, it was shown that no relationship in reference to chemical composition was likely to be found by the usual method of calculating the results of the observation of unit-lengths of the fluid bodies examined, but that, if lengths related to each other in proportion to their molecular weights—making the necessary correction for the difference of densities—were compared, a useful result would probably be obtained. Experiments have proved this to be the case; and in the series of homologous compounds it was found that for every addition of CH_2 a definite increase of what is called the "molecular rotation" is obtained. Besides this it was found that the rotation also was capable of indicating differences in the construction of organic compounds. Iso, secondary, tertiary bodies give different results from the normal compounds. The compounds containing the halogens were also referred to, and formulæ given by which the molecular rotation of twenty-six series of compounds could be calculated.

Spectroscopic Studies of Explosions, by Profs. Liveing and Dewar.—The explosions observed were chiefly those of hydrogen and oxygen and of carbonic oxide and oxygen, and were made in an iron tube fitted with quartz ends. The spectra were both observed with the eye and photographed. Linings of thin sheet metal of various kinds were introduced into the tube. The metals iron, nickel, and cobalt gave many lines in the flash. No other metal gave anything like so many lines as these three, but magnesium gave the *b* group, copper gave one green and two ultra-violet lines, manganese the violet triplet, and chromium three triplets. On the other hand, zinc, cadmium, mercury, aluminium, bismuth, antimony, and arsenic developed no lines in the flash. It appears to be proved that iron, nickel, and cobalt are volatile in some degree at 3000°. It might be possible to establish a spectroscopic scale of temperature if the lines successively developed with increasing temperature were noted. Thus, the iron line T seems to be just developed at 3000°, the aluminium lines at H at a somewhat higher temperature, the lithium blue line may be just seen in the inner green cone of a Bunsen burner, while the green line comes out in the explosion flash. [The photographs of the explosion spectra were exhibited to the Section.]

On Evaporation and Dissociation, by Prof. William Ramsay and S. Young, D.Sc.—The authors described experiments made with the object of ascertaining whether the coincidence of the curves which represent the vapour-pressures of stable solid and liquid substances at different temperatures with those indicating the maximum temperatures attainable by the same substances at different pressures, when evaporating with a free surface, holds good also for substances which dissociate in their passage to the gaseous state. The substances examined were chloral hydrate, ammonium carbamate, phthalic acid, succinic acid, aldehyde ammonia, ammonium chloride, nitric peroxide, and acetic acid. It was found that, with chloral hydrate and ammonium carbamate, which cannot exist at all in the gaseous state, the temperatures of volatilisation do not form a curve. When the dissociation was considerable, but not complete, as in the case of phthalic and succinic acids, an indication of a curve was observed at low pressures, but it differed widely both in form and position from that representing the vapour-pressures or pressures of dissociation. As the dissociation increases the curves approach each other more closely, and they appear to be coincident in the case of ammonium chloride and nitric peroxide within the limits of temperature at which observations were made, and at which the amount of dissociation is probably small. With acetic acid very numerous observations proved the perfect coincidence of the curves. The results appear to be unfavourable to the view that, when liquefaction of a stable substance takes place, gaseous molecules coalesce to form more complex groups of molecules, and that these complex molecules dissociate when the substance is vaporised.

A Redetermination of the Atomic Weight of Cerium, by H. Robinson, B.A. Cambridge.—Cerous chloride was prepared by passing hydrochloric acid over cerium oxalate at first gently heated and afterwards raised to redness. The solution of pure chloride was added to a pure solution of silver nitrate, and then dilute solution of silver nitrate was added from a weighed bulb, until the precipitation of chlorine was complete. The liquids were illuminated by yellow light only during the precipitation. As a mean of seven closely concordant results, the atomic weight of cerium is given as 140·2593, that of silver being 107·93.

The Action of Sulphuretted Hydrogen on Silver, by Prof. F. P. Dunnington, University of Virginia.—A piece of pure silver, flattened and carefully polished on each face, was placed in the middle of a glass tube two feet long. At each end of the tube a plug of five inches of phosphoric anhydride was confined by glass wool. Pure dry hydrogen was passed through this tube while it was gently heated throughout. The hydrogen was then removed by a Sprengel pump, the silver being heated to 300° C. This operation was repeated three times, and then pure dry sulphuretted hydrogen was slowly passed through the apparatus for an hour, and the tube finally drawn off at each end. After a few days the silver was slightly darkened near its edges, and after five months the silver was blackened on its edges, while the main portion of the surface was white and bright. [The silver was exhibited to the Section in this state.]

On Molecular Volumes, by Prof. W. Ramsay.—The object of this research was to ascertain whether, as has long been taken for granted, the boiling-point of compounds under equal pressures really afforded suitable points for a comparison of their molecular volumes. The experiments made with the following series of compounds—water, methyl alcohol, ethyl alcohol, propyl alcohol, isopropyl alcohol, isobutyl alcohol, and ether—prove that the value of the group CH_2 is by no means constant. (1) While at the boiling-points of these liquids at low pressures the value is approximately constant (fluctuating between 17·5 and 22), at high temperatures the difference becomes much more marked, attaining at 20 m. of mercury pressure the greatest irregularity; *e.g.* the difference between the molecular volumes of ether and isobutyl alcohol, two isomeric substances, amounts to a total of twenty units. (2) It was found by experiment that when the liquids were at temperatures corresponding to equal vapour-pressure, but exposed to their critical pressures, no correspondence between their molecular volumes was observable. (3) It was thought possible that if the liquids, still at temperatures corresponding to equal vapour-pressure, could have existed under no pressure, some basis of comparison might be found. From the known compressibility of the liquids it was possible to calculate their volume in this hypothetical state. Although by this method their relative volumes were considerably altered, yet no point of comparison was reached. (4) The author therefore concludes that the boiling-points of liquids, under whatever pressure they may be taken, are not suitable temperatures at which to compare their molecular volumes.

On Some Phenomena of Solution, Illustrated by the Case of Sodium Sulphate, by Prof. W. A. Tilden, F.R.S.—The study of the solubility of sodium sulphate in water at temperatures above 100° C., leads to the conclusion that the salt dissolves in the anhydrous state. In order to determine whether this salt dissolves in water at lower temperatures in the anhydrous or the hydrated state, the author has made a series of calorimetric measurements of the thermal changes which attend the act of solution of Na_2SO_4 in water at temperatures below and above 33° to 34°, the critical point in the curve of solubility.

Calorimetric Effect of Dissolving Na_2So_4 in n Molecules of Water at T°

n	T°	C
100	31·7	1740
100	35·4	1522
100	42·85	1342
100	46·1	1071
100	55·0	985

These figures establish the fact that by dissolving anhydrous sodium sulphate in water at temperatures above 33°, the thermal change is still positive, although a diminishing quantity, and

hence that the act of solution is still attended at these temperatures by chemical combination between the salt and the water. These results when plotted out give a line which is nearly parallel to the curve of solubility between these limits of temperature.

On Calcium Sulphide and Sulpho-carbonate, by V. H. Veley, M.A.—Calcium oxide, free from metals of the iron group, was obtained by heating perfectly transparent crystals of Iceland spar in a current of hydrogen. This oxide was hydrated in a damp atmosphere free from carbonic acid. The hydroxide was heated to 60° C., and hydric sulphide passed over it. The resulting calcium sulphide and water were weighed, and the synthetic results thus obtained were found to agree closely with the results of the analysis of the calcium sulphide. It is worthy of note that perfectly dry calcium oxide is unaltered by the passage over it of perfectly dry hydric sulphide, and generally the formation of calcium sulphide proceeded the more rapidly the greater the quantity of water originally present in the hydroxide. This result may be due to the formation, at first, either of the hydrosulphide, or the hydroxy-hydrosulphide (CaOH,SH), and the subsequent conversion of either of these substances into the sulphide. The calcium sulphide, prepared as described above, was moistened with water, and hydrogen saturated with carbon bisulphide passed through it. It gradually turned yellow, and finally red, and on exhaustion with cold water a red solution was obtained, from which, on evaporation *in vacuo*, red, deliquescent, prismatic crystals separated. The composition of these crystals was found by analysis to correspond with the formula $Ca(OH)_2CaCS_3rH_2O$. A solution of this substance gave characteristic precipitates with metallic salts, which the author intends to examine more minutely.

On the Velocity of Explosions in Gases, by H. B. Dixon, M.A.—MM. Berthelot and Vieille have shown that in oxygen and hydrogen and several other mixtures of gases the "explosive wave" is propagated at a velocity closely approximating to the mean velocity of translation of the gaseous products of combustion calculated on the assumption that all the heat of the reaction is contained for the moment in the products formed. The mean of a number of determinations with electrolytic gas gave a velocity of 2810 m. per second, the calculated mean velocity of the steam molecule formed being 2831 m. per second. These experimenters found that carbonic oxide exploded either with oxygen or nitrous oxide did not agree with the rule. The author has shown that steam is necessary for the burning of carbonic oxide both with oxygen and nitrous oxide, and that, as the proportion of steam is increased, the rate of inflammation is also increased. Experiments made in a lead tube 55 m. long and 13 mm. in diameter entirely confirmed MM. Berthelot and Vieille's experiments with hydrogen and oxygen. The rate of the "explosive wave" was found to be 2817 m. per second as the mean of several closely concordant experiments at 10° C. With carbonic oxide and hydrogen nearly dry, the explosive wave was not established until the flame had traversed a distance of 700 mm. from the firing-point: the explosive wave was found to have a velocity rather over 1500 m. per second. After the explosion a fine layer of carbon was found to cover the inside of the explosion-tube, showing that at the enormous temperature of the explosive wave carbonic oxide is decomposed into its constituents.

A Theory of Solution, by W. W. J. Nicol, M.A., B.Sc.—The author has proposed the theory that the solution of a salt in water is a consequence of the attraction of the molecules of water for a molecule of salt exceeding the attraction of the molecules of salt for one another. It follows, therefore, that, as the number of dissolved salt molecules increases, the attraction of the dissimilar molecules is more and more balanced by the attraction of the similar molecules: when these two forces are in equilibrium, saturation takes place. Any external cause tending to alter the intensity of either of these two opposite forces disturbs the condition of equilibrium, and further solution or solidification ensues. The contraction which occurs on the solution of a salt in water has been regarded as strong evidence in favour of chemical combination having taken place, but the author finds that a further contraction takes place on further dilution, even when the number of water molecules per salt molecule is far in excess of the number in the cryohydrates.

On the Manufacture of Soda and Chlorine, by W. Weldon, F.R.S.—Chlorine is at present manufactured exclusively from hydrochloric acid, obtained as a by-product of the manufacture of soda by the Leblanc process. It is owing to this that the Leblanc process has been able to withstand the severe competition of the ammonia process, which gives soda much more cheaply than the Leblanc process, but does not yield either hydrochloric acid or chlorine. The author announces a process for the preparation of chlorine in connection with the manufacture of soda by the ammonia process. The new process consists in decomposing by magnesia the ammonium chloride of the ammonia-soda process, adding magnesia to the resulting solution of magnesium chloride, and so obtaining solid oxychloride of magnesium, which, heated in a current of air, gives off chlorine and leaves magnesia.

On the Diamond-bearing Rocks of South Africa, by Prof. Sir Henry E. Roscoe, President.—After an introductory description of the geological and physical aspects of the remarkable diamond-bearing deposits at Kimberley and elsewhere, the author gave the chemical composition of these rocks. The most noteworthy feature of the examination of these rocks is the discovery in the so-called diamond earth of a volatile crystalline hydrocarbon, soluble in ether, which seems to confirm the hypothesis that the Carboniferous shales, which are penetrated by the diamond-bearing pipes, have been the source of the carbon now found in the crystalline state in the diamond. The physical structure of the ash or incombustible portion of the diamond is of a very singular character, and has hitherto not been examined. A careful study of the diamond ash may possibly throw light on the important question of the mode of formation of the diamond.

Colour of Chemical Compounds, by Prof. Carnelley, D.Sc.—The colour of chemical compounds is conditioned by at least three circumstances, viz. (1) temperature (Ackroyd); (2) the quantity of the electro-negative element present in a binary compound (Ackroyd); (3) the atomic weights of the constituent elements of the compounds (Carnelley); and that in such a way that the colour passes or tends to pass through the following chromatic scale—white or colourless, violet, indigo, blue, green, yellow, orange, red, brown, black—either by (1) rise of temperature, or (2) increase of the quantity of the electro-negative element in a binary compound, or (3) with *increase of* the *atomic weights* of the elements A, B, C, &c., in the compounds Ax Ry, Bx Ry, Cx Ry, &c., in which R is any element or group of elements, whilst A, B, C, &c., are elements belonging to the same sub-group of Mendeléeff's classification of the elements. Tables accompany the paper in illustration of the above. Out of 426 cases in which the third of the above rules has been applied, there are but sixteen exceptions, or less than 4 per cent. Finally a theoretical explanation is given which appears to account in a very simple manner for the influence of the above three circumstances on the colour of chemical compounds.

Notes of Nitrification, by R. Warington.—He considered the present position of the theory of nitrification, and next gave a short account of the results of recent experiments conducted by him at Rothamsted. Messrs. Schloesing and Müntz, early in 1877, showed that nitrification in sewage and in soils is the result of the action of an organised ferment, occurring in soils and impure waters. The experiments of the author have confirmed the soundness of this theory. The evidence for the ferment theory is now very complete. Nitrification in soils and waters is strictly limited to range of temperature within which the vital activity of the living ferment is confined. It proceeds with slowness at 0°, is at a maximum at 37°, and ceases at 55°. Nitrification is also dependent on plant food suitable for organisms of low character. Further proof of the ferment theory is that antiseptics are fatal to nitrification. Heating sewage to boiling-point, or soil to the same temperature, effectually prevents it. Finally, nitrification can be started in boiled sewage or other sterilised liquid by the addition of a little surface soil or a few drops of a solution already nitrified. These nitrifying organisms have as yet received but little microscopical study.

On the Liquefaction of Oxygen and the Density of Liquid Hydrogen, by Prof. Dewar, F.R.S.—The problem of liquefying oxygen and hydrogen, and consequently others of the so-called permanent gases, having been solved by Cailletet and Pictet, the author has since been employed studying the physical characters of these gases in the condensed state. The critical pressures and temperatures at condensation have been determined, and the relation of one to the other is shown to be constant. The merits of various cold producers that could be employed in the process were discussed. Condensed ethylene he considered the best, then condensed nitrous oxide and carbonic acid. The lowest temperature that could be obtained by carbonic acid is about 115° C., and by nitrous oxide 125° C.

On the Production of Permanent Gas from Paraffin Oils, by

Dr. Stephen Macadam.—For the last fourteen years the author has devoted much attention to the illuminating values of different qualities of paraffin oils in various lamps, and to the production of permanent illuminating gas from paraffin oils. The earlier experiments were directed to the employment of paraffin oils as oils, and the results proved the superiority of the paraffin oils over vegetable and animal oils, especially for lighthouse service. The later trials were mainly concerned with the breaking up of the paraffin oils into permanent illuminating gas, and the results formed the basis on which paraffin oil gas has been introduced into the lighthouse service of Great Britain, both for illuminating purposes and as fuel for driving engines of foghorns. The following table shows the results of his investigations on the relative values of the crude, green, and blue oils:—

	Crude	Green	Blue
Gas per gallon in cubic feet ...	98	102	127
Candle power	50	53	54
Light value of gas from ton of oil given in lbs. of sperm candles	4494	4741	6044

On the Assimilation of Atmospheric Nitrogen by Plants, by W. O. Atwater.—It is almost a universal opinion that free nitrogen is not assimilated by plants. He referred to the classic experiments of Boussingault and Lawes, of Gilbert and Pugh, which, commonly regarded as decisive, may have been performed without consideration to certain conditions. Experiments made by the author show that at any rate certain plants grown under normal conditions do assimilate nitrogen. Peas were grown in sand which had been purified by burning and washing, and to which were applied nutritive solutions containing known quantities of nitrogen. The amount of nitrogen supplied to the plant plus the amount contained in the seed was compared after the experiment with the amount given by analysis of the plant and the residual solution. The excess of the latter amount over the former, which in some cases was excessive, represented the nitrogen acquired from the air.

Prof. Gilbert dissented from the conclusion drawn by Prof. Atwater, as he had found that, the greater the care used to prevent foreign matters accumulating on the plants under experiment, the less nitrogen was found in excess of that obtained from the seed and soil.

Prof. Frankland communicated the results of a study of the phenomena attending the discharge of accumulator-cells containing alternate plates of lead peroxide and spongy lead: (1) The energy of a charged storage-cell is delivered in two separate portions, one having an E.M.F. of 2 volts and upwards, the other an E.M.F. of 0·5 volt and under. One of these may be conveniently termed *useful*, and the other *useless*, electricity. (2) The proportion of useful electricity obtainable is greatest when the cell is discharged intermittently, and least when the discharge is continuous. (3) Neither in the intermittent nor continuous discharge at high E.M.F. is the current, through uniform resistance, augmented by rest. At low E.M.F., however, the current, after continuous discharge of the high E.M.F. portion, is greatly augmented, but only for a few minutes. This augmentation of current at low E.M.F. after rest is hardly perceptible when the high E.M.F. discharge has been taken intermittently. (4) The suddenness of fall in potential indicates two entirely distinct chemical changes, the one resulting in an E.M.F. of about 2·5 volts, the other in one of about 0·3 volt. (5) The chemical change producing low electromotive force is the first to occur in charging, and the last to take place in discharging, the cell. It is the change which occurs during what is called the "formation" of a cell, and, for economy's sake, a reversal of this change should never be allowed to take place. (6) Currents of enormous strength can be readily obtained from storage batteries coupled up in parallel, viz. a current of 25,000 amperes from only 100 cells. Such a current reduces to insignificance the output of the largest dynamo ever built. It is to be hoped that currents of this magnitude will open up new probabilities of research into the constitution of matter.

SECTION C—Geology

Plan for the Subject-Bibliography of North American Geology, by G. K. Gilbert, of the U.S. Geological Survey.—The United States Geological Survey is engaged on a Bibliography of North American Geology. The work when completed will give the title of each paper with the title-page of the containing book, and the number of plates, the whole being arranged alphabetically by authors. There is in contemplation also the simultaneous preparation of a number of more restricted bibliographies, each covering a division of geologic literature. The plan includes abbreviated titles of papers with reference to the pages on which the special subjects are treated, the entries in each bibliography being arranged alphabetically by authors. The selection of topics for treatment in this manner involves the classification of geologic science, and Mr. Gilbert submitted a tentative classification requesting the criticism of geologists.

Marginal Kames, by H. Carvill Lewis, A.M., Professor of Geology at Haverford College.—After reviewing the work on American kames, and the theories of the origin of kames, the author describes his investigations of short kames at the extreme margin of the ice-sheet along the line of the terminal moraine in Pennsylvania. These *marginal kames* run *backwards* from the edge of the ice, draining it by a sub-glacial drainage. These kames are discussed in detail, and are thought to represent sub-glacial rivers formed during the melting of the ice-sheet.

On the Geology of South Africa, by T. Rupert Jones, F.R.S., F.G.S., &c.—The contour of the south coast is parallel with the outcrop of the strata in the interior, from Oliphant's River (31° 40′ S. lat.) on the west coast, southward to the Cape, and then eastward to about 33° 30′ S. lat. Here the edges of the strata, formerly bending round to the north, have been swept away to a great extent; but their outcrop is again seen on the east coast at St. John's River (31° 40′ S. lat.), where they strike north-eastwardly through Natal, probably far up the country. (1) Gneissic rock and the Namaqualand Schists apparently underlie the others, coming out on the north west, and exposing a narrow strip on the south coast. (2) Mica Schists and Slates, interrupted by Granites here and there, form a curved maritime band, from about 30 to 70 miles broad, and are known as the Malmesbury Beds (Dunn). These and the beds next in succession (the Bokkeveld Beds, 3) are overlain unconformably by the Table-Mountain Sandstone (4), 4000 (?) feet thick, which forms patches and extensive ridges, and possibly dips over No. 3, to join No. 5, the Witteberg Beds. Nos. 3 and 5, together about 2100 feet thick, lie parallel, and form a concentric inner band. The former contains Devonian fossils; the latter is probably of Carboniferous Age (with Lepidodendron, &c.), and forms the Wittebergen and Zwartebergen in the Cape District, and the Zuurbergen in Eastern Province. The Ecca Beds (6) come next; Lower Series, 800 feet; Conglomerate Beds (Dwyka), 500 feet; Upper Series, 2700 feet; conformable with No. 5; in the south much folded, and in undulations throughout, until it passes under the next set of beds, No. 7, in some places 50 miles to the north. The Ecca Beds have fossil wood and plant remains in abundance here and there, but these have not been clearly determined. This series has not been well defined until lately, and even now its limits are not fully determined. It includes the Karoo Desert, and therefore takes in the lowest members of Bain's great Karoo Formation, Nos. 12 and 14 of his map (1856), or the Ecca, Koonap, and part of the Beaufort Beds of Jones (1867). The series No. 7, horizontal and unconformable on the Ecca Beds at the Camdeboo and elsewhere, retains the name of Karoo Sandstones: and after a width of about 40 miles is conformably surmounted by a set of somewhat similar beds (8) in the Stormberg; and thus No. 7 should be regarded as the Lower, and No. 8 the Upper, Karoo Sandstones. The latter end off northwards in the Draakensberg, Natal, Orange Free State, the Transvaal, and Zululand, with the still horizontal Cave Sandstone and associated beds. The Lower Karoo Sandstones probably thin away northwards beneath the others. Below the Karoo Sandstones, and dying out southwards near the Camdeboo (Prof. Green), are the Shales (7*), which constitute the country around Kimberley, described as the Olive Shales of the Karoo Formation by G. W. Stow. These die out northward against the old rocks of Griqualand-West and the Transvaal. They contain Glacial Conglomerates in their lowest (earliest) beds, in Griqualand-West, just as the Ecca series has its great Glacial Conglomerate (the Dwyka Conglomerate in No. 6) in its lowest portion. As the Stormberg Beds (8) lie upon the Olive or Kimberley Shales (7*) in the Orange Free State, the Lower Karoo Sandstones (7) must die out northwards. The Kimberley Shales contain some Reptilian bones and plant remains, and some coal on the Vaal; the Karoo Sandstones are rich with Dicynodont and other Reptilian bones, and have some Fish remains; and their upper portion (Stormberg) contains Ferns and Cycadeous leaves, and some seams of coal. A fossil mammal also has been found in this series. Throughout its range the

Karoo Series is traversed with igneous dykes. Limestones and Sandstones (9) with fossils of nearly pure Jurassic, but with some of Cretaceous type, occur unconformably in the Eastern Province. Their fossil Flora is like that of the Stormberg Beds. Cretaceous strata (10) are known on the Natal coast: and Tertiary and post-Tertiary deposits (11) form several patches on the east, south, and west coasts.

THE SOUTH AFRICAN FORMATIONS

11. Tertiary and Post-Tertiary, 100'?

(Unconformable on several different rocks)

10. Cretaceous

(Unconformable on Carboniferous?)

9. Jurassic — Uitenhage Formation: Trigonia Beds; Wood-bed; Saliferous Beds; Zwartkop Sandstone } 400'?; Enon Conglomerate, 300'

(Unconformable on Devonian and other old rocks in Albany)

Triassic — Karoo Beds:
- 8. Upper: Cave Sandstone, 150'; Red Beds, 600'; Stormberg Beds, 1000'
- 7. Lower: Sandstones and Shales, 5000'; 7*. Kimberley or Olive Shales and Conglomerates, 2300'

(Unconformable on Ecca Beds in the south, and on the old Vaal and Kaap series in the north)

Carboniferous?
- 6. Ecca Beds: Upper Ecca Beds, 2700'; Dwyka Conglomerate, 500'; Lower Ecca Beds, 800'
- 5. Witteberg and Zuurberg Quartzites, 1000'?
- 4. Table-Mountain Sandstone, 4000'

(Unconformable on the Old Cape Schists and Slates and on the Bokkeveld Beds)

Devonian
- 3. Bokkeveld Beds, 1100'

(Probably unconformable to the Malmesbury Beds)

Silurian?
- 2. Malmesbury Beds, Mica Schists and Slates of the Cape

(Probable unconformity)

1. Namaqualand Schists and Gneiss

SECTION G—MECHANICAL SCIENCE

On the Flow of Water through Turbines, by Arthur Rigg, President of the Society of Engineers, London.—After remarking that a strict adherence to the older accepted rules of design never produces thoroughly efficient turbines, and that in the best of such motors these rules are disobeyed, the writer pointed out how little reliable practical information can be obtained from all the voluminous literature relating to turbines. He also stated that the course of a stream flowing through the guides and buckets of a turbine had no appreciable influence upon the duty obtained, so long as one essential condition was observed—namely, that its velocity should be gradually reduced to the least that will carry it clear of the buckets. In comparing screw propellers and turbines, each were shown to possess similarities; and experiments made by the writer, and published in the *Transactions* of the Society of Engineers for 1868, were referred to as explanatory of this view of the case. It was further pointed out that there is no such thing as absolute motion, for all velocities are relative to something else; and thus in a turbine we need only concern ourselves with such diminution in velocity as occurs in relation to the earth, and not necessarily with velocities in relation to the moving buckets of a turbine. Impact was considered as a pressure due to the destruction of velocity in a direction perpendicular to a plane surface, while reaction, from a vertical stream, is the natural integration of the horizontal elements of the successive pressures which act vertically in regard to the concave surface upon which the stream is caused to flow. In most theoretical investigations it is assumed that impact and reaction are equal when a current is divided at right angles to its original course, and this condition implies that a maximum result should be obtained from screw propellers when their blades stand at 45° to the plane of rotation. But in practice an angle of 42° is found best, and this is so because impact and reaction under the conditions stated are not equal, but bear to each other the proportions of 71 to 62; and these proportions give an inclination of screw blade of 41° by taking an experiment which corresponds most closely with the conditions of a screw propeller. The resultant due to these proportions is found to be 94·25 units, whereas if impact had been the same as reaction it would have been 100·75 units, and this is the total amount that can be aimed for in designing a screw propeller, or pure impact turbine, where the stream is merely turned through a right angle from its original course. But if instead of turning the current only 90° it is turned through 180°, then impact and a still further reduced reaction both act vertically downwards; and it is their sum, and not merely their resultant, that constitutes the total pressure obtainable from a jet of water. Taking the standard unit employed in the experiments described, this sum is found to be 126, of which 71 represents impact, and the remaining 55 the effect of a complete reaction. Therefore, in designing a turbine or screw propeller, it would seem desirable to aim at changing the direction of a stream, so far as possible, into one at 180° to its original course, for it may be said that carrying out this view has placed the modern scientifically designed turbine in that pre-eminent position it now holds among all hydraulic motors.

The Severn Tunnel Railway, by T. Clarke Hawkshaw.—This paper described the Severn Tunnel Railway works, begun in 1873, and now approaching completion. The railway is being made to shorten the direct railway route between the South of England and South Wales. It passes under the River Severn about half a mile below the present steam ferry, which connects the South Wales and Bristol and New Passage lines. The river, or estuary, is about 2¼ miles wide. The length of the line is 7½ miles, of which 4½ miles are in the tunnel which passes under the Severn. The bed of the river is formed principally of Trias rocks (marls, sandstones, and conglomerates), in nearly horizontal strata. These overlie highly inclined Coal-measure shales and sandstones, which are also exposed in the river bed. The tunnel is made almost wholly in rocks of the Trias and Coal-measure formation, the exception being a little gravel passed through near the English end. The lowest part of the line is below the shoots, the deepest part of the river, where there is a depth of 60 feet of water at the time of low water, and 100 feet at the time of high water. Below the shoots, the line is level for 13 chains, rising 1 in 100 to the English end, and 1 in 90 to the Welsh end. Below the shoots, there is a thickness of 45 feet of rock (Pennant sandstone) over the brickwork of the tunnel. Under the Salmon Pool there is less cover, only 30 feet of Trias marl. Much water has been met with throughout the works, which have been flooded on several occasions. In 1879 the works under the Severn were drowned for some months by the eruption of a large land spring into one of the driftways under land on the Welsh side of the river. On another occasion a cavity was formed from the driftway under the Salmon Pool to the bed of the river, when a hole, 16 feet by 10 feet, was found in the marl. The works were flooded by the water which found an entry through this hole. It was filled with clay, and the tunnel is now finished beneath it. The quantity of water now being pumped is about 19,000 gallons per minute. Additional pumps have been erected, as the large land spring, which has been penned back by a brick wall, still remains to be dealt with. When all the pumps are available, the total power will be equal to 41,000 gallons a minute. The tunnel is for a double line of way, and will be lined throughout with vitrified bricks set in Portland cement mortar. It is being made by the Great Western Railway Company. Sir John Hawkshaw is engineer-in-chief; Mr. C. Richardson, engineer; and Mr. T. A. Walker, the contractor.

SECTION H—ANTHROPOLOGY

THE first paper read in this Section was that of Prof. Boyd Dawkins, *On the Range of the Eskimo in Time and Space*. In his introductory sentences Prof. Dawkins remarked on the importance and interest of his subject. He began his inquiry into the condition of the Eskimo by particularising those of Greenland. By the aid of a sketch-map upon the blackboard, he traced the progress of the dwellers on the Arctic shores, following them to the continent of Asia. He noted that in the

vast region which is occupied by the Eskimo the degree of civilisation is practically the same, that civilisation being of a rude nature. Speaking of their relations to other nations, the Professor remarked on the broad belt of enmity, a debatable ground, that exists between the Eskimo and the Red Indian, between whom there is no friendship. But, he said, there is a likeness between the tongues of the two races, though this does not by any means prove any affinity between them. Coming to the question of the date of the settlement of the Eskimo in Greenland, he said that Markham's assumption that they crossed by Behring Straits from Asia, being driven forth by Tartar hordes, was purely assumption, and that this opinion was not shared by Mr. Dall or himself. He held that there was proof that the Eskimo, in the year 1000, ranged farther southward than where we are now. There was reason to believe this, he said, by archæological proofs, and he maintained that the Eskimo were a retreating race, being continually driven farther north by stronger and more powerful tribes, such as the Red Indians, and that if the Arctic regions had been less inclement (this being safety to this people), before this time the Eskimo would have been exterminated by the Red Indians. Even in Asia, he said, these were a retreating race, pushed farther to north and east by pursuing tribes. The lecturer remarked on the word "kayak" or boat, used by the Eskimo, and its likeness to the word (caique) used for the same object by the Turkish people, and quoted his friend Dr. Isaac Taylor, who had traced the history of this word. He explained the etymology of this word in an interesting manner, and caused a little laughter by remarking that the boat was used by the Eskimo to carry their "wives, children, and other chattels." He said, in concluding the first portion of his inquiry, that, from proofs established, the Eskimo formerly lived in a wide range of country far more south than their present habitation, and that they were driven to the north by more powerful nations. Speaking of the range of the Eskimo in time, Prof. Dawkins made some very interesting remarks on the habits and implements of the cave-dwellers in Europe. Illustrating the artistic power of these dwellers, the lecturer pointed out an enlarged sketch of a reindeer, drawn on bone, and found in a cave in Switzerland. This sketch, he said, was perfectly natural, and was admirably done by the skin-clad artist whom he pictured. He also showed the picture of an elephant, with trunk uplifted, and mouth opened, found in a cave in Auvergne. The habits of life of these cave-dwellers in Europe, he said, were the same as those of the Eskimo, and those only of the Eskimo; their implements were the same, and he would connect them in many ways, such as neglect of the rites of sepulture, for instance. The cave-dwellers, he maintained, were in every respect similar to the Eskimo, and this bore out his theory that the latter people are a retreating race in Europe, and once lived far southward of their present range. With regard to the time at which these cave-dwellers existed, and when the Eskimo came into America, the Professor said that the former dwelt in Europe in what is known as the "Pliocene" period. He said that in his opinion the Eskimo represented as a race the ancient cave-dwellers of Europe, and as such he regarded them with interest and respect. He thought that the difficulty of the question of migration was partly disposed of by the fact that the water of Behring Straits was extremely shallow, and in concluding a most interesting address, he recapitulated the proofs that he had brought forward in order to support his assertions.

Mr. F. W. Putnam, Curator of the Peabody Museum of American Archæology and Ethnology at Harvard University, gave a short notice of *The Recent Explorations by Dr. C. L. Metz and himself in the Little Nicàmi Valley, Ohio.* The particular mounds to the singular structure of which Mr. Putnam confined his remarks he has called the Turner group. The mounds, out of one of which he had taken seventy-three skeletons, were burial mounds of the ancient Indians, and some seem to have been erected for an entirely different purpose. By means of rough sketches, Mr. Putnam illustrated the formation of these mounds. One of these seemed, from the fact that everything in it had been burnt, to be erected for a sacrificial purpose. A mass of a peculiar substance, like ashes, but which was not ashes, was found in the mound. What this substance was the lecturer did not know, but it was now being analysed by chemists. He described in detail the interior of the mounds which had been explored, noticing the covered pits which were found in them, some of these containing ashes and animal bones. A mixture of iron and gravel, forming a solid cement, was a curious feature in the mound, as the presence of the iron could not be accounted for. He said that previous explorations of the mounds had been very superficial, and had led to misrepresentation on the subject, but he had found that the removal of every inch of earth was necessary in order thoroughly to explore them, and this was done. In one mound two complete skeletons were found, in the midst of ashes. Round these were fragments of three other skeletons, and sixteen skulls, six of these latter having holes bored in them, evidently with stone drills. Scratches on the skulls showed how the flesh had been scraped away with a stone knife, and the skulls had evidently been placed round the skeletons for the purpose of ornament. Mr. Putnam said that in many respects these mounds were totally different from any that had yet been discovered and explored in this country. He showed photographs to illustrate his subject, amongst them being a remarkable specimen of art in the shape of a representation of a human face cut out of a sheet of mica. This, he said, would favourably compare with Dr. Dawkins' sketch of an elephant's head drawn by a cave-dweller of Europe. The speaker also noticed many other artistic objects, such as bracelets of copper covered with native silver, and peculiar and large earrings of the same material. In other cases he had found objects covered with native meteoric iron and with native gold; also terra-cotta images of small size, most of them much broken by the action of the fire into which they had been thrown. He remarked upon the likeness in many respects that the ornamentation of these objects bore to the work of the Egyptians.

A paper by Dr. Paul Topinard was read, entitled *Instructions anthropométriques élémentaire.* The author described various instruments that had been devised by him for enabling inexperienced travellers to take measurements of the human body with moderate accuracy.

Mr. Jeremiah Curtin read a paper *On Myths of the Modoc Indians.* He said that there were between three and four hundred Modocs, most of whom were in the Indian Territory and Southern Oregon. He proceeded to read a "myth" of these people which related to a personage called the Blue Woman, who was supposed by the Indians to be the second person in the Universe. This story, which was something like a fairy tale, was taken down in the original language by the speaker himself. He described the hardships through which the young Modocs went in order to fit themselves for manhood, such as climbing a mountain in order to reach an almost inaccessible pond, in which they swam.

SCIENTIFIC SERIALS

Journal of the Russian Chemical and Physical Society, vol. xvi. fasc. 6.—On the succession of reactions, by M. Lvoff, being an introduction into a series of researches undertaken by the author and several students, in order to disclose the mechanism of polymerisation.—On the action of chlorine on butylenes, by M. Chechoukoff.—On constants of chemical affinity, by W. Ostwald. The author, who maintains the views of Berthollet, further elaborated by Guldberg and Waage, considers that there is, for each body, a certain numerical coefficient of its chemical affinities as characteristic for the body as its atomic weight; and in addition to his former works, already published in the *Journal für pract. Chemie*, he publishes now a preliminary list of "constants of chemical reactions."—On glycidic acids, by P. Melikoff.—On the displacement of chlorine by bromine, and an explanation of the reactions which are accompanied by a disengagement of heat, by A. Potylitzin. The substitution of chlorine by bromine, in seeming contradiction with the law of maximum work, and which Berthelot has endeavoured to explain by the formation of chloric bromine and bromides of metals, could be explained by admitting that the reaction is going on with the heat received from the surrounding medium. This important inquiry, pursued by the author for several years past, brings him to interesting conclusions on thermo-chemistry.—On asarone, by MM. Rizza and A. Butleroff, being an inquiry into the properties of the camphor received from *Asarum europæum.*—On a new apparatus for determining specific heat, by W. Loughinin. It is a modification of the apparatus of Neumann.—On the reduction of isodinitrobenzyl, by P. Goloubeff.—On the preparation of animal colouring matters from albuminoid substances, by W. Mikhailoff.—On azophenylacetic acid, note by M. Wittenberg.—On the solution of lithium carbonate in water, note by J. Bevad.—On a hygienic photometer for schools, by Prof.

Petroushevky. It allows the amount of light received by books, paper, &c., on the desks of scholars, to be rapidly and accurately measured.—On the volume of a liquid considered as a function of temperature under a constant pressure, by K. Jouk. Diethylamine and ethyl chloride both agree with Prof. Avenarius's formula: $v = a + b \log (\tau - t)$.—On the relation between pressure and the density of rarefied gases; preliminary communication by K. Kraevitch.—Notes on the structure of the atmosphere, by MM. Stankevitch and Rogovsky.

Annalen der Physik und Chemie, No. 7, June 15.—On the electric discharge in gases, by O. Lehmann (2 sheets of figures).—Contribution to the investigation of the origin of thermo-electric streams in a continuous homogeneous conductor, by Rudolph Overbeck (10 figures).—On the changes which the molecular structure of iron undergoes by heating and cooling, by Carl Frounne (2 tables).—On the appearance of electricity with the development of gases, by W. Hankel.—On a constant battery for electrical measurements, by W. von Beetz.—On the position of the pole, the induction and temperature coefficient of a magnet, and on the determination of the magnetic moment by bifilar suspension, by F. Kohlrausch.—On the dispersive power of a diamond, by A. Schrauf.—Researches on radiant heat, by Heinr. Schneebeli.—On the construction of Bohnenberger's reversible pendulum for the determination of the length of a pendulum for observing the period of oscillation in relation to a given length of mass, by Wilhelm Weber.—On the equilibriums of floating elastic plates, by H. Hertz.—The electricity of flame; reply by J. Kollert.—On a new position for the measuring wire in the Wheatstone-Kirchoff bridge combination, by Hugo Meyer (2 figures).—Wheatstone's rheostat and mercury contact, by J. Bodynski (2 figures).

Journal de Physique théorique et appliquée, July.—On the analytical expression of absolute temperature and Carnot's function, by G. Lippmann.—On the electro-chemical equivalent of silver, by M. Mascart.—On the phenomenon of crystalline overheating of sulphur and the rapidity of transformation of octahedral to prismatic sulphur, by D. Gernez.—Study of the distribution of potential in conductors of two or three dimensions traversed by continuous currents, by A. Chervet.—On an electrostatic standard of potential, by Messrs. Crova and Garbe.—On the variation of the capillary constant at water-ether and water-carbon bisulphide surfaces under the action of an electromotive force, by M. Kronchkoll and Lord Rayleigh.—On the electro-chemical equivalent of silver, and on the absolute electromotive force of Clark cells, by B. C. Damien.

SOCIETIES AND ACADEMIES

PARIS

Academy of Sciences, September 22.—M. Rolland, President, in the chair.—On algebraic equations: part third, on irrational equations, by M. de Jonquières. The author arrives at the somewhat unexpected conclusion that all algebraic equations, whether rational or not, which belong to the same "species," possess the same maximum number of real roots, whatever be their respective degrees.—Observations on the corona now visible round the sun; variations in its form and colour; a method of increasing its luminosity; polariscopic observations; polarimetric and photometric observations, by M. A. Cornu. The author is still disposed to connect this phenomenon with the Krakatoa eruption. The facts adduced are regarded as numerous enough to support the natural hypothesis of a cloud of particles with a nearly constant mean diameter, projected by the volcano and held in suspension in the higher regions of the atmosphere.—On the general evolution of the vegetable functions in annual plants: the Amaranthaceæ, by MM. Berthelot and André.—On the movement of Hyperion, by Prof. S. Newcomb. The author concludes that all the conjunctions of Hyperion with Titan take place near the aposaturn of the latter satellite. The point of conjunction oscillates about 180° on either side of the aposaturn during the period of revolution of the perisaturn of Hyperion in relation to that of Titan.—On the completion of the new method for resolving the most general linear equation into quaternions, by Prof. Sylvester.—Remarks on the third instalment of the new topographical map of Algeria presented to the Academy by Col. Perrier. This section consists of six sheets, comprising Miliana (province of Algiers), Saint Denis-du-Sig (province of Oran), Herbillon, Cap-de-Fer, Cap-de-Garde, Bugeaud (province of Constantine). The surveys are executed on a scale of 1 : 40,000, and the map, engraved on zinc, is issued at the scale of 1 : 50,000. Each sheet comprises seven plates, the relief being figured geometrically by equidistant curves of 10 m. in 10 m., and the plastic disposition of the surface being obtained by means of a dubbed drawing with lithographic crayon, based on the zenithal light and heightened by a slight touch of oblique light. The map marks a great improvement in the cartographic art.—On a development in a continuous fraction, by M. Stieltjes.—Note on the antiseptic properties of the sulphuret of carbon, by M. Ckiandi-Bey. From numerous experiments carried on for several years, the author finds that this sulphuret, which is soluble in water, arrests all fermentation, kills all microbes, is a most powerful antiseptic, and is, moreover, endowed with considerable penetrative power. Hence he strongly recommends it as a most efficacious remedy for cholera, typhus, diptheria, phthisis, and all diseases traceable to living germs.—Contributions to the study of the Cretaceous flora of the west of France, by M. L. Crié.—The Perpetual Secretary announced to the Academy that the International Committee of Weights and Measures representing the high contracting parties to the Convention for the Metre signed at Paris on May 20, 1875, has received the adhesion of England, which had hitherto taken no part in the Convention. With the further accession of Roumania and Servia the Committee now represents an aggregate population of 421,440,396, distributed over Germany, England, Austria, Hungary, Belgium, the Argentine Republic, Denmark, Spain, the United States, France, Italy, Peru, Portugal, Roumania, Russia, Servia, Sweden, Norway, Switzerland, Turkey, and Venezuela.—The photolithographic facsimile of a letter addressed by Gauss to Olbers on September 5, 1805, was presented to the Academy by Prince Boncompagni.

CONTENTS

	PAGE
The "Challenger" Reports	533
The English Flower Garden	534
Our Book Shelf:—	
Kerry-Nicholls's "King Country; or, Explorations in New Zealand"	535
Brown's "Forests and Forestry of Northern Russia and Lands beyond"	535
Letters to the Editor:—	
M. Thollon's Views of "Great B" in the Solar Spectrum.—Prof. C. Piazzi-Smyth	535
Shifting of the Earth's Axis.—W. H. M. Christie, F.R.S.	536
The Sky-Glows.—Prof. A. S. Herschel; Miss T. M. Browne	536
September Stream of Krakatoa Smoke at Strong's Island.—S. E. Bishop	537
Biology *v.* Botany.—Rev. George Henslow	537
Animal Intelligence.—R. J. Harvey Gibson; Thomas Harrison	538
Meteors.—Consul E. L. Layard	538
The Milleporidæ.—John J. Quelch	539
To Find the Cube of any Number by Construction.—R. Tucker	539
The Failure of the Parsley Crop.—W. H. C. B.	539
Wasps as Fly Killers.—George Lawson	539
George Bentham	539
A Model Lens for Use in Class Demonstrations. By John B. Haycraft. (*Illustrated*)	543
The Electrical Exhibition at Philadelphia	543
A New Application of India-rubber. (*Illustrated*)	544
Notes	545
Our Astronomical Column:—	
Comet 1884 *b* (Barnard, July 16)	547
Comet 1884 *c*	548
The Lunar Eclipse on October 4	548
Hydroxylamine and the Assimilation of Nitrogen by Plants	548
The British Association:—	
Reports	548
Section B—Chemistry	549
Section C—Geology	553
Section G—Mechanical Science	554
Section H—Anthropology	554
Scientific Serials	555
Societies and Academies	556

THURSDAY, OCTOBER 9, 1884

THE CHOLERA POISON

THE reporter of the French Commission appointed to investigate the mode of action of the cholera poison and its method of propagation, as judged of from the behaviour of the disease during the epidemic in the southern provinces of France, has made public the conclusions which have been arrived at. It will be remembered that the French Commission which studied the same subject in Egypt last summer differed from the German one in regarding the blood as containing the specific organism of the disease, a contention which found no support in this country when the medical societies had had an opportunity of examining microscopically the preparations which were supposed to afford proof of it. Dr. Koch, chief of the German Commission, on the contrary, declared that the French statement was due to an error of observation, and maintained that the comma bacillus which he had discovered in the coats and contents of the intestines formed the specific germ of the disease. The French Commission of 1884 now return to the subject by still maintaining that the blood contains the poison, and that the initial lesion of cholera takes place in the blood. In proof of this they describe the changes which the blood cells undergo during the process of cholera; they regard certain modifications, such as result from the entire loss of elasticity of the globules, as one of the most certain signs of the patient's impending death; they maintain that by the hourly examination of the blood of cholera patients the progress of the malady can be mathematically followed; they assert that cholera, as such, is transmissible to the rabbit as the result of the injection into its veins of the blood of a cholera patient at the algid period; and lastly, they maintain that the microbe specially described by Dr. Koch has no such specific properties as have been claimed for it.

So far the two sets of observations are diametrically opposed to each other, and neither of them finds much support from the investigations of Drs. Lewis and Cunningham in India. The French contention that cholera is transmissible to one of the lower animals is at variance with all previous trustworthy experiments, and until the details of the method of operating and of the symptoms induced are made public, it would be premature to accept the conclusion at which the Commission have arrived at as in any way proven. But, on the other hand, time is not lending support to the contention of the German Commission, and it is asserted that the early labours of Dr. Klein in Calcutta have confirmed the view which he has all along held, that the announcement of the discovery of a specific cholera organism in the comma microbe is, at least, premature. Fortunately, many observers are now at work in the field of cholera micro-pathology, and the opportunities which have been, and still are, afforded for such work both in Europe and in India are exceptionally favourable. The interests of science will be best observed by waiting for the results of the labours now in progress, and by the exercise of caution in accepting any views which are based on any isolated series of experiments. But whatever be the result, Dr. Koch and the German Commission must be regarded as having given fresh life to a scientific question the interest in which had for some time past been flagging, and to them must be given the credit of having secured in Dr. Klein's work at Calcutta the establishment of an English laboratory for the elucidation of a subject which this country should always regard as peculiarly its own, in view of the fact that among its possessions is the country which has always been regarded as the home of cholera.

THE SANITARY INSTITUTE AT DUBLIN

THE Sanitary Institute of Great Britain succeeds, by its annual migrations from town to town, in securing a widely-diffused interest in matters relating to public health, and there are but few large towns in the United Kingdom that stand in greater need of some such stimulus than Dublin, where, under the presidency of the veteran sanitary engineer, Sir Robert Rawlinson, C.B., the Institute has met this autumn. Within the past twelve years we have made great strides in organising a sanitary administration in this country, every portion of which is subject to the control of a sanitary authority having at least two executive officers—the medical officer of health, who is intended to be a skilled adviser as to the principles which should be held in view in action taken for the promotion of health; and an inspector of nuisances, whose functions relate in the main to the periodic inspection of his district with a view of the removal of such conditions as are likely to cause injury to health, or nuisance. In Ireland a somewhat similar organisation has also been established, and, as in this country, the working of the system is subject to the control of a central body known as the Local Government Board. But to judge from a paper read before the Institute by Dr. Edgar Finn, there is a wide difference between the efficiency of the two systems, and it is certain that, whether judged by the progress that has actually been made or by the amount of money that has been raised by way of loan for the execution of sanitary works in England and in Ireland, the latter country must be regarded as comparing very unfavourably with the former.

According to Dr. Edgar Finn, this is partly due to the fact that the Irish Local Government Board is in itself unmindful of using the ordinary means at its disposal for enforcing the proper carrying out of the provisions of the Act under which it is constituted, partly to the circumstance that in the large mass of the sanitary districts the Boards of Guardians who have been constituted the sanitary authorities take but little interest in their sanitary duties, but mainly to the faults inherent to the system under which the medical officers of health are appointed in the rural districts. In Ireland the dispensary or poor-law medical officers are appointed to act as rural medical officers of health, and Dr. Finn points out that the miserable addition of from 10*l.* to 15*l.* to their other salaries does little more than suffice to induce them to hold their tongues, and to take no official notice of the conditions of dirt and unwholesomeness with which they come into contact. And not only so, but it is alleged that such officers cannot possibly be unfettered and independent in their action, for they are generally the medical attendants of the Guardians whom they serve, and who

are probably in most cases the owners of the properties needing sanitary amendment. In England, on the contrary, Dr. Finn points to the frequency with which rural sanitary authorities combine amongst themselves, and at times also with urban authorities, in the appointment of a single officer of health, to whom it is then possible to give such a salary as will command the entire services of a really competent and independent officer. The contention is true to a certain extent, but it must be remembered that the same system which Dr. Finn describes as faulty in Ireland is precisely the one which the poor-law inspectors, to whom the English Local Government Board originally looked for advice in this matter, secured throughout a very large portion of England when first the appointment of medical officers of health became compulsory in 1872, although it is true that the same Board has during the past five or six years been striving its utmost to undo the arrangement then carried into effect. It was originally felt that a local officer whose other duties necessitated his constant presence in every portion of his district would be the most competent of all to advise as to its sanitary circumstances, the more so as he, of all others, would have the earliest information as to the existence of preventable sickness and death. At first sight the idea seems a very plausible one, and if the principal duties of an officer of health were to be performed on the occurrence of disease, it might still find intelligent supporters. But it is essentially the prevention of the conditions leading to such diseases, and not their remedy after the disease has occurred, that should be looked for from the officer of health, and it is daily becoming more and more apparent that wider districts, supplying wider experience and commanding more skilled services, tend to this, rather than narrow areas which are only looked after during the performance of multitudinous duties of a more pressing character. It is not that the dispensary or poor-law medical officer is necessarily incompetent to perform the duties expected of an officer of health, for in England such officers at times hold both appointments with considerable advantage; but the great mistake which was originally made in England, and which has been repeated in Ireland, was to regard men as competent to perform the duties of one office merely because they held another office involving the performance of totally different duties.

The present is, however, a period of transition in this matter, and the public cannot expect to secure the highest procurable services until degrees and diplomas in sanitary science shall be so universally taken by those who seek public health appointments, that it shall always be possible to find candidates possessing the needful guarantee that they are competent to perform the duties of medical officer of health. The principle of combination by several authorities to secure the entire services of a single officer of health over a reasonably large area tends to efficiency, and most of such officers recently appointed have been able to prove their fitness for the post by the possession of some such diploma as we have referred to, and which can now be procured in each of the three divisions of the United Kingdom.

We have given this matter some prominence because of the importance which attaches to it wherever medical officers of health are appointed, but the Institute dealt at Dublin with many other subjects which are of equally pressing importance in Ireland. The need for improved dwellings for the poor, for adequate supplies of wholesome water, for efficient means of drainage, and for some proper methods for the disposal of refuse, are urgent requirements in many parts of Ireland. The lack of them causes needless mortality and sickness, and the methods by which they may best be supplied were fully indicated. As a test of the needs of the country in these respects, statistics as to deaths and sickness need to be intelligently examined, and amongst the contributions to the Congress few papers were of more value than that in which Dr. Grimshaw, Registrar-General for Ireland, dealt with the statistical measures of the health of communities, and so explained how a proper estimate of the health of a district may best be arrived at.

CONTRIBUTIONS TO PHENOLOGY

Beiträge zur Phänologie. By Dr. Egon Ihne and Dr. Hoffmann. (Giessen: Published by the Authors, 1884.)

PHENOLOGY, the observation of the first flowering and fruiting of plants, the foliation and defoliation of trees, the arrival, nesting, and departure of birds, and such like, has attracted the attention of naturalists from time to time for nearly 150 years. Some have continued their observations for several years and have formed therefrom a "Calendar of Nature"; others have gone still further and have tried to deduce more general results. But the subject is beset with difficulties, especially when an observer endeavours to procure the aid of others, and this has proved so great at times that the work has not flourished as much as it deserved. The subject has been most carefully studied by M. Quetelet of Brussels, and his writings have served as the basis for most of the subsequent attempts which have been made at organising a System of observation. Dr. Egon Ihne of Giessen, in connection with Dr. Hoffmann, whilst endeavouring to form a series of Charts of plant-flowering for Europe generally, has consulted all accessible works likely to contain any information on the subject. This information is most generally scattered through the Transactions and Reports of Botanical and Local Societies, but still there is much to be obtained from other works, whose titles would not lead one at first to consult them for the purpose. The number and minuteness of the notices mentioned by these Professors, shows that they must have spent a long time in preparing this work, and very valuable service has been rendered to Phenology by publishing the list of sources from which information can be obtained. The total number of works noticed is 196, and naturally those published in Germany are most numerous. It will, however, surprise many to find that, whilst 102 German works are noticed, Great Britain with only 21 comes next, leaving 73 for the rest of Europe. It must be evident, therefore, that, notwithstanding the great care taken in compiling this list, there must be many works not noticed which contain phenological information, and the Authors would doubtless welcome notices of any works omitted from their list.

The main part of the book consists of a short account of the progress of Phenology in each of the countries of Europe, followed by a list of the works published in that country, with such short notes as may suffice to explain the nature of the information each contains. To this is

added a very complete index in two parts. The first part gives a list of the stations at which observations have been made, arranged alphabetically under the names of the countries of Europe in which they are situated; the total number of such stations is 1926. The second part consists of the names of these 1926 stations arranged alphabetically, with the years in which observations have been taken, and references to the works in which these observations are recorded. Some very curious facts may be obtained from this index. Whilst there are 315 stations in Great Britain, there are no less than 918 in Germany and Austria, and consequently 693 for the rest of Europe. But a more critical examination of the list reveals the fact that, of these 1926 stations, only 334 were taking observations in 1882, the date of the compilation of the work, and at only 97 of these 334 stations had observations been continued for ten years or more. Even this small number requires modification, for out of the 97 only 60 had observations for ten *consecutive* years, thus showing how spasmodically the subject had been treated till quite a recent date. Of the 1592 stations at which observations have ceased, there are only 210 with records of ten years and over. Considering the nature of the subject, ten years' work must be considered as the very least from which anything reliable may be deduced; whence, small as the number is compared with the large number of stations at which phenological work has been done, it is yet satisfactory to find that there is some good material to be obtained. Of late years the subject has been much more attended to, especially in England, since the Royal Meteorological Society took the matter in hand, and of the 334 stations at which observations are now taken, no less than 94 are in Great Britain and 112 in Germany.

Dr. Ihne regrets that the observations as taken for the Royal Meteorological Society refer to herbaceous rather than woody plants, and are exclusively confined to wild flowers and not to cultivated ones. His own list, which has been very generally distributed throughout Europe, has been drawn up on a different principle, and without entering into definite reasons, he condemns the Meteorological Society's list. Certainly in England, in the only case besides that of the Meteorological Society where a comparison of flowering throughout England has been tried, cultivated plants have been entirely excluded, being found by actual experience to yield no reliable results.

The second part of the work is taken up with an enumeration of the notices on the plants in the list issued by the Professors taken during the years 1879 to 1882. It would have been perhaps more convenient if they had been exhibited in a tabular form; at present it would be a work of some labour to extract the notices for the purposes of comparison.

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 Younger School of Botanists

A COMMUNICATION from the Rev. George Henslow to last week's NATURE (p. 537) concludes with the following passage:—

"There are not wanting signs elsewhere of the evil effects of the younger school of botanists not recognising the importance of first training students in a thorough course of practical and systematic botany before proceeding to laboratory work. In an examination lately held for a post at Kew, I am informed that two gentlemen who had been trained at Cambridge competed with a gardener for the post. The gardener secured it. *Verb. sap.*"

The last sentence is no doubt intended as a sort of *argumentum ad hominem*, which it may be admitted is not without a certain apparent force. Assuming for the moment the statement to be true, it must be pointed out that the only scientific posts at Kew which are open to public competition are those of assistants in the herbarium. These posts demand qualifications of a somewhat technical character, for which a general training in botany would by no means necessarily fit the candidates. I can imagine that a senior wrangler might fail in a competition for a post of computer in an observatory where arithmetical dexterity was the main thing required; a senior classic might cut an equally poor figure in seeking an appointment of library assistant if he were tested in the art of writing catalogue slips. I apprehend that in neither case would failure prove anything as regards either mathematical or classical education.

The examination to which Mr. Henslow alludes can only be one which was held by the Civil Service Commission during the past summer. There were, I believe, some dozen candidates; whether any Cambridge men were amongst them I am unable to say. But the successful candidate was not a gardener, but the laboratory assistant of the late Professor of Botany at Oxford—a gentlemen whose services the present Professor is in despair at losing.

On a former occasion it is true that one of our garden staff did obtain one of these appointments in an open competition. It is not very remarkable that it should be so. Men of ability on the spot have, of course, great facilities for seeing the nature of the duties required and for qualifying themselves accordingly; furthermore they have the advantage of the lectures of my colleague Mr. Baker, which are especially directed to the branch of botany which principally occupies us at Kew.

As to the larger question raised by Mr. Henslow, I am afraid I am not wholly free from some responsibility for the proceedings of "the younger school of botanists," the effects of which he regards as evil. In the face of the successful revival in this country of many branches of botanical study which the younger school has effected, I am emphatically of the opinion that these effects are the reverse of evil. I believe I was one of the first to organise a course of so-called laboratory work in botany on lines which it is only right to say were borrowed and extended from the teaching and example of Prof. Huxley. In what I attempted I had the generous aid of many now distinguished members of the younger school. I do not doubt that they have immensely improved on the beginning that was in the first instance somewhat tentatively made. But the principle, I believe, has always remained the same, namely, to give the students a thorough and practical insight into the organisation and structure of the leading types of the vegetable kingdom. When, therefore, Mr. Henslow, himself a teacher, asserts that such laboratory teaching as this should be preceded by a thorough course of practical and systematic botany, it appears to me that he is bound to explain what he precisely means by this very dark saying. For, if botanical laboratory work in this country is not thorough, is not practical, and, in dealing with types drawn from every important group, is not systematic, it is important to know in what respects it falls short of these requirements.

W. T. THISELTON DYER

Royal Gardens, Kew, October 4

The Solar (Dust?) Halo

THE reddish halo to which Mr. Backhouse draws attention in his letter of September 20 in NATURE (p. 511) has of late been noticed by several observers, and this I think is because, while the sunrise and sunset glows have exhibited a marked decline in their duration and brilliancy since last winter, the halo has shown no similar diminution of intensity, and thus attracts more attention relatively than it did at first, when it remained for some time almost entirely unnoticed in this country. In reply to Mr. Backhouse's question as to whether this halo has been seen in England previous to last November, I have a very strong impression that it made its first appearance here coincidently with

the arrival of the unusual sunsets last year, and that it has never been seen here before, at any rate within the last twenty years. This impression is founded, first, on the fact that, like Mr. Backhouse, I have been in the habit of frequently looking at solar halos for years past. Secondly, I have been engaged since September 8 last year in a series of observations with anemometers attached to a kite-string (latterly wire), which has naturally necessitated my frequently looking up at the sky. I remember noticing the halo in November, and calling the attention of my assistant to the beautiful salmon colour it showed in the interstices of a mackerel sky, which shut off the direct glare of the sun.

On several occasions I measured its radius with a theodolite I was using, and in every case the value came out either 22½° or 23°. It must therefore be due, like the ordinary ice-halo, to refraction through hexagonal prisms. I noticed it all the way going out to America in August last, and saw it beautifully when standing on the Terrapin Bridge over Niagara Falls on August 23. A large black cloud had shut off the sun's glare, and the red border happened just to coincide with the edge of the cloud. I called the attention of some American ladies to the spectacle, which they had of course never noticed before, and which they admired immensely. I regard the sunset glows as partly an intensification of the halo, produced by the greater thickness of the stratum through which the refraction takes place when the sun is below the horizon (the sunset, in fact, being formed of the upper half of the halo which lingers behind) plus reflection from the same stratum, which can of course only come into operation when the sun shines obliquely on it. The fact of the halo remaining constant while the sunset glows have become weaker may be readily explained on the hypothesis that the stratum has gradually sunk to a lower level than it had last winter, since the duration and even brilliancy of the glow must of course vary directly with its height, whereas the halo at midday need not be sensibly altered by a variation in its level.

Three weeks ago yesterday, I saw the sun rise from the summit of Mount Washington, 6293 feet above sea-level, and at ten minutes to five o'clock saw, in addition to the usual sunrise effects, a large circle of rosy purple haze situated about 15° above the horizon, and apparently having no connection with the yellow and red horizontal bands beneath it. The morning was exquisitely fine, the only clouds being a few light streaky cirro-strati, as shown in diagram, and the air was as clear as it only can be in America. I may add that the haze circle appeared almost suddenly after the first yellowish light had been visible for twenty minutes, and as soon as the sun rose above the horizon it seemed to vanish almost entirely. I have seen the sun rise from various altitudes up to 12,000 feet, but I never saw anything so curious as this sunrise before. In fact, I went up mainly to see it, and was not disappointed.

E. Douglas Archibald

Tunbridge Wells, September 27

Cole's Pits

Your note on the result of Gen. Pitt-Rivers' examination of the Pen Pits (Somerset) in this week's number of Nature (p. 545) reminds me of a series of similar pits in this county of Berks, known as "Cole's Pits." They are situated near the branch of the Great Western Railway which runs from Uppington to Faringdon. I have visited them more than once when on visits to Wadley, the residence of my friend Mr. T. L. Goodlake, J.P. They correspond generally with the description given in Nature of the Pen Pits, are probably of quite equal extent, are similarly situated on rising ground forming the cap of a ridge of hills, and are on the same Greensand formation. Many and various theories have been propounded from time to time by antiquarians, and of course the name by which these pits have been known for generations has been appealed to as connecting them with the "merry King Cole," and giving support to the views of those who regard them as traces of an "ancient British town." The utter absence of order in the arrangement of these shallow holes and rude mounds (for they are nothing more) excited my suspicion, nor could I see much in them to suggest occupation by any race which has inhabited these islands even so late as the time of the ancient Britons. On further investigation of them I came across a more modern sort of hut, consisting of a space rudely roofed over, the back of which was cut into the side of one of these grass-grown banks. The idea occurred to me that this would help to furnish evidence, since, if these hollows were dug in the strata of the hill to be roofed over for human habitation (the notion which, I am told, finds general favour) we ought to find some traces of *stratification* in a section thus presented to us. Not a trace of this was to be found; the section showed nothing but a chaotic mass of rubbly material with no more order in its arrangement than is to be found in the waste heaps of any old quarry or in a terminal moraine.

So far one's first impressions of the "pits" and mounds, as of an extensive series of old disused quarries, received confirmation. I cannot hazard a conjecture as to the extent to which querns-stones may have been obtained from the "Cole's Pits"; but it seemed to me extremely likely that the range of hills in question, here so many hills on sandy formations (our Bagshot Sands, for example) owed its existence, *quâ* hills, to the protection of the hard "paw" which is so frequently met with in such formations, which I have attempted to account for in the *Proceedings* of the Geological Association (vol. viii. No. 3), and which was certainly largely worked in places for rude building construction in very early times, large masses of it being seen still in the old Roman wall which to-day completely encircles the area occupied by the ancient town of Silchester. It is possible, too, that such ironstone may have been rich enough in the metal to serve as ore, when iron "forges" were common in past centuries in the forest districts of the south of England. Further support is given to the view which I venture here to put forward as to the origin of the Cole's Pits, by the fact that lower down the hill, and at a rather lower "horizon," there is a sand-pit open in the side of the hill, in which thin bands of ironstone occur, some of which, to judge from their specific gravity, might certainly have been available as ore, under conditions which obtained in the iron industries of the country a few centuries ago. A. Irving

Wellington College, October 3

The Flow of Streams

The observations made by Mr. Maw on a stream flowing into the Lake of Thun are an extremely interesting example of well-known hydraulic laws. It would be well, however, if he would tell us what was the depth of the water; from the observed phenomena I presume it was small. Mr. Smith's very ingenious mode of practically showing the different strengths of a current from surface to bottom should also be supplemented by an account of the size of the stream operated upon. The situation of the point of greatest velocity varies considerably with the conditions of the river or stream, and is by no means fixed. The observations made on some large rivers, notably those by Mr. Revy on the large rivers of South America, seem to show that the greatest velocity is, in such cases, almost, if not quite, on the surface, and that from that point it diminishes uniformly downwards to the bottom. The ratio between the surface and bottom velocities is, however, a constantly changing one, and in large rivers varies with the depth of the water. Mr. Revy's observations seem to show that in large rivers, where the influence of the banks is practically inappreciable, the surface velocity varies directly as the depth, whilst the bottom velocity varies as the square of the depth; as the depth increases, the difference between the top and bottom currents diminishes, until at a depth of about 71 feet they are practically equal. These results are borne out by the observations of Messrs. Humphreys and Abbott on the Mississippi and Mr. Gordon on the Irrawaddy. All observations to be useful, therefore, should give the size of the river or stream operated on. If Mr. Smith has not seen the diagrams given by Mr. Revy in his "Hydraulics of Great Rivers," I think he would be interested in them. George Higgs

Lepidoptera

I am at present carrying on some researches here, for which a supply of living caterpillars of such large Lepidoptera as the Death's Head, Goat, or Hawk Moth is necessary. As I have had some difficulty in obtaining these, I should feel exceedingly obliged to any of your readers who may find or possess larvæ of the above or other large species, if they could furnish me with specimens. G. Lovell Gulland

Zoological Laboratory, University College,
Gower Street, London, October 4

Animal Intelligence

MR. HARRISON, like most of those who deal with animal communications, assumes that sounds or words must form the basis. This rests upon the assumption that speech is a primary system of communication for mankind, instead of being secondary. Many babies will begin with sign communication, and show a preference for it after they are well able to articulate words. The dog will follow human gestures as well as sounds and words. It is indeed worthy of consideration how far signs play a part in communication between animals. Instead of supposing a complicated system of words, as Mr. Harrison does, it is easy to conceive that, with the apparatus he describes, many signs may be made. Expressions of alarm, joy, direction, can be as well made with antennæ as with hands.

32, St. George's Square, October 6 HYDE CLARKE

Shifting of the Earth's Axis

PERMIT me to say that it was from the diagrams in the paper by Mr. Christie which he quotes (NATURE, October 2, p. 536) that I drew the conclusions of decrease of latitude. In the fuller statement to which I referred, I had expressly said that it was from the Polaris observations that a decrease of latitude might be deduced. The question turns on whether the truest result is obtained by trusting entirely to Polaris, or by including other stars which are at greater N.P.D. and have more variation in the refraction: as the former is less dependent on the most uncertain element of reduction—refraction—I inclined to rely on it entirely. It would be remarkable if the great oceanic circulation should have a mean axis of motion so nearly coincident with that of the earth as not to produce 1/100th of a second change in the Pole during half a century; the presumption would seem against such a fixity. W. M. FLINDERS PETRIE

Bromley, Kent

To Find the Cube of any Number by Construction

CAPT. H. BROCARD (of Montpellier), writing to me on the subject of my note in last week's NATURE (p. 539), communicates the following two simple constructions:—

1. On two rectangular axes Ox, Oy, take A on Ox and B on Oy, such that $\angle OAB = \alpha$, through B draw $BC \perp^r$ to AB, meeting OX in C, and draw $CD \perp^r BC$, meeting OY in D: join AD. Then $\tan OAD = \tan^3 \alpha$.

2. Take $BOD = \alpha$, from A on OD erect $\perp^r$ to meet OB in B: draw $BD \perp^r$ to OB, and let fall $AC \perp^r$ to BD. Then if we take $OA' =$ unity (A' is the projection of A on OB), $BC = \tan \alpha$, $A'B = \tan^2 \alpha$, $CD = \tan^3 \alpha$.

It may be of interest to note with reference to the figure indicated in my construction, that M. Brocard finds that if $FK \perp^r FD$ meets CB in K, and $KL \perp^r FK$ meets FO ($\perp^r BC$) in L, then LD passes through H.

October 6 R. TUCKER

THE ASCENT OF WATER IN PLANTS

THE fact that water is taken up by plants and passes off as vapour at the leaves is one of the best known data of vegetable physiology. The current of water passing up the stem of the transpiring plant is known, moreover, to be copious and rapid, and to pass through certain parts of the wood only. Apart from other questions, it has long been sought to explain by what forces this current can be maintained in the plant, and the difficulties which have arisen and been surmounted have been many; certain of these difficulties, however, are still outstanding.

It was an immense stride forwards when the fact was demonstrated that the water absorbed by the roots passes up the stem in the younger wood; and when it was recognised that in the Conifers this consists of definite elongated cells, not openly communicating, and is not complicated by the presence of vessels, &c., the problem promised to be much simpler.

As is now well known, the earlier hypotheses which were made to explain the ascent of water in transpiration have been long put aside, as new facts were observed which could not be satisfactorily explained by them: the old theory of capillarity succumbs evidently to the facts; and Quincke's hypothesis, though less easily despatched, must also be relegated to the list of past errors.

Two theories, or rather hypotheses, have attracted so much attention lately, that we may fairly regard them as the two rival views for the explanation of the ascent of the transpiration current. The one, especially advocated in its earlier shape by Boehm, seeks to explain the ascent as due essentially to the pressure of the atmosphere acting on a system of air-bubbles and water which can be shown to exist in the plant: this hypothesis, but shortly stated here, is obviously in contradiction to several important facts, *e.g.* the height of tall trees, and the difficulty of explaining how the atmospheric pressure could act on the closed system of the plant.

The second, and very different hypothesis, is the one recently proposed by Sachs. Assuming that the molecules of water imbibed by the wood cell-walls are held between the complex molecules of these walls in a peculiar condition—very much, in fact, as salt molecules are held between the molecules of water in the sea—then the difficulties in connection with tall trees disappear; for by the peculiar properties of the wood cell-walls it matters not whether a given molecule of water is a yard or a hundred yards high. This hypothesis undoubtedly explains numerous facts, and, if choice lay between it and the theory of atmospheric pressure only, no doubt could exist as to which we should accept; nevertheless, there are objections to it apart from the assumption of such very peculiar properties of lignified walls.

Before saying anything as to the possible modifications of the former theory, it will be well to see how it arose in the first instance.

Jamin, in the *Comptes Rendus* for 1860, published an investigation on some capillary phenomena, and particularly on the behaviour of capillary tubes containing air-bubbles in addition to water.

Suppose an open capillary tube of glass filled with alternating drops of water and bubbles of air. If pressure is exerted at the one open end of such a tube, of considerable length, it is observed that the pressure is not transmitted simply through the system, but that each successive one of the alternating columns of water causes a lessening of the effect. Of course each column of water, between two air-bubbles, has two concave ends, and the changes produced in these can be observed. Without here going into the explanation of this phenomenon of the apparent disappearance of the pressure, it suffices for our purpose that an open column consisting of air-bubbles alternating with drops of water may be placed upright and the water not flow out. Jamin showed that with long tubes, the water-columns of which were sufficiently broken by air-bubbles, even a pressure of three atmospheres applied to one end failed to move the lower parts of the column. Such a column of alternating drops of water and air bubbles is called a "*chapelet de Jamin*."

It is known that porous bodies, such as gypsum, absorb water with great force: such bodies when saturated with water are very impervious to air, a fact which may be illustrated by means of the wet linen in any wash-tub. Jamin even proposed an explanation of the ascent of water in accordance with these facts, regarding the wood simply as a porous body.

It is not necessary to go into details as to the various modifications of the theories which in any way depended upon ordinary capillary phenomena; enough that the objection that, even if the plant had capillary tubes sufficiently fine to support the water columns required by a tall tree, the water could not flow through them so rapidly as the requirements of respiration demand seemed fatal to any of these theories, and made Sachs's assumption of the extraordinary properties of wood cell-walls appear the more necessary. Moreover, the Conifers have no such capillary tubes in the secondary wood.

It is impossible to put in a short space all the reasons which led Sachs to draw a sharp distinction between the behaviour of water entering into preformed capillary cavities or interstices, and water which is "imbibed," *i.e.* forces its way between the molecules or micellæ of an organised body. It may be remarked that cases may easily be supposed where it would be difficult to draw the line, and it is certainly not easy to see why "imbibed" water should be held less fast than water in capillary interspaces. It is just here, in fact, that the assumption of the extraordinary conductibility of wood comes in.

It is clear, then, that the great difficulty which is to be put aside by assuming, with Sachs, that the water of transpiration is held in a peculiar mobile condition in the substance of the cell-walls, is that of accounting for the great height of the water columns in tall trees. The old capillary theory will not explain this away, because, although the requisite columns of water could be *supported*, the water could not be *moved* as required.

Frederick Elfving brought forward an awkward objection to Sachs's theory a couple of years ago. By stopping up the lumina of the cells and vessels in such a manner that the edges of the cut elements could still be exposed, it was shown that no water could be pressed through a piece of wood. He showed, moreover, that coloured solutions passed into the cavities of the wood-cells through the thin membranes of the bordered pits, but—as must be concluded from his results—not through the thick substance of the walls. Objections have been raised to some details, but it seems difficult to avoid the conclusion that Elfving's results contradict every other view than that the water passes through the thin membranes of the bordered pits, and through the cavities of the elements, and not through the main substance of the walls of the lignified cells.

Elfving has recently published a paper on this subject ("*Acta Soc. Scient. Fen. nicæ*," t. xiv. 1884) proposing an important modification of the views hitherto held. It is needless to go into the reasons why the theory of gaseous pressures generally must be abandoned, even in its later form, as was Boehm's air-pump theory before; though it is instructive to note that much insight into the physics of the plant may be obtained by a careful study of Boehm's, and especially Hartig's, views, and the various criticisms of them. We may, however, summarise Elfving's remarks, and the chief points for criticism in all the views, as follows.

In advocating the "imbibition theory," no proof is afforded that the lumina of the elements of the living wood are ever *entirely* devoid of water: some water is always present at least in the cells. This does not go against either theory; but the proof that the cells were at any time entirely devoid of water would decidedly support the "imbibition theory."

Enough has already been said as to why we may reject the theory of atmospheric pressure.

Confining our attention to the wood of Conifers, for obvious reasons, the chief facts are as follows. As the young wood-cells lose their protoplasm, water, containing air in solution, occupies the cavity, and bubbles of air are formed alternating with drops of water—in fact, a series of "*chapelets de Jamin*" are formed; only, instead of being simple and in one long tube, each one is complex, and the broken water-columns are confined in closed chambers permeable (to water, but not to air) at the bordered pits, and therefore communicating. One advantage of this is that the "*chapelets*" are less easily broken.

Elfving then passes on to show that, according to Jamin's researches, these columns of water may be of any height likely to come under our consideration: we have thus no more difficulty as to the *suspension* of the continuous columns of water—continuous, that is, in a serpentine course. The molecules of water can pass between the supporting bubbles of air as if they had no weight, since it is only the movement of the masses of water as a whole in the longitudinal direction which is prevented by the capillary forces in the "*chapelet de Jamin*": the individual particles of water have perfect freedom of motion, and will of course travel towards the transpiration surfaces.

Elfving then goes on to show that many other facts are explained by his theory, and especially the loss of conductivity for water in branches cut off in the air. We must refer the reader to the original paper, however, for further details.

In conclusion, while there is no doubt that Sachs's ingenious "imbibition theory" of the ascent of the water in plants was startling, on account of the bold assumption of the peculiar condition of the water in the cell-walls, it must not be forgotten that it was suggested after a series of profound researches into the properties of wood, and by a master-mind which had tried all previous explanations and found them wanting; moreover, the strangeness of an hypothesis is in itself no argument, and so long as the "imbibition theory" explains more facts than any other it must be accepted on those terms.

If, however, the theory proposed by Elfving turns out to explain the same number of facts equally well, it will have to be allowed that it rests on a foundation of a very different nature, and which can be experimentally tested. It is not easy to suggest a distinctive name for the latter theory; perhaps it might be known as the "step" theory, since the intra-cellular movement of the water up to the leaves seems to be somewhat of the nature of a series of ascents by steps, or from side to side. We recommend the subject to the careful consideration of those physiologists who have an adequate knowledge of the structure of plants.

NATURAL SCIENCE IN TASMANIA

ALTHOUGH the scientific energy of Tasmania is not all that could be wished for, still the Royal Society of Tasmania is doing something to keep the flame alive. It is much to be wished that some of its hundred Fellows would devote themselves to an investigation of the flora and fauna of their districts, about which there is still much to be learnt. The *Proceedings* of the Royal Society for 1882 and 1883 have just reached us. The volume for 1882 contains over 180 pages, and is illustrated by four creditably executed lithographic plates. The details of the proceedings at the monthly meetings of the Society are first given, then follow the papers, the more important of which are as follows:—On the fishes of Tasmania, with a classified catalogue of the hitherto recorded species, by Robert M. Johnston. Incidentally he mentions that out of a population of 120,000 persons, it is estimated that about 1050 persons are directly dependent upon the capture and sale of fish. Hobart is the chief centre of the industry. Out of the 188 known species, about one-third are regarded as good edible fish, though only some 21 of these are sufficiently abundant to be ranked as of importance from a food point of view, and of these, some, like the sprat and anchovy, are quite neglected, from want of knowledge and want of energy. Among the so-called fresh-water fish, *Lates colonorum*, though a well-known fish in Australian waters, is confined, so far as is yet known, in Tasmania to one small river discharging into Anson's Lagoon, on the north-east of the island. Though not a sea-going fish, it is chiefly to be found at the mouth of small streams whose connection with the sea is frequently closed by shifting sand-bars; and possibly in this way it became originally acclimatised to fresh water. The fresh-water herring (*Prototroctes maræna*) is said to be the finest of the native fresh-water fishes; chiefly insect-feeders, they give the angler some sport. Some fourteen years ago they suddenly almost disappeared

from most of the rivers where formerly they had abounded, and thousands were seen floating dead down the stream, destroyed apparently by some species of Saprolegnia. It is satisfactory to note that of introduced fish the colonists have now a fine non-migratory trout (brown trout) and a splendid sea-going migratory salmon, the exact species of which is still involved in uncertainty. Among marine fishes special mention is made of the Barracouta (*Thyrsites atun*) and Kingfish (*Th. solandri*), which abound all the year round; but there would appear to be next to no attempt to cure the fish for the foreign market. Mr. R. Etheridge contributes a paper on Trilobites and other fossils from the Lower Silurian rocks of the Mersey River district, Tasmania. Several new species are described, and the species of Trilobites and Brachiopods are figured. Lieut. Beddome describes sixteen new species of Tasmanian shells, and Messrs. Higgins and Petterd some new species of Antechini and Muridæ.

The volume for 1883 contains 65 pages and but few memoirs. Messrs. Higgins and Petterd describe in it some new Tasmanian mice, and the same authors contribute an interesting account of a new cave-inhabiting spider. This species (*Theridion troglodytes*) was found in a recently-discovered cave in the Chudleigh district. The cave was found to consist of several chambers, in the innermost of which the spiders were found. The floor of the cave is about thirty feet below the level of the present entrance, and is only reached by two well-like descents of from fourteen to sixteen feet each, connected by low passages. There was also found a large deposit of mammalian remains, some in the crevices of the rocks, others imbedded in the earthy and stalagmitic floor. These remains can be all referred to non-carnivorous marsupials and mice. It is strange that no insects were found, but the cave would seem to be worth a more detailed investigation, which the authors promise, adding that the stalactites surpassed in beauty those of the well-known Chudleigh Caves.

EXPLORATIONS IN ICELAND

THE LAVA DESERT OF ÓDÁÐAHRAUN

IN about the central region of Iceland, on the northern skirts of Vatnajökull, the largest glacier in Europe, is situated the most extensive occidental lava desert, the Ódáðahraun, covering a total area of about 16,000 square miles English. The whole of this wilderness is almost entirely one barren mass of lava, though here and there the traveller may observe patches filled with drifts of sand giving growth to some few stray tufts of upright lyme-grass (*Elymus arenarius*); but frequently a journey may be made through this region for days together without one single blade of grass being sighted. The total absence of vegetation and water in these tracts makes travelling here excessively arduous and risky, and these difficulties are still more aggravated by the elevation of the country above the level of the sea, in consequence of which it may frequently happen, even in the midst of summer, that the traveller is enveloped in blinding snow-storms, which preclude all attempts at further progress while they last. In such predicaments no reliance can be placed on the compass, because of iron entering so very largely into the composition of the lava-masses. Hence this desert has hitherto remained a *terra incognita*, and has never been surveyed; yet volcanoes of gigantic dimensions are found here, and many natural phenomena beside, which command great scientific interest. Not only to the world of science has Ódáðahraun been an unknown region, but even the inhabitants of the surrounding country-side have at all times entertained the most vague and ignorant ideas concerning it. For ages they pictured it to themselves as the home of trolls and mountain sprites. Even as late as the present century it was commonly believed that up among the volcanoes there were to be found verdant valleys containing a whole population of outlaws; a belief which took its rise and received its fortification from the fact that jets of steam issuing from the crevassed mountains were taken by distant beholders for smoke ascending from the chimneys of the abodes of outlaws. The outlaws themselves were pictured to the imagination as either human beings of a savage type, or as some preter-human race of gigantic strength. So firmly ingrained in the people was this belief, that even as late as 1830 an armed expedition was despatched from Mývatn for the purpose of exploring the haunts of these communities of outlaws, the result of which, I need not say, proved discouraging.

In ancient times one of the highways of the country ran across the northern portion of Ódáðahraun, which early records show the bishops of Skálholt to have been in the habit of taking on their visitation tours to the east country. This road was used for the last time in 1736, but has been lost since, and now no one is able to point out its locality and direction. Across the southern portion of the lava no attempt at forcing a passage had ever been made by man until a certain adventurer named Pjetur Brynjúlfsson, in 1794, succeeded in threading his way from the East Fjörds westward between the lava and the northern spurs of Vatnajökull, until he struck the road of Sprengisand, which traverses the country right across from the northland to the southland quarter. In 1838 Björn Gunnlaugsson, the famous constructor of the best map of Iceland, undertook a journey of exploration to Ódáðahraun, but fell in with such tempestuous weather that all his attempts at exploration were defeated, and he himself barely escaped with his life. Next year he repeated his journey, and, being favoured with better weather, he forced his way from the south up into the boundary line between the lava and the glacier, and pushed on some distance to the eastward. In this trip he attained some positive results. In 1840 a Danish naturalist, Schythe, intending to explore this region, took the same route, but was overtaken by such excessively stormy weather that, after having lost most of his horses, he just escaped with extreme difficulty into the country-side of Jökuldal in the east country. From this time no attempt at reconnoitring this wild country was hazarded until the stupendous explosion from Askja in 1875 gave such surprising evidence of the enormous activity of the volcanoes in these wildernesses. This year Mr. Watts made his way right across Vatnajökul, striking Askja in his descent over its northern spurs. Shortly afterwards Askja was visited by an Icelander, Jón Thorkelsson, who made his way up to it on foot in the midst of winter. In the summer of 1876 the Danish Government despatched Prof. Johnstrup with a party of scientific men to these volcanic wastes, who explored the region of Askja and constructed a map of the volcanoes. Prof. Johnstrup's is the only scientific exploration that ever yet was carried out in Ódáðahraun. At more recent dates Askja has been visited by several English tourists, such as Messrs. Lock, Coles, and Morgan. In 1880 several farmers from the districts of Mývatn and Barðardal made the complete circuit of Ódáðahraun. But, in spite of all such reconnoitring trips, the whole of Ódáðahraun is practically unknown yet, with the exception of the corner occupied by Askja.

Instructed by the Government, I have now for several years been engaged in surveying the upland tracts of Iceland, exploring the country geographically, and examining into its geological structure and character generally. This summer I resolved to attempt an exploration of Ódáðahraun with such means as I had at my command. With a view to more expeditiously effecting my purpose, I adopted the plan of selecting certain fixed stations on grassy spots here and there about the wildernesses which

surround the lava (the Ódáðahraun), and from each of these in turn, as my base of operations, to undertake trips into and about the lava to such a distance as circumstances in each particular case seemed to warrant. To attempt any comprehensive survey of the whole lava at once, the explorer must be supplied with a far larger stock of ponies than I, with my limited means, could muster, and unless such an expedition can carry sufficient fodder for the animals, any lengthened sojourn in one and the same spot is out of the question. But, by the method of exploration that circumstances forced me to adopt, the result must always come short of one's aspirations.

During the first part of July, which I spent in the country-side of Mývatn, I was engaged in examining the volcanoes of the neighbourhood, which for the most part as yet are quite unknown. I also investigated the geology of the country generally, made collections of insects and plants, and ascended the highest mountain peaks in order both to take the bearings of the mountains about Ódáðahraun, which are visible from Mývatn, and to connect my surveys with such points in the neighbourhood as Björn Gunnlaugsson had formerly fixed trigonometrically. Having finished my outfit and other preparations, I started on July 16, from the place where I am now writing, for the desert. The weather was cold and threatening, with snow-showers travelling along the higher mountain rises. Our first day's eastward march took us over the mountain called Námafjall into the large wilderness of Mývatnsöræfi, which is bounded on the east by Jökulsá í Axarfirði, the longest river in Iceland. Generally speaking this wilderness is covered with old lavas, which are connected with that of Ódáðahraun; but plains of drift-sand open here and there, which are studded with hillocks sustaining tufts of *Elymus arenarius*. In these wilds are found a great number of craters arranged in rows on defined lines from north to south, many crevasses, and rifts floored with earth at the bottom (jarðföll, *i.e.* earth-falls, sinks, or dips), which is but what might be expected, where so many lavas have welled forth from the disruptured bowels of the earth. In this locality there occurred a great eruption in 1875, and in shaping our course to the more southern localities, which were the object of my exploration, we passed close under the northern skirts of the new lava which that eruption created. As the day wore on, a gale of wind arose, and in such a case travelling over these parts ceases to be a pleasure. For some time we had the sand-storm at some distance to the northward before our eyes until it overtook us at last; columnal clouds of brown ashes are whirled into the air, and on joining together in ever increasing numbers the whole view soon becomes enveloped in such dusty darkness that eyesight becomes of little avail; eyes, nostrils, ears are filled with pulverised sand, which is of such a fineness as to penetrate without difficulty even the traveller's clothes; drifts of it find their way into the boxes, and gather together under the saddles and the packing gear on the horses; when in contact with the skin it causes great irritation and general discomfort to the body.

As we proceeded through this wilderness, we were struck by the frequent occurrence of horses' bones, in some cases singly, in others in masses, peeping through the sand between the hillocks. This day, by 11 o'clock at night, we halted in Fjallagjá, a long glen between two rifts, where we found *Elymus arenarius* growing in considerable quantity, but no water; it was a troublesome task to secure our tent in the loose drift-sand, but after repeated attempts we succeeded at last in fixing the pegs tolerably securely in the flanks of the hummocks among the interwoven tissues of the roots of the upright lyme-grass. In the evening the temperature fell to 30°·2 F., and during the night the earth was covered white with snow; our ponies spent the uncomfortable time in constant attempts at running away, which, however, were frustrated by our vigilance. The following morning the same weather continued, still alternating all through the day between sand-storms, snow-showers, hail and sleet squalls. With our view obscured so that we could not take any bearings of the mountains, we still pushed on all day long in a southerly direction, reaching our baiting-place to the south of Herðubreið late at night, in some grass plots along the River Lindaá, a tributary to the above-mentioned Jökulsá, which it joins close on the northern spurs of Herðubreið. The evening came on bitterly cold, and with such a thick fog that even the mountain of Herðubreið in our close neighbourhood was rendered invisible. From this spot, where I remained for a fortnight, I directed my excursions in various directions about the eastern portion of Ódáðahraun. Herðubreið is one of the highest mountains in Iceland (5290 feet), and of remarkably commanding aspect, terminating, towards the top, in a shoulder of precipitous rocks capped with a cone of perennial ice. This mountain, in spite of repeated attempts, has never yet been ascended. In a north-westerly direction from Herðubreið there arises a mountain-range of considerable length, on a line from south to north, which is called Herðubreiðarfjöll or Dyngjufjöll ytri (the outer, *i.e.* northern, Dyngjufjöll), and is utterly unknown. My first excursions I directed to the examination of these mountains. To the south of this range there rises a great volcano called Dyngja, built up of layers of lava with an inclination of 8° to 9° on all sides and rising shield-fashioned to an elevation of 3600 feet; it bears a close resemblance to the famous volcano Skjaldbreið in the south. On the 19th I set to examine this volcano. Starting in the early morn from my tent on the banks of Lindaá, I had to traverse a lava plateau 1500 feet above the level of the sea, and such was the difficulty of travelling here, that frequently we were on the point of giving up all further attempts at pushing our ponies on, but by dint of perseverance we reached the volcano after a tortuous scramble of four hours and a half. The layers of lava forming the slopes of this volcano are excessively rough and of peculiar formation, all split up into fissures from north to south or hollowed out by caves and lava bubbles. Wherever the foot is planted the ground sounds hollow; in every direction there are innumerable hornitos, seemingly formed originally of a variety of strands of the fiery ooze twisted into all sorts of fantastic shapes, the outer surface suggestive of a tangle of intertwisted snakes of inordinate thickness. When we had made the ascent half way up the mountain, we were overtaken by fog and snowstorm, so that in a short time all objects were hidden out of view and the earth covered with snow. Still in the expectation of the fog clearing away, and the snowstorm blowing over, we went on, and after two hours' brisk walk reached the summit of the volcano. Here all was covered with ice and snow in a temperature of 28° F. Although the blinding snowstorm prevented anything being seen, I set my theodolite on the chance of the darkness clearing, and had to wait for an hour and a half shivering in the biting blast, when the weather so far cleared that I could take the bearings of several surrounding mountain peaks. This volcano has never been ascended by any man before me, nor would the fact have been passed over in silence, if such had been the case, for even in Iceland the activity of fire has hardly left any traces behind comparable to what is witnessed here. The original crater is 1500 to 1600 feet in diameter, and has, some time subsequent to its first formation, been filled with masses of lava, and now exhibits in the centre a large patch of lava round the circumference of which there stand twelve peak-formed lava columns. In the centre of this plain again there is an enormous crater 400 to 500 feet in diameter and 600 to 700 feet deep. It is hardly possible to picture to the imagination any sight more stupendous than that which

opens to view by looking over the verge of this crater down into the precipitous abyss. The crater, with its bottom covered with snow and the sides all whitened with a glacial crust, suggests to the beholder a gigantic cauldron hollowed out in marble. Enormous rocks, which have tumbled down from the brim of the crater, look like minute black specks against the whiteness of the bottom. The composition of the lava is practically entirely basaltic; but reddish rocks of trachyte are strewn about the circumference of the original crater, which shows that sometimes trachytic eruptions have taken place here, as in Askja in 1875. When the weather cleared, I had distinctly in view the greater part of Ódáðahraun as well as Dyngjufjöll proper, and all the lava currents which have taken their course from the latter complex of volcanoes. In a north-westerly direction from the above-described volcano is another, lower, but quite as wide in circumference, to which we gave the name of Kerlingar-Dyngja. Having surveyed Dyngja, we returned the same way we had come, and reached our tent at half-past two o'clock the next morning.

In a southerly direction from Herðubreið there extends a very considerable mountain range, 3400 feet high, which is called Tögl (Tails); it is separated from Herðubreið by a narrow gate through which, once upon a time, a lava current has found its way. Thus Herðubreið is surrounded by lava on all sides, though that mountain itself is no volcano, but a pile of coarse palagonite breccia interspersed with stray thin layers of basalt throughout its lower parts. One of my excursions I directed to the Tögl. From the tops of these mountains an extensive view opens southward over the sands along the course of Jökulsá and the northern region of Vatnajökull. The aspect of the country to the south of Herðubreið is truly forbidding, all covered with the yellow-gray scoriæ from the explosion of Askja in 1875, generally one to two feet in thickness, and no sign anywhere of vegetation. The whole southern horizon exhibits the vast expanse of the snow-white glacial bolsters of Vatnajökull, out of which, in a northerly direction, rises the enormous complex of volcanoes called Kverkfjöll. In some fiery convulsion this mass of mountains has split from end to end, and through the rent a glacier has found its way right down to the level land below. To the west of this rent I observed in the jökull a mass of craters, from one of which huge clouds of white steam ascended into the air. Nothing is known about the volcanic activity in this spot, no one having ever visited those parts of Vatnajökull. On the western side of Kverkfjöll the jökull is one flat ice plateau all the way down to Ódáðahraun, skirting into a number of moving glaciers terminating in sands and extensive moraines, from which flow innumerable affluents to Jökulsá in Axarfjörd. Towards the east, about the approaches to Sandfell, the next highest mountain in Iceland (5800 feet), the jökull exhibits sharp-cut black vertical walls, probably ledges of underlying basaltic belts; but further to the west the flatness of the jökull owes its formation to the substratum being made up of palagonite tufa, a softer and more easily ground material. Our western view was determined by a part of Ódáðahraun, southern Dyngjufjöll, Askja, and the southern parts of Herðubreiðarfjöll. At the southern termination of Dyngja there rises a very peculiarly formed tufa "fell," along the crest of which is to be observed a row of a number of vertical tufa peaks, each from one to two hundred feet high, so that the outline of the mountain gives the impression of a gigantic hedgehog.

Next day I set out on the examination of Herðubreiðarfjöll. Directing our course to the north-east, we ascended on our way a mountain by the banks of Jökulsá called Ferjufjall, near which, as the story goes, there was a ferry in those olden times, when the bishops were in the habit of taking that road over the northern skirts of Ódáðahraun, to which I have alluded already. In a north-westerly direction from this place excessively ancient lavas come to view, which are clearly older even than the Glacial period, exhibiting everywhere large and unmistakable signs of glacial abrasions. In this excursion we came upon a row of those beacons which by general custom in Iceland are erected to point out where roads run through wildernesses. Most of these beacons were but cumuli of stones; one, however, we found still standing, covered with moss and lichens. This we knew now must be the eastern end of the long-lost road, an assumption which subsequent discovery corroborated. As we approached nearer to Herðubreiðarfjöll we came upon a series of craters surrounded by a recent lava, and so rough that no horse might cross it, almost impassable even for a traveller on foot. Leaving our ponies behind, we made our way across this lava, however, as best we could, and reached the highest crest of the mountains shortly before sunset, and enjoyed from it an extensive view. All about these mountains, which are composed of palagonite breccia, there is a number of ridges observable, with small dales and narrow dips scooped out between them, all, however, totally barren of vegetation. About the central portion this range sinks down into low necks honeycombed with many large craters, from which floods of lava have spread over the surrounding country on both sides, east and west, covering an area of some tens of square miles. Having completed my survey of this region, we returned and joined our ponies shortly after midnight, all scratched and lacerated from the lava, with our shoes and stockings in shreds.

TH. THORODDSEN

Reykjahlíð, near Mývatn, August 4

(To be continued.)

THE CONNECTION BETWEEN CHINESE MUSIC, WEIGHTS, AND MEASURES

CHINESE music can now be heard by all who desire to hear it at the Health Exhibition, and more may be learned on the subject from the pamphlet published by the Commissioners for the Chinese department. A curious account of the common origin of Chinese weights, measures, and musical notes is contained in a paper read some years ago before the German Asiatic Society of Japan by Dr. Wagener. The story is based on native legends, and is also to be found among the Jesuit "Mémoires concernant les Chinois." Dr. Wagener says there is not the slightest doubt that the Chinese system of weights and measures is more than 4600 years old; and it is a highly remarkable circumstance that, quite irrespective of the fact that it is more scientific and exact, it possesses all the advantages for which the French metrical system is so much praised. In the first place, it starts from a basis supplied by Nature; secondly, the decimal arrangement is almost consistently employed throughout; thirdly, linear and dry measure proceed directly from the same unit as the measure of weight; and lastly, what the metrical system does not do, it regulates in the simplest manner the relations of musical notes, which latter form the starting-point for the whole system of weights and measures. The following account of the origin of this system (says Dr. Wagener) contains fact and fancy mingled, but it is easy to distinguish between them. In the reign of the Emperor Hoang-ti, who ruled over China in the twenty-seventh century before Christ, the scholar Lyng-lun was commissioned to complete the musical system which had been discovered 250 years earlier, and particularly to lay down fixed rules for making musical instruments. Naturally he had to commence with the bamboo, which had already been long used to give the note for other instruments. He therefore betook himself to the province of Siyung in North-Western China, where, on the northern slope of a range of

high mountains, a species of bamboo grew, which, on account of its uniformity and its structure, being neither too hard nor too soft, was exceedingly suitable for a wind instrument. He cut one down and tried it. Tradition says that it gave the same note as his own voice when he was excited by no emotion; and the rippling of the sources of the great Hoang-ho, or Yellow River, which were in the vicinity, followed in the same tone. At the same time the fabulous bird Fung-Hiang, accompanied by his mate, flew to the place. Both perched themselves on a neighbouring branch, and commenced a song, in the course of which each of the birds gave six separate notes. These are the notes which are called the six male and six female tones in the scale discovered by Lyng-lun, and which correspond to the ancient doctrine of the male and female principles in Nature. As a matter of course, the deepest of the male notes was the one already discovered by the philosopher himself. He now endeavoured to reproduce the other notes with the help of bamboo pipes, and succeeded. His task was now to lay down fixed rules as to the length of the pipes, so that thenceforth they could be easily constructed everywhere. For this reason, and also because such a scale of notes depends upon slight differences of length, and there were scarcely at this time instruments to divide great lengths, he necessarily arrived at the notion of passing from the less to the greater, and of laying down an adequately small natural unit for his measurements. That could be nothing else but a grain of seed; and now the point was to get seeds of the greatest possible uniformity. He chose a sort of millet, the *Sorghum rubrum*, the seed of which is of a dark brown colour, and which is said to possess the advantages of greater hardness and uniformity than that of the gray and other kinds. The seed is pointed at the ends, and from one point to the other the length is somewhat greater than in the direction at right angles. Lyng-lun now fixed the length of the pipe, which gave the keynote at 81 grains of the seed placed lengthwise in a row. But when the grains were placed breadthwise it took 100 grains to give the same length. Thus the double division of 9 × 9 and 10 × 10 was naturally arrived at. According to the dimension in question, it was called a musical or an ordinary foot, the latter being introduced with the decimal subdivision as a measure of length. The breadth of a grain of seed was 1 *fen* (a line), 10 *fen* = 1 *tsun* (an inch), 10 *tsun* = 1 *che* (a foot), 10 *che* = 1 *chang*, 10 *chang* = 1 *uy*. In subsequent times the line was divided into tenths, hundredths, &c. Lyng-lun also laid down rules for the breadth as well as for the length of the pipe, because, although the note is essentially dependent on the length, it is nevertheless necessary for its purity that the pipe should be neither too broad nor too narrow. He therefore fixed the circumference on the inside at nine grains laid lengthwise. With these dimensions, namely, a length of eighty-one grains, and an internal circumference of nine, the pipe which gives the keynote contains just 1200 grains, and this volume accordingly was made the unit of dry measure, and was called a *yo*; 2 *yo* = 1 *ko*, 1 *ko* = 1 *cheng*, 10 *cheng* = 1 *ten*, 10 *ten* = 1 *hu*. So far we see how the units of length and dry measure were connected with the musical keynote. The twelve notes of the scale are all derived from the keynote, and are to a certain extent comprehended in it. Hence if the 1200 grains contained in the pipe are divided among the twelve notes it gives to each a hundred, and the weight of these hundred grains was made by Lyng-lun the unit of weight. This was divided and subdivided on the decimal system until a single grain became the lowest weight of all. At a later period even the coinage became connected with this system, for one of the weights, the *leang*, corresponding to our ounce, became the weight of metal put into a coin, so that the modern *tael*, in which mercantile quotations are found every day in the *Times*, is merely an ounce of silver, and is thus directly connected with the musical scale. Finally, says Dr. Wagener, it appears from this account that, in China, weights, measures, coinage, and the tuning of musical instruments have been derived quite consistently from a constant unit supplied by Nature herself, and that the essentials of this system are over 4600 years old.

NOTES

THE Queen has been pleased, through His Grace the Duke of Richmond and Gordon, to intimate a subscription of 25*l.* to the Scottish Marine Station for Scientific Research, Granton, Edinburgh.

THE Washington International Prime Meridian Conference discussed at length on Monday a resolution for adopting the Greenwich meridian, which several American and British delegates advocated. M. Janssen, the French delegate, opposed the motion in a long address, arguing in favour of what he called a "neutral" meridian, and suggesting that the prime meridian should run, either through Behring Straits, or one of the Azores. After some further debate the Conference adjourned subject to the call of the chairman. No opposition to the election of Greenwich was shown excepting by France, but doubts are expressed as to whether the Conference will have any result.

ACCORDING to the *Standard's* Calcutta Correspondent, the Commission under the direction of Dr. Klein, appointed by the Indian Government to examine into the cholera question, is satisfied that Dr. Koch's microbe is not the cause of the disease. The Commission is still continuing its inquiries, but so confident is Dr. Klein on the microbe question that he swallowed a number of them without any evil results.

"THE Philadelphia meeting of the American Association," *Science* states, "is credited with being the most successful up to this time. The total attendance was 1249. Great Britain contributed 303; Pennsylvania, 246; New York, 161; Massachusetts, 87; District of Columbia, 84; New Jersey, 58; Ohio, 57; Connecticut, 32; and Virginia, 22. The membership was increased nearly 25 per cent., 515 new members being elected, the number of members up to this meeting being 2033. The number of papers read was larger than ever before, and it is to be hoped that the weeding-out of the trivial matters so often offered was carried to a greater extent than usual. There was a general feeling that there was too much going on. A large portion of the physicists were engaged as examiners at the Electrical Exhibition, and were, of course, interested in the meetings of the Electrical Conference. Somewhat less science, and somewhat more time to enjoy the junketing, would be more in accordance with the desires of many, if one may judge from the opinions expressed on the way home. A proposition to confine the reading of papers to the mornings would have met with many supporters."

IT would seem that the International Scientific Association, which it was proposed at Philadelphia to organise, has been really founded. *Science* informs us that it has now a more assured existence, thanks to the fund of twenty thousand dollars which will be established through the liberality of Mrs. Elizabeth Thompson. Of this fund five thousand dollars have already been paid to the Association, and five thousand more will be paid next year on condition of ten thousand being raised from other sources. The income from this fund is to be devoted to research. Not only did Mrs. Thompson give liberally to this new Society, but she also gave one thousand dollars to the American Association for the Advancement of Science, to be used in researches on light and heat. Mrs. Thompson takes great interest in the recent marvellous advances in the application of electricity, and felt a desire to contribute, as far as lay in

her power, to the advancement of our knowledge of the forces of Nature. Appreciating the unity of energy, whether displayed as heat or light or electricity, Mrs. Thompson gave the money for researches as to the nature and sources of light and heat, in the hope that more may be learned of the connection which may exist between heat and light and electricity.

PROF. COSSAR EWART has sailed for the United States on a semi-official mission connected with the Fishery Board. He is to make full inquiry into the fishery regulations of the United States, to examine the fish hatcheries there, and otherwise to gather all possible information on the subject upon which he was engaged at home during last winter and spring with so much energy and success.

THE death is announced of Dr. Leopold Fitzinger, formerly custodian of the Zoological Court Cabinet at Vienna.

THE latest news from the Lena Meteorological Station at Sagastyr appeared in the last issue of the St. Petersburg *Izvestia*, dated January 3 and February 14. The small-pox, brought last year from Yakutsk, has made great ravages among the already scarce population of the delta. Nearly all (seventy) Yakuts living at Bouloun have died from the epidemic; and in the three settlements at Cape Bykoff forty persons died from it; even at Kytakh, close to the Meteorological Station, a Yakut who had fled from small-pox died in December last. The staff of the Observatory were quite well in February, and, with their provisions of fresh meat, were not afraid of scurvy. The magnetic storms were not so strong nor so frequent as last winter. The greatest cold witnessed in December was − 48° C., and, on the whole, the winter was far milder than last year. Frosts below − 40° were rare, and temperatures as low as − 52° were not witnessed this winter. The average temperature of February was only − 33°, instead of − 41°, as it was in 1883. On the contrary, strong winds were more frequent than last year.

THE new astronomical Observatory in Hong Kong appears to be now in full working order under Dr. Doberck. We have received its usual monthly weather reports, containing copious observations on the barometric pressure, temperature, temperature of evaporation and radiation, relative humidity and tension of aqueous vapour, duration of sunshine, rainfall, duration and velocity of the wind, &c.,—in all, fifteen tables. The meteorological work, especially when taken in connection with that of the Observatories at Siccawei, Manilla, and Tokio, and the observations at the various Chinese Customs stations and lighthouses must be of great value. For the benefit of shipmasters the Astronomer publishes daily a *China Coast Meteorological Register*, giving a summary of the atmospheric circumstances along the coast of China.

AT the same time as the German Association the German Meteorological Society met at Magdeburg and held a public meeting on September 20. Prof. Neumayer spoke on the development of meteorology and its importance in the life of nations. The following gentlemen were elected honorary members of the Society:—Profs. Buys-Ballot (Utrecht), W. Farrel (Washington), J. Hann (Vienna), G. Mohn (Christiania), A. Mühry (Göttingen), and E. E. Schmid (Jena).

PHYLLOXERA has made its appearance in the Pomological Institute of Proskau (Silesia). It is hoped, however, that the spread of the disease may yet be prevented.

THE Russian University of Kief has elected Profs. Kolbe, Helmholtz, Kirchhoff, Pettenkofer, and Hoppe Seyler as honorary members.

A COMMITTEE has been formed at Lucerne with a view of erecting what is called a "universal column." It is to measure 300 feet in height, and is to contain in its interior relief portraits of all the celebrated men and women of the present era on bronze tablets. Another project of the Committee is the building of a "museum of the nineteenth century," to be dedicated to art, science, inventions, commerce, and industry, and to contain the busts and statues of all distinguished persons in these domains. The cost is estimated at seven to eight million francs (280,000*l.* to 320,000*l.*), and is to be met by subscription, lotteries, &c.

THE old lighthouse erected by Smeaton upon the Eddystone rocks 125 years ago, recently replaced by a new lighthouse, has been re-erected upon the Plymouth Hoe. It was opened on September 24 with appropriate ceremony.

PROFESSORS and teachers of mechanics and mechanical engineering have the greatest difficulty in getting suitable models to illustrate the different machines, and combinations of parts, under discussion in their classes; diagrams go a long way as a means of illustration, but appear sometimes very complicated, more especially when the paths of the moving parts are drawn. Take, for instance, the link motion of the locomotive,—the diagram of the motion showing the relative positions of the different parts, when one of the cranks is placed in eight different positions in its path, is very complicated; when a model is used all this vanishes, the action being very simple, and perfectly plain to the average student. Then again the various arrangements of spur-driving gear, nest-gearing, and similar appliances, are very soon understood when illustrated with a model; with a diagram, or drawn on a blackboard, they look complicated and confusing. Perhaps the best and simplest form of demonstrating mechanics is by means of scale models, saving the teacher many long descriptions, and giving the student at once the best possible opportunity of understanding the construction as well as the motion of the different parts. We have before us an Illustrated Catalogue of Apparatus for Technical Instruction, &c. (manufactured by James Rigg, engineer, Queen Victoria Street), issued to meet the demand for appliances required in the various branches of technical education. The grouping of the several subjects is similar to that adopted by the Science and Art Department, the corresponding number of the Government list of 1883 is given side by side with the catalogue number, and the selection of models is decidedly good. The index includes all the subjects generally taught in technical classes. The models are constructed to secure strength and durability, without unnecessary finish, thus placing before the public a valuable series of models for the advancement of technical education at a moderate cost.

THE Japanese Government nominated Mr. Kikuchi Dairoku to attend the Meridian Congress at Washington. This gentleman is a Cambridge Wrangler, and at present fills the Chair of Mathematics at the Tokio University. It says not a little for the scientific advance of the Japanese that they can find one of themselves qualified to represent them at such a scientific meeting as that now being held at Washington.

WE have received from the Commissioner for Japan to the Health Exhibition a catalogue, with explanatory notes, of the exhibits of the Japanese Education Department now at South Kensington. It is not, we believe, generally known that the Japanese section was intended to have been much larger, and the articles were actually shipped from Japan; but owing to a fire on board the steamer by which they were being conveyed, they were spoiled. The loss was chiefly among the appliances, designs, &c., relating to art education, silk-weaving and embroidery by girls at the industrial schools, and specimens of work in bronze by the deaf-and-dumb. The pamphlet before us is much more than a bare catalogue; it is much more a long series of notes on Japanese education and educational appliances past and present, those dealing with the past being by far the

more interesting. On p. 27 we notice a curious statement. No. 61 to No. 85, says the catalogue, are works published by the University of Tokio. "As English translations accompany many of them, the visitor will be able to gather at once what they treat of," in other words, it is implied that the works were originally written in Japanese, and were afterwards translated into English. This is wholly incorrect; the works which are spoken of as "translations" are the originals, and were written by European gentlemen (whose names, by the way, are suppressed) in the educational department of Japan. Most of them were noticed at the times of their appearance in our own columns. They are all works of high scientific value, and their publication reflects much credit on the University, but, if any remark were necessary at all, it should have been that the Japanese was the translation, and the English the original, and not as stated in the catalogue. Exhibits 86 to 103 are the theses of the students in chemistry presented on graduation, and here the writer's name is in every case given. These papers are no doubt creditable in their way; still they are only the ordinary work of good students, while the others approach in many cases to the dignity of considerable volumes, and represent much labour and knowledge. Yet here the authors' names are withheld, and they are actually spoken of as translations. The writers were men whose names will long be connected with Japanese educational advancement—Messrs. Morse, Knipping, Korschelt, Ewing, and others—and the Commissioner can hardly have been ashamed to have their names in his catalogue, for all who know anything of Japanese education know how much science in Japan is indebted to the labours of these and others like them. Probably quite unintentionally there is not only the *suppressio veri* but also the *suggestio falsi* in the catalogue under this head.

AT the Working Women's College the opening address for the year to students and friends will be delivered in the Maurice Hall of the College, 7, Fitzroy Street, W., to-morrow (Friday) night at 8 p.m., by Mr. George Macdonald. Those interested in the work of the College are invited to be present.

MESSRS. LONGMANS AND CO. announce the following publications as forthcoming:—"Louis Pasteur, his Life and Labours," by his Son-in-Law; translated from the French by Lady Claud Hamilton. "The Science of Agriculture," by F. J. Lloyd. "Custom and Myth; Studies of Early Usage and Belief," by Andrew Lang, M.A. "A Manual of Telegraphy," by William Williams, Permanent Assistant to the Director-General of Telegraphs in India. "Above the Snow Line: Mountaineering Sketches between 1870 and 1880," by Clinton Dent, Vice-President of the Alpine Club.

WE have to record the death of M. Bourdon, the inventor of the metallic barometer and manometer which are so largely used.

IN the report last week of the paper read by Prof. Ramsay and Mr. Sydney Young before the Chemical Section of the British Association, "On Evaporation and Dissociation" (p. 551), in the sentence "as the dissociation *increases* the curves approach, &c.," "increases" should be "decreases." In Mr. Nicols's letter on "Salmon-Breeding" (September 25, p. 513, col. 1, line 13 from top), *parrs* should be *pairs*.

THE additions to the Zoological Society's Gardens during the past week include a Lesser White-nosed Monkey (*Cercopithecus petaurista* ♂) from West Africa, presented by Miss Ethel A. Hutton; a Bonnet Monkey (*Macacus sinicus* ♀) from India, presented by Mr. W. Phillips; two Great Bats (*Vespertilio noctula*), British, presented by Capt. W. St. George Ord; a Horned Lizard (*Phrynosoma cornutum*) from Texas, presented by Mrs. S. Russell; an Erxleben's Monkey (*Cercopithecus erxlebeni* ♀) from West Africa, a Common Marmoset (*Hapale jacchus*), a Black-eared Marmoset (*Hapale penicillata*) from South-East Brazil, a Pig-tailed Monkey (*Macacus nemestrinus* ♀) from Java, two Small Hill-Mynahs (*Gracula religiosa*) from Southern India, a Blue-bearded Jay (*Cyanocorax cyanopogon*) from Para, an Alligator (*Alligator mississippiensis*) from the Mississippi, deposited.

PHYSICAL NOTES

M. GARBE has laid down the two following laws in connection with Lipmann's capillary electrometer:—(1) The capillarity constant of mercury is greatest when the electrical difference at the meniscus is *nil*, and, as a rule, its value is independent of the sign of this difference. (2) The electrical capacity at a constant surface of an electrode plunged in a liquid is purely a function of the electrical difference, independent of the sign of that difference, and is least when that difference is *nil*.

M. BEETZ has made a standard cell which is a modified form of Latimer Clark's mercurous sulphate cell. It consists of a tube in which a compressed cake of mercurous and zincic sulphates is placed; at one end of the cake the zinc pole is placed, and at the other end the mercury pole. On short-circuiting the following results were obtained:—

5 minutes ...	1·440 volts	6 hours ...	1·437 volts
1 hour	1·439 ,,	12 ,, ...	1·434 ,,
4 hours ...	1·439 ,,	48 ,, ...	1·408 ,,

The resistance was 15·700 ohms.

M. DECHARME has made some experiments comparing a drop of water falling on to a surface of glass, which he had covered with a thin layer of minium so as to preserve forms obtained, with a rifle bullet striking a target. He found a striking analogy in the results.

M. FOUSSEREAU has found the specific resistance of distilled water, in the same apparatus, to vary from 118,900 to 712,500 ohms, that is to say, in the ratio of 1 to 6. He accounts for this in three ways: (1) by the solution of the surface of the containing vessel; (2) by the solution of matter from the air; (3) to the effect of the dissolved matter during distillation. On the first point he found that at 15° C. after standing in a glass vessel for forty-eight hours the resistance fell 1/30. At 30° C. the change was more rapid, and at 75° C. the resistance varied, so that he was unable to make any measurements. The solution of gases from the air had only a small effect. On the third point great care was observed. Experiment proved that the addition of 1/1,000,000 of potassium chloride reduced the resistance 1/3; according to M. Bouty, hydrochloric acid is five or six times as powerful. In respect to ice, M. Foussereau found that at the moment of congelation the resistance increased nearly 15,000 times, and continued to increase as the temperature fell. Thus ice at −1° C. has a specific resistance of 4865 megohms, and at −17° C. 53,540 megohms. A sample of ordinary water gave 65 times the conducting power, whilst the ice from it was from 30 to 40 times as conducting.

HERR WARBURG has succeeded in electrolysing glass; the method that he adopted is as follows:—He heated a piece of soda lime glass to about 300° C.—at which temperature it is a conductor—and placed it between mercury electrodes. It was necessary to use from 15 to 30 Bunsen cells for a long period. He then found that at the anode side of the glass he had a layer of silicic acid; this layer very quickly reduces the strength of the current owing to its bad conductivity.

M. DUTER has made some very interesting experiments on magnetic shells. He finds that, if thin disks of steel be placed in the field of a powerful electro-magnet so as to magnetise them through from face to face, when they are removed from the field they have almost entirely ceased to be magnets; but the faint trace left still showing that the disks were magnetised as shells. Again, M. Duter built up a series of steel disks, either separated by thin paper or cardboard, or placed directly together. This series was then magnetised with the disks in the same position as before: now on removing the whole from the field he found he had a permanent magnet, fairly powerful and regularly magnetised. His next step was to take the magnet to pieces by separating it disk from disk; each disk was then found to have almost ceased to be a magnet, but on placing them together again he found that he still had a permanent magnet, but weaker than before.

M. Bouquet de la Grye has invented a multiplying seismograph. The instrument has been fixed at Puebla, and a series of observations made during November and December 1882 show twenty-two abnormal movements in one month, probably seismic, only one being felt at Puebla. The sun and moon have been proved to have a direct action on the pendulum, the sun repelling it and the moon attracting it.

M. A. Righi has published a paper in the *Journal de Physique* on "The Influence of Heat and Magnetism on the Electrical Resistance of Bismuth." He says that the resistance of bismuth increases between some temperatures and decreases between others. These variations can be drawn in a curve which shows a maximum at a low temperature, then a minimum, again another maximum just before fusing, and a second minimum whilst in a liquid state, this minimum being in value about one-half the foregoing maximum. The positions of these maxima and minima vary with the physical conditions of the bismuth; if the bismuth be cooled rapidly, the two maxima approach one another until they even merge together, and the curve becomes similar to a parabola. In the first case the two maxima occur at −40° C. and 240° C., the intervening minimum being at 115° C. In the case of rapidly cooled bismuth the single maximum is at 50° C. These results only occur in commercial bismuth, and are more exaggerated as the bismuth is hardened in the preparation, wire showing them more than castings, and cold drawn wire more than hot. Pure bismuth behaves like an ordinary metal. The resistance of bismuth either pure or commercial is increased in the magnetic field; in some experiments the increase has been one-eighth of the original resistance. The increase in resistances is generally proportional to the magnetic force, and decreases with a rise in temperature.

In a recent paper by M. Planté, he gives the result of some experiments made to arrive at the cause and explanation of ball lightning; he was led to these experiments by having one of his [illegible] condensers destroyed by a similar phenomenon. He charged one of his condensers from his secondary battery of 500 pairs, when the condenser was pierced, and instead of a bright spark a small incandescent globule was formed, which moved slowly over the surface of the condenser, following the parts where the insulating layer had least resistance, and destroying the metal film; the path being most curious and erratic. This motion continued, and the globule lasted one or two minutes, until the batteries ran down. In the case of a condenser in which the insulating material was ebonite, a sound was emitted similar to a toothed wheel being rapidly rotated against a piece of cardboard or sheet metal; at the same time there was a strong smell similar to that produced when ebonite is burnt. M. Planté repeated this experiment with 1600 secondary cells, which gave an electromotive force of 46,000 volts, and obtained a similar but much more complicated result. The second experiment made was to make a condenser of two flat pads of filter paper moistened with distilled water and brought near together so as to form an air condenser; now on connecting this condenser with his battery he obtained an incandescent globule which moved about between the pads and passed from one to the other. In this case he noticed that if the pads became dry at any point the globule disappeared, but either appeared at some other point, or at the same point again, as soon as it again became damp. In this experiment he found that the globule lasted a much greater time than in the case of the mica condenser, which fact was owing to the greater resistance in the condenser plates which did not allow the battery to discharge so rapidly.

GEOGRAPHICAL NOTES

In the *Bollettino* of the Italian Geographical Society for September Prof. Bellio contributes an account of a curious manuscript by the Sicilian missionary Fra Teramo Castelli (1597–1659), who spent the better part of his life in Trans-Caucasia. This altogether unique work comprises seven thick folio volumes, originally preserved in the Theatine Convent, Palermo, but, after the suppression of the religious orders, rescued from destruction and removed by P. di Marzo to the communal library of that city. Its peculiar character will be at once evident when it is stated that there is no written text, all the volumes containing nothing but pen-and-ink sketches and other illustrations, accompanied by brief legends or explanations mostly in Italian or indifferent Latin, but occasionally also in Greek and Georgian. This method was deliberately adopted by the author or artist to convey his impression of men and things, because, as he naively remarks, "we thus see at a glance the fact, which, if written out, would take up much time both of the writer and of the reader." Of the designs, of which there are altogether 1176, 347 are of little value, being occupied with mystic, devotional, or ascetic subjects. But all the rest are highly interesting, especially to students of geography and ethnography. The two regions chiefly illustrated are Mingrelia (basins of the Rion and Ingur) and Georgia proper (basin of the Kur), jointly stretching from the Euxine to the Caspian, and bounded on the south by Armenia, on the north by "the kingdom of Astacan," that is, the Tatar khanate of Astrakhan. Mingrelia is identified with the ancient Colchis, while Georgia, "quæ Gurgistan barbaris dicitur," is said to comprise not only Iberia, but also a part of Greater Armenia and a portion of Atropatia, or Atropatene. Frequent allusion is made to the great fertility, rank vegetation, and moist climate of the low-lying tracts, whence arise "dropsy, extremely dangerous tertian and quartan fevers, causing worms to abound in the stomach and flesh of the people, on which account they consume vast quantities of salt." They are otherwise described as Christians of the Greek rite "with a little difference," very numerous and warlike, especially the highlanders, still sometimes wearing armour, and endowed with great physical beauty. There is a portrait of a certain Mamia "Goriehi Princeps Armatus," mounted on a charger, and dressed in a complete coat-of-mail, with high boots, helmet, plume, spear, and shield. It is curious that this practice of wearing armour still lingers among the Khevsur highlanders of the same region. A striking contrast to the Gorelian warrior is presented by the picture of Vominissa, a poetess wearing a simple robe, a double row of pearls round her neck, a head-dress also fringed with pearls, and a rich mantle lined with fur. She holds a quill in her right hand, a scroll of paper or parchment in her left, and round about are disposed an ink-bottle, more paper, a penknife, a pair of scissors, and a vase apparently containing perfumes. Another lady, the Princess Lipardiani, is provided with a fan somewhat in the shape of a violin, with a little square mirror let in at the narrow part, exactly of the same form as is still fashionable in the country. "According to the seasons they gather the harvests of barley, millet, grapes, and nuts," is a legend occurring under one of the numerous designs representing peasants reaping corn as high as a man and making sheaves such as are commonly seen in Italy. Elsewhere is figured a scene in a market town with the explanation: "Trade is carried on by barter; one hen for two pounds of salt, one sheep for two hens, one sword for two goats, one horse for three oxen," adding that all these values are determined by official tariffs. Amongst the sports is one called *trocus*, which from the accompanying description seems to be identical with the game of polo recently introduced into England from the East. "Four horsemen gallop about playing with a ball the size of an orange, which they endeavour to pick up from the ground, hurl into the air, and drive forward with a racket." Then it is added in Latin: "Equites ludentes hoc pacto ut aspicis rarissimi sciunt se ipsos gerere, requiritur agilitas quædam cum certo determinato impulsu ita ut si plus aut minores ponuntur spiritus non bene ludunt sæpeque quasi novi *fetotontes* cadunt in terra ab altis equis cursoribus." Under several characteristic portraits of natives occur Latin verses pointing out how the mental faculties and moral tendencies may be deduced from the form of the head and expression of the features, thus anticipating the doctrine of Lavater. Of forty-six designs figuring the Sultan and his Court, his army and chief subjects, several are of considerable ethnological interest, comprising portraits of Persians, Arabs, Tatars, Egyptians, Circassians, Indians, Chinese, Portuguese, and other nationalities. Appended to these figures is the, for the times, remarkably liberal sentiment that all nations have good and bad qualities irrespective of their religions, and that the Chinese have a good system of philosophy and theology, although different from that of Christian peoples. Prof. Bellio's paper is enriched with a large number of facsimiles conveying an excellent idea of these curious volumes.

The two last numbers of the *Russische Revue* contain articles on the little-known peninsula of Kamchatka, its geography, natural resources, and the history of its conquest. The districts adjoining the sea are so mountainous as to be almost uninhabitable. There is, indeed, one magnificent harbour in Awachinska Bay, and on this stands Petropaulovski. A chain of volcanic

mountains, some of them reaching to a height of 5000 feet, runs down the centre of the peninsula, and through this the large navigable river Kamchatka makes its way to the Pacific Ocean. The valley of this river is the most cultivated portion of the district. The hills are covered with forests of fir, larch, cedar, birch, &c., and in these are found numerous wild animals, such as the fur sable, the otter, foxes of all colours, and the bear, which latter, on account of the great supply of food, attacks neither man nor the domestic animals. It is curious to note that the squirrel, which is universal in Siberia, is not found here at all. Swans, wild ducks, &c., are found in great quantities in the lakes and marshes in the interior, and their eggs, as well as the birds themselves, are taken in great numbers by the people. The fish which throng the rivers in enormous numbers in the summer form the principal food of the natives. For the most part they are salmon (*Salmo salar*), and are dried and stored up for the winter; but owing to the scarcity and dearness of salt the fish frequently become rotten, and the people suffer great privation. The rigour of winter is much softened by warm ocean currents, which create those thick continuous fogs that render the coast so dangerous to navigation. The total population of both sexes is put down at only 6500 souls, but owing to the total absence of agriculture, and to the primitive methods adopted for preserving food for the winter, these are frequently in a state of semi-starvation. For all except bare food they have to look abroad—clothes, utensils, tea, tobacco, &c., and all these they purchase by means of their fur sable, which is unequalled in any other part of the world. About 5000 of these skins are sold each year at 15 to 20 roubles each. At the beginning of the present century, cattle were introduced from Yakutsk, and, owing to the excellent grass and water, would have thriven well, but on account of the lack of industry or energy on the part of the natives, it was found impossible to lay in sufficient stores of fodder in winter. The question whether agriculture is possible in the peninsula has never yet been answered. Markets exist in the ports of Eastern Siberia, which are at present supplied with such articles as salt meat, butter, cloth, and hides from San Francisco. The main obstacle to agriculture is the excessively damp and constantly foggy climate. The sun seldom shines, and does not therefore give enough warmth for the growth of rye and wheat. The trade is almost wholly with California; and as there is little or no money there it is carried on by a system of exchange, the natives offering their sable skins in return for such goods as they require. The articles conclude with an historical sketch of the peninsula down to the annexation of the Amoor region to Russia in consequence of the treaty with China of 1860.

THE latest news from Col. Przevalsky communicated to the Russian Geographical Society is dated January 20 and March 22. In the first of his letters the Russian traveller writes from Dynyouan-in, where he was staying at the residence of the Prince of Alashan. After leaving Urga on November 20, he reached this small town in Alashan on January 15, after a journey of 740 miles across the desert of Gobi. The cold in the neighbourhood of Urga was very intense, and the mercury was sometimes frozen; in Alashan it was, on the contrary, quite warm when there was no wind. M. Przevalsky proposed to leave Dynyouan-in the next day, and *viâ* the Tchebsen temple reach Kuku-nor. He wrote his second letter from this place. He had crossed Southern Alashan and the Han-sou Mountains without difficulty. There he spent the month of February, principally in hunting and in zoological explorations, which yielded rich collections. On March 23 he was to leave Tchebsen for Kuku-nor. The Chinese authorities did not hinder his advance, but refused to give him a guide for the sources of the Yellow River (Hoang-ho); the indefatigable traveller did not, however, attach any importance to this refusal, being sure of finding the sources of the Hoang-ho himself. When the Tsaidam was reached, M. Przevalsky proposed to establish his first station there, and to continue his journey with a few men and provisions. His second station would be established at Ghast in Western Tsaidam. As to Thibet, he had decided to go to Lassa if the Thibetians did not oppose him. Otherwise he would explore only Northern Thibet as far as Lob-nor, endeavouring to penetrate as far south as possible.

ANOTHER traveller who has been sent out by the Russian Geographical Society, M. Potanin, wrote on April 17 from Tientsin. The expedition had reached Chefoo on April 13 on board the corvette *Skobeleff*, and continued the journey on board a Chinese merchant ship. They proposed soon to reach Pekin, and there to obtain authorisation for the journey to Ordos and Han-sou *viâ* Uiay or Kuku-Koto.

IN a paper contributed to a recent issue of the *Revue de l'Histoire des Religions*, M. Léon de Rosny, the Japanese scholar, argues that one of the two chief chronological factors in the present Japanese race is the Aino. It has long been recognised that there was a certain intermingling of the original Japanese invaders with those whom they drove before them, and who now remain in parts of Yezo, the Kuriles, and Kamchatka; but M. de Rosny thinks that the Aino element is an exceedingly large one, and permeates the whole race. His arguments are based on an examination of the cosmogony described in the earliest works. He finds here two separate and distinctly marked mythologies, one of a transparently aboriginal character. The Japanese of to-day is, he believes, a mixture of the conquering yellow and the conquered white races.

THE Berlin Geographical Society heard a lecture on October 4 from Herr Robert Flegel, who has just returned from making an exploration in the region of the Niger, as agent of the German African Society. Herr Flegel's exploration has occupied the last two years, in the course of which he explored all Adamawa and discovered the sources of the Binuë; but his effort to travel from the Binuë to the Congo ended in failure, owing to the feuds and violence of the intervening tribes. Herr Flegel carried away with him the conviction that the Binuë is navigable for 1100 kilometres, and its chief affluents, as for instance the Taraba, for a distance of from fifty to sixty nautical miles during five or six months of the year. Herr Flegel is accompanied by two natives, who attended him on his travels, and who listened on bended knee and with crossed arms to the praise bestowed upon them by the President of the Geographical Society for their devotion to their master.

NEWS has been received from the leader of the German expedition in South America, Dr. von den Steinen. The expedition had arrived at Aldea dos Bacairis, on the Rio Paranatinga, the ultimate point from which regular communication with the civilised world is possible. Their journey had been considerably delayed by untoward circumstances and difficulties. They left Cuyaba on May 26, and reached Rosario on June 2. There they stayed a few days to purchase provisions. On June 14 they reached the first Aldeamento of the Bacairis on the Rio Novo, a tributary of the Arino. There they remained a week, making anthropological and linguistic investigations. They continued their march on June 21, and arrived at Aldea on the 28th. On July 5 they were to cross the Paranatinga.

A GEOGRAPHICAL SOCIETY is about to be founded in the Scottish capital; it is to be opened next month by Mr. H. M. Stanley.

A GIGANTIC EARTHWORM

IT is well known that earthworms exist in many parts of the world of enormous size compared to those with which we are familiar in this country.

Dr. Templeton mentions (see *Proceedings* of the Zoological Society, 1844, p. 89) large worms which are abundant after heavy showers in many parts of the island; this species, named by him *Megascolex caeruleus*, is represented by a number of examples in the British Museum, some of which are certainly more than two feet long. In South America at least two distinct genera are to be found which attain to a very considerable size. Prof. Perrier, who is so well known as an authority upon the anatomy of the group, has given them the appropriate name of *Anteus* and *Titanus*. Dr. Horst of Leyden, also well known for his researches into the anatomy of earthworms, has published in the "Notes from the Leyden Museum" a description of two species belonging to another genus, *Acanthodrilus*, which measure three feet or so in length; they are natives of Western Africa. Australia and New Zealand are also inhabited by these gigantic creatures. Prof. Thomas, of Auckland, New Zealand, informs me that he has heard of a large earthworm two or three feet in length, which is to be found in the interior of the island, and one of similar size has lately been described from South Australia, by Prof. M'Coy, under the name of *Megascolides*. There is, however, a still larger species which inhabits South Africa. Forty years ago Rapp described

and figured an earthworm six feet two inches in length, which was obtained from the neighbourhood of Port Elizabeth, but since that time there does not appear to have been any further description of the animal. Being anxious to secure a specimen for dissection, I applied to the Rev. G. R. Fisk, who most kindly sent me a living one; it is the same species as that described by Rapp, but is not quite so large; it measured between four and five feet in length, and about half an inch in diameter; these measurements are, however, rather under than over-stated; it is not easy to get an exact idea of the length of the animal, since it expands and contracts within such very wide limits. The general appearance is much like that of the common British species, the bristles being disposed in four series of pairs to each segment; this outward resemblance is not borne out by the internal structure, which is very different from that of *Lumbricus* or any other genus.

These monstrous worms appear to be fairly abundant in the neighbourhood of Port Elizabeth and other parts of the Cape Colony (see the *Cape Times* for May 29, 1884), but are only rarely seen; they do not seem to move about at night like our British worms; only heavy and prolonged rains drive them to the surface from their underground burrows; on such occasions, as I am informed by a correspondent at Kleinpoort, which only take place a few times a year, the ground is often covered by hundreds of these creatures slowly crawling about in all directions; they must present a most remarkable sight; as a general rule they do not return into the earth after the rain has ceased, but remain above ground, and are shortly killed by the sun. The same gentleman states that the soil in which he has observed them is of a hard clayey nature, and retains a considerable amount of water, which is invariably brackish. This fact has some significance in connection with the geographical distribution of earthworms. It was formerly believed that earthworms and their eggs were killed by immersion in salt water, and consequently the presence of similar or closely-allied species in two regions now separated by the sea would be a strong indication of a previous land connection, setting aside, of course, those cases evidently due to man's interference (*i.e.* the importation of earthworms from tropical countries among the roots of plants). The fact that this earthworm from the Cape, and presumably its eggs, are unaffected by brackish water, and still more the occurrence of another genus, *Pontodrilus* (cf. Perrier, *Arch. de Zool. Exp.*, t. ix.), among decaying seaweed cast up by the sea, shows plainly that the greatest caution must be observed in drawing any such conclusions.

Zoological Gardens, N.W. F. E. BEDDARD

THE ACTION OF AMMONIA UPON SOME LEPIDOPTEROUS PIGMENTS

TWO or three years back, some entomological friends induced me to kill all my insects with ammonia, instead of employing potassium cyanide, and I have never regretted the change I then made. Nearly the first species so treated was *Melanargia galathea*, and on opening the pill-boxes I was much surprised to find every one of them of a beautiful primrose-yellow colour. In a few moments the primrose-yellow had vanished and the insects were of their normal white again. Evidently this phenomenon was due to the volatile ammonia, so I held a specimen over the bottle, and instantly the primrose colour returned, only to disappear again with the departure of the pungent ammoniacal fumes. The reagent employed was a saturated aqueous solution of ammonia, and the black pigment of the wings remained unchanged throughout. Now here was something of great interest and well worth investigation, so I determined to follow it up, and since that time have never lost an opportunity for experiment or study. Many of my friends are now familiar with the results obtained, but as they appeared to be previously unknown to all those with whom I have communicated on the subject, I have thought it best to place them on record. They may be well known and authenticated, but to ascertain this a careful search through the vast mass of the chemical and microscopical literature both of this country and the Continent would be required, and for this my spare time is quite inadequate. I must therefore crave the indulgence of those who may be familiar with the facts herein recorded. Naturally, the first species selected for experiment was *Melanargia galathea*. As before, ammonia gave the primrose coloration. The next reagent employed was a solution of potassium hydrate, in which pieces of the wing were placed, and they immediately turned yellow. Other alkalis, such as solutions of sodium hydrate and barium hydrate, were tried, and gave similar results, the only difference being that with the fixed alkalis the primrose coloration was permanent, whereas with ammonia it was necessarily fleeting.

As alkali turned the pigment yellow, acids I thought might prevent this, or even produce another colour. Accordingly the wings were treated with a great many acids, the chief being sulphuric, nitric, sulphurous, hydrochloric, phosphoric, and acetic. With all these, when used in excess of the alkali, the pigment was restored to its natural white colour. I also found, that whenever the liquid employed was exactly neutral to both red and blue litmus, the pigment remained unchanged, whilst the slightest addition of alkali produced the primrose-yellow, and when acid predominated the normal colour prevailed. Thus, we see, this pigment is a good test for alkalinity.

To enumerate all the species experimented upon would occupy too much space, so I will only give the most important. As some Continental species are mentioned, I have followed Staudinger's arrangement. *Papilio machaon* and other Papilios were unchanged, and the same may be said of the genus *Thais*. *Parnassius apollo*, *P. delius*, and *P. mnemosyne* turned a pale yellow. With such semi-transparent species a deeper coloration could not be expected, from the small amount of pigment present.

None of the species of *Aporia*, *Pieris*, or *Anthocharis* showed any alteration with ammonia, but *Leucophasia sinapis* and its vars. *lathyri*, &c., exhibited a delicate primrose colour. Not a single species in *Colias*, *Rhodocera*, *Thecla*, or *Polyommatus* was changed; but the behaviour of the species of *Lycæna* was extremely curious and somewhat unexpected. *L. argiades*, *L. argiolus*, *minima* (= *alsus*), *semiargus* (= *acis*), *alcon*, *arion*, and *cuphemus* remained unaltered. *L. batica*, *argyrotoxus* (= *agon*), *argus*, *opilete*, *orbitulus*, *eros*, *icarus* (= *alexis*), *eumedon*, *amanda*, *bellargus* (= *adonis*), *meleager*, *jolas*, and especially *astrarche* (= *agestis*), *corydon*, and *damon* were beautifully suffused with primrose on the under side and cilia, wherever the white pigment occurs. It is difficult to say why some of the species in this genus are unaffected, whilst others exhibit the most gorgeous colouring; but in the case of *L. argiolus*, at least, this may be accounted for. The pale bluish white of the under side is not the result of white pigment at all, but is due to reflected light from the almost pigmentless scales, in which a change could not be looked for. All the species which were examined in *Nemeobius*, *Charaxes*, *Apatura*, *Limenitis*, *Vanessa*, *Melitæa*, and *Argynnis* exhibited no change. In the Satyridæ, besides *Melanargia*, *Œnis œllo* is clearly suffused with primrose beneath. In *Satyrus*, *S. circe* and *S. briseis* have the white bands changed, but *S. alcyone* and *S. semele* are not affected. *Erebia* and *Pararge* are alike unchanged. *Cœnonympha hero*, *C. arcania* (and vars.), *C. pamphilus*, and *typhon* (= *davus*), have the cilia and under side deeply suffused with yellow. Of the Hesperidæ, *Spilothyrus alceæ*, *Syrichthus alveolus*, *S. serratulæ*, and *malvæ* (= *alveolus*), all have the whites changed to primrose, but *Nisoniades*, *Hesperia*, and *Cartocephalus* are not affected.

With the *Heterocera* I have obtained but negative results, although the number of species operated upon are to be counted by hundreds. It would be unsafe to generalise with such scanty data to go upon, but a few remarks may be ventured. The white pigmentary deposits of *Pieris* and *Melanargia*, although to the eye the same, must have a very different chemical constitution, and at one time I thought the negative ammonia results would be a good character of the Pieridæ, in contradistinction to *Melanargia*, &c.; but facts would not support this speculation, for *Leucophasia* proved refractory, and the Satyridæ gave results by no means uniform. Many more experiments must be performed. Nature must be thoughtfully questioned again and again before we can possess a firm basis for speculation.

Hitherto changes of colour only have been dealt with, and few reagents employed, but by recent experiments on the solubility of the various pigments in different media, most interesting facts have been brought to light, which in the future I hope to communicate. What a wonderful and lovely sight is the under side of *Vanessa atalanta!* It has at least a dozen shades of colour, most exquisitely mingled. Some day these colours will be analysed and their constitution made known. The results herein recorded may then be of service.

GEORGE COVERDALE

24, Fleming Road, Lorrimore Square, S.E., August 16

SCOTTISH FISHERY RESEARCHES

APPENDIX F of the Report of the Scottish Fishery Board contains a series of valuable papers with accurate and well executed plates. Dr. Stirling gives a preliminary report on "The Chemistry and Histology of the Digestive Organs of Fishes." The first part gives the results of chemical investigations of the digestive processes in the herring, cod, haddock, and skate. The second part deals exclusively with the intestinal tract of the herring. The muscular coat of the œsophagus consists of striped muscular fibres arranged more or less regularly at the upper part, but disposed circularly in several layers at the lower. The mucous membrane of the œsophagus has longitudinal folds, and is lined with cylindrical epithelium interspersed with numerous goblet cells. The œsophageal glands are simple tubular glands, with, at first, a very short secreting portion. The glands in the "cardiac sac," or "crop," are, like those of the œsophagus, branched tubular glands lined in their upper part by tall columnar epithelium, and in their secretory parts by a single layer of cubical cells, like the "outer" cells of the fundus in mammals. The gland tubes become shorter towards the lower part of the cardiac sac, and they are absent in the pneumatic duct, which is lined by a single layer of columnar epithelium, and divided into two compartments by folds of the mucous membrane. Dr. Stirling has found that the organ which has been hitherto known as the "crop" in the herring, is something more than a mere receptacle, and corresponds in structure and function to the cardiac portion of the stomach of higher vertebrates. There is a striking resemblance between the cells lining the secretory portion of the gland tubes and the "outer cells" in the mammalian stomach, the point of difference being that the tubes are lined by a single continuous layer of these cells. There are apparently no internal layers of cells comparable to the inner cells of mammals, and, as might be perhaps expected, the glands are simpler than those of the mammals, and without that differentiation of tissue which is brought about by specialisation of function. One cell may subserve two functions, and, from an evolutionist's point of view, the secretion of an acid and the formation of a ferment have not as yet in the fishes been relegated to two distinct sets of cells. The pyloric sac or stomach is that short tubular organ with thick muscular walls, and resembling a gizzard, which opens out of the crop and is continued into the intestine. The surface of the mucous membrane consists of irregular depressions, which are deeper than those of the cardiac sac and may be regarded as crypts. The pyloric sac is always lined by a very thick coating of mucus, which not only lies on the surface, but dips down into the pyloric crypts. The surface of the pyloric sac and the glands or crypts are lined throughout with a single layer of tall, narrow, columnar epithelium, having the same character as that which lines the gland ducts and the surface of the cardiac sac. There is no muscularis mucosæ. The circular muscular coat is very thick, while the longitudinal is thin. Structurally the pyloric sac is comparable to the pyloric end of the mammalian stomach. Plates i. and ii. give series of figures illustrating various points in the anatomy of the intestinal part of the herring.

Prof. Macintosh gives a short note of preliminary observations made at the Marine Station, St. Andrew's, on the ova of various food fishes. Cod ova were specially examined, and experiments made as to their buoyancy and the effects of impure water, which proved very marked, and of changes of temperature. The small size of the yolk-sac, as well as the activity shown from the first by the newly-hatched fish show that they must soon take in nourishment from without. The ova of the common flounder were successfully hatched out. Other forms examined and experimented on were the long rough dab, turbot, *Cyclopterus lumpus*, herring, &c., and amongst invertebrates the ova of squids, *Natica*, whelk, nudibranchs, mussel, *Asterias rubens*, lobster, and shore-crab.

The vexed question as to whether the sprat is a separate species of the Clupeidæ or merely the young of the herring is satisfactorily settled in favour of the former opinion in the first part of the Report on the Sprat Fishing during the Winter of 1883-84, by J. Matthews Duncan, F.R.S.E., in which definitions of the differences in external and internal characters are distinctly proved. The sprat is more graceful in shape and slightly thicker in body than the young herring. The dorsal surface of the head is proportionally slightly longer in the herring, the operculum therefore extending further back. The suboperculum in the sprat is shorter and more triangular. The lower jaw is always longer and the diameter of the eye rather larger in the herring. In both sprat and herring the lower edge of the belly from the anal fin forwards is covered by a series of scales, having a central longitudinal "keel" and two lateral rays projecting forwards and upwards. These are more numerous but weaker in the herring than in the sprat, where the central keel is stronger and the termination forms a sharp point, so that the difference can easily be felt. In the sprat the pelvic fin is anterior to the first ray of the dorsal, whilst in the herring it is posterior to it. The pectoral fin is placed proportionately further back in the herring, and the centre of the dorsal slightly behind the centre of the body. The position of the dorsal fin varies more in the sprat, the position of the anal fin more in the herring. The number of rays in the pectoral, dorsal, and anal fins is not constant in either species, but appears invariable in the pelvic fin, that of the herring having two rays more. The arrangement of the teeth in both species is the same on the maxillæ, premaxillæ, and tongue, but those on the tongue are smaller in the sprat, and the vomerine teeth present in the herring are entirely wanting. The same superiority, as far as number is concerned, shown by the herring in the fin rays, scales, &c., is seen in comparison of other organs, the vertebræ, gill-rakers, and filaments, the branchial and pseudo-branchial filaments, and the branchiostegal rays, being all more numerous than in the sprat. The pyloric cæca are also more numerous. The slender duct by which the stomach (crop of Huxley, NATURE, vol. xxiii. p. 607) communicates posteriorly with the swim-bladder is slightly shorter and thicker in the sprat. In the herring the anterior end of the swim-bladder gives off two delicate branches, which run forward at first along each side of the parasphenoid, then diverge, and enter a small spindle-shaped capsule. From the anterior end of this capsule the duct passes out, and divides into two branches, one of which runs straight forward from the vesicle, whilst the other passes outwards at nearly a right angle. In the herring the ducts are very delicate tubes, measuring, in a herring 120 mm. long, 0·9 mm. in diameter, and are surrounded by a cartilaginous sheath, ·25 mm. in external diameter. The ducts meet posteriorly in the middle line, and open by a single aperture into the narrow anterior end of the swim-bladder. The spindle-shaped capsule is about 1 mm. long by ·6 mm. broad, and the spherical capsules are about 1·3 mm. in diameter, the anterior one slightly larger. The sprat, however, shows a remarkable departure from this arrangement. The ducts are about the same size as, and their form and direction are similar to, those in the young herring, though, at the point where they diverge from the parasphenoid (about 5 mm. from the swim-bladder) they lie higher, and are more difficult to follow. But the duct on each side ends in a *single* capsule only, exactly similar to that of the herring, and it neither forms a spindle-shaped dilatation, nor gives off a branch to a second vesicle. Thus, while in the herring there are three vesicles on each side of the head, all containing air, in the sprat there is only one. The foregoing differences are so numerous and so constant at all seasons that there can be no question as to the sprat being a distinct species from the herring, a further proof being that the former is found with developed milt and roe. Mr. Matthews shows in Plate iii. the difference between sprat and herring in the shape of the body and the keel scales, in the size of the ova, and in the formation of the air-vesicles of the ear.

In the valuable paper on the "Natural History of the Herring" Prof. Cossar Ewart, Convener of the Scientific Committee, treats of the varieties of the herring, the migration, the spawning-ground, the process of spawning, and the artificial fertilisation and hatching of ova. The varieties of the herring have long been discussed in all countries frequented by this fish, and differences believed to exist not only between herring of different countries, but of different districts and seasons. How far this may be true could not be determined even by careful examination and figuring of over 500 specimens, taken at different parts of the coast during winter and spring. Comparisons of outline show not so much that the herring of one district differ from those of another, but that there is a remarkable variation amongst herring caught at the same time. Heincke ("Varietäten d. Herings. Jahrb. d. Comm. in Keil, 1876-78") considers the position of the dorsal and pelvic fins of great importance, but, as specimens examined of the same length, caught at the same place, and as nearly as possible at the same stage of maturity, showed more difference than Heincke finds in his autumn and spring herring, some better character must be

considered requisite. It seems unlikely that the same herring spawn twice a year, but that the fish which spawn in the spring and autumn of one year do not spawn again respectively till the spring and autumn of the next year, in which case it is difficult to account for two distinct races of herring. It may be supposed that at first all herring were in the habit of spawning about the same period, but as time went on they were found spawning during every month of the year. Specimens of ova, for example, have been sent nearly every week from the Aberdeenshire coast, showing that herring have been spawning uninterruptedly in one district for at least ten months, from August 1883 to June 1884. The explanation of why at the present day there are two great spawning periods is not that spring and autumn are the two best periods for the depositing and hatching of the eggs, but that these are the two most favourable periods for the appearance of the fry, as then the surface-forms on which they feed are more abundant, as examination of the Ballantrae Bank showed. In the case of the herring the number of individuals does not depend so much on the number of eggs hatched as on the number of fry that survive. These when hatched are at first protected by their minute size and great transparency, and, given sufficient food, are likely to pass safely through the larval stage. If the larval food were more abundant in autumn and in spring, more fry would naturally survive at these periods, and this would ultimately result in the formation of great shoals of autumn and spring herrings. All that has been written on the migration of the herring leaves us still very much in the dark as to either the extent or the causes of it. Meantime, we may suppose that the movements of the herring are regulated during a greater part of the year by the supply of food, which naturally renders their movements very inconstant, and during the rest of the year by what may be termed their spawning instinct. This seems to imply several things, but it specially leads the herring to select ground suitable for the deposit of eggs, waters having a suitable depth, and water which will provide abundant food for the young fry. It has been long known, and was placed beyond doubt by the Fishery Board investigations of 1862-63, that herring were wont to spawn on hard ground. A very complete survey of the Ballantrae not only corroborated this fact, but showed that the herring even preferred to deposit their ova in the basin-shaped gravel-coated areas, where presumably the water is stiller than over the stone-covered ridges, and where it covered many square yards with a layer nearly half an inch in thickness. Eggs were also often found arranged in low masses over the surface of the long stems of laminaria. In several instances the dredge had apparently come upon part of the bank where the eggs lay "to a very great depth," but on examination it was found that the spawn, instead of forming thick masses, was arranged in irregular heaps ranging from a quarter to half an inch in thickness, and varying in size from scarcely an inch to nearly six inches square. By laying the portions side by side in a tank it was possible to obtain a very accurate notion of the arrangement of the undisturbed ova, which certainly often form a regular layer covering several yards of the bottom. On the east coast, judging from the specimens brought up by the long-line fishermen, the herring seem to select hard ground plentifully covered with sea firs, especially *Hydrallmannia* and *Antennularia*. Fishermen and others believe that there is some relation between the herring deserting any given spawning-ground—such as the once much-frequented bank off Dunbar and the equally famous Guillam Bank in the Moray Firth—and the loss of herring-nets during storms, or when over-fished. The reason is that nets loaded with putrefying fish, when left on the ground, cause the herring to seek more agreeable banks elsewhere. This pollution would be continued and extended by portions of the net continuing to fish during the whole season, so that not only might the eggs first deposited be destroyed, but fish which might have spawned on other portions of the bank be taken, and their eggs, though shed, rendered useless. In this way not only the greater part of a shoal, but, what is of even greater importance, nearly all the eggs deposited during the spawning period might be destroyed, and the survivors of the comparatively small brood hatched desert their birthplace as spawning-ground and cast in their lot gregariously with the first large shoal they met with. In the artificial fertilisation and hatching of herring ova the natural process of spawning was followed as far as possible, and many thousands of eggs treated in this way on March 8 hatched out on March 28, 29, and 30, the temperature varying from 41° to 44° F. When the eggs had been plentifully supplied with pure water, the extremely active embryos kept revolving or wriggling inside the capsule, till this ruptured and allowed the larval herring to escape head-foremost. But if the supply of pure water had been limited, the capsule gave way prematurely, the long, slender body escaped, but the head remained within, and the embryo usually perished in spite of all efforts to escape. The hatching was greatly expedited by the temperature of the water being slightly raised. As soon as the fry escape, they begin to try and ascend towards the surface, which they generally succeed in reaching on the fourth day, when they are found swimming freely about. This instinctive desire to rise to the surface as soon as they escape from the egg-capsule is evidently intended to bring them to the vicinity of the food, on which, after the fourth or fifth day, they depend for nourishment. Sketches are given (Plates iv. v.) of herring, illustrating the different positions of the fins. A map of the Ballantrae spawning-bank (Plate vi.), and drawings of a colony of *Hydrallmannia falcata* (Plate vii.) and *Antennularia antennina* (Plate viii.), with cluster of eggs attached. A series of figures (Plate ix.) show the eggs deposited artificially on glass and naturally on stones, gravel, and on a lost net dredged at Ballantrae.

A number of interesting specimens received by the Board are likewise described and figured:—(1) A new Blenny (*Lumpenus lampretæformis*, Plate x.), believed to be the first specimen recorded from the shores of the British Isles; it measured 10·7 inches in length, and was taken in forty fathoms of water, fifteen miles off St. Abb's Head. (2) A fine *Torpedo nobiliana* (Plate xi.) taken off Lybster in forty fathoms of water. (3) A Comber (*Serranus cabrilla*, Plate xii.) taken off Shetland, the first recorded in the North Seas. (4) A Turbot (*Rhombus maximus*, Plate xiii.), dark on both sides, with an eye on each side of the head and rounded frontal process, taken off Anstruther. (5) A splendid Opah (*Lampris luna*), four feet in length, taken in seventy-five fathoms of water off Fluga, Shetland, and now being examined by Prof. Turner, F.R.S. Another item is a list compiled by Miss Maclagan of edible British fishes and mollusks, with their Latin, French, Italian, and German synonyms.

THE BRITISH ASSOCIATION

SECTION D—BIOLOGY

Department of Zoology and Botany

Remarks on the Characteristic Features of North American Vegetation, by Prof. Asa Gray.—The first impression produced on a visitor from Europe to the Atlantic coast would be the similarity of the flora to that of England, many of the plants being almost or quite the same. The larger number of these are obviously introduced. The mullein, the toad-flax, the ribworts, the milfoil, the clovers, thrive by every roadside as in England, and perhaps with even greater luxuriance, the competition being less. This strongly suggests the idea that the distribution of plants is not always due so much to adaptation as to opportunity. As one proceeds westward and southward, the difference becomes more marked, the European type gradually disappearing. But as European settlements extend, the settlers carry their plants with them, and the plants are well up to the time, and travel by rail. On the other hand, some plants, but a much smaller number, are carried from America to Europe, and naturalised there. Such are *Impatiens fulva* and *Erigeron canadensis*. Turning from similarities to differences, one of the first points that strikes a European visitor is the great wealth of trees and shrubs. This Prof. Gray illustrated by giving the number of European and North American species in the most important arborescent orders. The reason of this is probably to be found in the different conditions of the two continents during the period of glaciation. The flora of Europe is exceptionally poor in trees, and, on the return of a warmer climate, the return northwards of those that survived in the south was barred by the Mediterranean. The fossil remains of trees belonging to many tropical orders are found in our Miocene and Pliocene strata. In America, on the contrary, there was nothing to prevent their gradual return from the south, and accordingly we find solitary examples, or in some cases a larger number of representatives, of many tropical orders among the trees of the Northern States. Such are *Menispermum* (Menispermaceæ), *Liriodendron* (Magnoliaceæ), *Diospyros* (Ebenaceæ), *Tecoma* (Bignoniaceæ), and many others. This difference is also promoted by the greater heat of the American summer as compared with that of Europe. On the high lands of North America are also many Arctic plants, which

remained after the Glacial period had passed away; but this flora is insignificant compared with that of Europe. A few species are found on the cool shores of Lake Superior, the shores of Labrador, and certain summits of the Appalachian Mountains. One of the most interesting features of North American botany is an outlying region of a true tropical flora which extends northwards up the Atlantic coast as far as the "pine-barrens" of New Jersey. Proceeding westwards, whether in the States or in Canada, a gradual striking change is observed: not only do the European importations disappear, but European genera give place to those specially characteristic of the western continent. Here above all is to be observed the extraordinary wealth of Compositæ, which make up about one-eighth of the total phanerogamous flora of North America; great numbers of species of *Aster*, *Solidago*, *Eupatorium*, *Silphium*, and other genera. Between the wooded region of the Atlantic and the wooded region of the Pacific coast, there is an immense tract of woodless prairie land, the home of the "buffalo" and of many grasses; and in the spring the number of bright coloured herbaceous plants is also very large. These plains are destitute of water, and probably never grew trees, and are capable of growing nothing but herbaceous plants, which completely disappear in the hot dry summer. Then comes the great chain of the Rocky Mountains, which are well wooded on their sides, and have on their summits a flora of about 200 Arctic species. When the traveller reaches the Sierra Nevada, he enters perhaps the noblest coniferous forest in the world. But while the Pacific coast is extraordinarily rich in Coniferæ, it has a smaller number of trees belonging to other orders than the Atlantic coast; the entire absence of oaks, ashes, and maples, is especially remarkable.

Observations on the Trapping of Young Fish by "Utricularia vulgaris," by Prof. Moseley.—Small perch just out of the ovum were found in the bladders of *Utricularia vulgaris*, some of them caught by the head, some by the tail; but very close observation failed to detect the actual act of capture. No process of digestion has been discovered, and the object of the capture requires further investigation.

On the Jessop Collection, to Illustrate the Forestry of the United States in the New York Natural History Museum, by Albert S. Bickmore.—The great importance of the forest industries and lumber trade of the United States led Gen. Walker, the Superintendent of the Tenth Census, to provide for a corps of competent experts, under the direction of Prof. Charles S. Sargent, who have made new explorations of our forest lands, and gathered original data regarding their present extent. The results of these elaborate researches have been partially published from time to time in the form of bulletins, and the completed work will soon appear in two large quarto volumes of the census series. To place this great fund of valuable information before the artisan and labouring classes in an accessible form, a great collection of our forestry and its products was needed, and this Mr. Morris K. Jessop offered to provide at his own expense. After the field work planned by the census had been finished, Prof. Sargent directed his assistants to return to the forests, and to carefully select the individually largest and soundest tree of each species. Prof. Sargent is preparing a manual which will be a guide to the collection, and which contains all the most important information in the large census volume that will be useful to the visitors and to the artisan classes. The museum is most fortunate in its location in Central Park, where more native and domesticated species are flourishing than can be seen together at any other place on the continent. This is the first effort yet made in this country to gather the native woods together into one collection on a scale commensurate with the extent of the new continent and the importance of its forests.

On the Origin of Fresh-water Faunas, by W. J. Sollas.—The author commented on the lack of interest which had been previously taken in the subject, and then referred to the experiments made by Bourdon in changing salt water into fresh. The old idea that salt water had been the mother of life was now generally acknowledged. In the River Jumna, one thousand miles from its mouth, were found marine forms of mollusks. We had to look further than change of temperature and the composition of the water for the manner in which marine specimens obtained their distribution. The currents of rivers always flowed seaward, and if free-swimming larvæ got a short distance up a river they were certain to be washed down again. The case was different with swift-swimming fish, the Salmonidæ, for instance, which were able to swim up stream and lay their eggs in lagoons. According to a table which he had prepared, nearly all the groups of fishes were both fresh-water and marine. He referred to the evidence afforded by geology to show that fresh-water forms were but modifications of those found in salt water. He believed the sea-water fauna had become fresh-water fauna in the times when tracts of salt water had become fresh-water lakes. He dwelt on the subject of secluded development, and concluded that the higher the organism the less possible was it to diverge from the parent stem. The tree of life at the present time rather put out new leaves than fresh branches.

Prof. Murat of Harvard briefly criticised the paper. The subject was one, he said, rather for suggestion than dogma.

On the Concordance of the Mollusca inhabiting both sides of the North Atlantic, by Dr. Gwyn Jeffreys.—It was recommended that this paper should be printed entire in the *Proceedings*.

On the Identification of Animals and Plants of India which are mentioned by early Greek Authors, by Prof. Valentine Ball, F.R.S.—He said that upon examination it had been found that many of the animals mentioned by Herodotus, Strabo, and other Greek historians, which had usually been regarded as myths by commentators, were easily identified as animals which were found to-day in the forests of India. For instance, the marticora mentioned by old classical writers, and usually regarded as a combination of tiger and scorpion, was really a tiger. It was said by the Greek writers that the marticora had poisonous whiskers and a sting at the end of the tail. In India to-day the inhabitants still regarded the whiskers of the tiger as poisonous, and when one was killed they always took care to burn the whiskers. With regard to plants, Herodotus mentioned the "Indian reed" or *Calamus indicus*, which was generally regarded by scholars as the bamboo. This was, however, impossible, as the bamboo did not grow large enough to furnish material for canoes, as Herodotus expressly stated that the *Calamus indicus* did. The speaker thought it was the Palmyra palm which grew in the valley of the Indus, and which was known in the Sanskrit language as the "Father of Reeds." There were many others of these animals and plants which could be identified, and when the writer's investigations were published he hoped it would be found that he had exonerated the old travellers from the imputations which had been cast on their veracity.

On the Rudimentary Hind Limb of the Humpbacked Whale, Megaptera longimana, by Prof. J. Struthers.—He said the humpbacked whale was extremely rare on the British coast. One had been seen often spouting for some weeks in December in the Firth of Tay; it was mortally wounded, and finally towed ashore dead near Aberdeen. It was a male, forty feet in length. After it had been exhibited for a couple of weeks at Dundee he had partially dissected it. Having been preserved, it was further exhibited, and he had only completed his dissection immediately previous to coming out. The presence of a rudimentary thigh-bone had been discovered in this species many years ago by the late Prof. Reinhardt of Copenhagen. The thigh-bone was composed entirely of a cartilage of conical shape, in length five and a half inches on the right side, four inches on the left; it was incased in fibrous tissue, and rested loosely on the pelvic bone without articular surface. Looking at the anatomical facts and comparing them with those of the other species he had referred to, the conclusion which must be arrived at was that the thigh-bone in the humpbacked whale was a rudimentary structure, a vestige of a more complete limb possessed by ancestors, from which it was descended. The skeleton of this whale would be placed in the Dundee Museum, he hoped, before the Association met in Aberdeen next year.

On the Value of Nerve-supply in the Determination of Muscular Anomalies, by Prof. D. J. Cunningham.—He spoke of the musculi sternalis as a new muscle in man, which had no counterpart among animals. It was, according to his experience, found more frequently among females than males, while Prof. Sheppard, of McGill College, had, he learned, had three cases, all among males.

Prof. Moseley said that this subject of the anomalies of the muscles had a very important bearing in solving many of the riddles of the evolutionary theory.

Prof. Struthers said that while it was not at all impossible that new muscles were starting up within us, it was also possible that the muscles might have existed before, and not been discovered, as our predecessors did not examine things as closely as did the modern investigators in muscular anomalies.

Dr. G. E. Dobson regarded this muscle as a rudimentary vestige of a muscle found in all the lower animals, by the use of which they are enabled to draw in their head and forelegs when they erect their spine.

On the Mutual Relation of the Recent Groups of Echinoderms, by Prof. A. M. Marshall.—Of these there were four groups, the common starfish, brittle starfish, sea-urchins, and holothurians. He said the nerve-system was originally derived from the skin. In some animals the nerve system sank below, in others it remained near the skin, these latter being in a more primitive condition than those in which the nerve-system had sunk down.

Prof. Moseley characterised the paper as very valuable, having fully borne out all the discoveries of Prof. Carpenter, whose advancing age had prevented his being present.

A paper *On the Fœtal Membranes of the Marsupiata*, by Mr. A. H. Caldwell, who was sent to Australia by the British Association to investigate certain interesting biological questions, was read, in his absence, by Mr. Sedgwick. It gave an account of the development of the marsupial embryo, which has been hitherto a riddle in biology. A letter from Mr. Caldwell as to the progress of his investigations in Australia was also read.

On Some Peculiarities in the Geographical Distribution and Habits of Certain Mammals Inhabiting Continental and Oceanic Islands, by G. E. Dobson, M.A., F.R.S.—The geographical distribution of mammals inhabiting continental and oceanic islands has been lately so ably treated of by Mr. Wallace, in his work "Island Life," that I do not purpose entering upon the subject from a general point of view, but will limit my remarks to some peculiarities of distribution which have attracted my attention while engaged in the special study of certain mammalian orders: I refer particularly to the Chiroptera and Insectivora. It is an interesting fact, not hitherto noticed, that many of the most characteristic species of the Chiropterous fauna of Australia have their nearest allies, not in the Oriental, but in the Ethiopian Region, thus contrasting remarkably with the avifauna. The remarkable genus *Chalinolobus* is represented only in Africa south of the equator and in Australia, a single species extending into New Zealand. Again, the species of the sub-genus *Mormopterus*, which belongs to a genus (*Nyctinomus*) of world-wide distribution, is limited to the same zoological regions, being found only in Africa south of the equator, Madagascar, the Mascarene Islands, Australia, and Norfolk Island. The presence of a species of this genus in Norfolk Island and its absence from New Zealand is very remarkable, for, as I pointed out for the first time about ten years ago, one of the two New Zealand bats known, namely *Chalinolobus tuberculatus*, is also common in Australia. The species of the extraordinarily specialised genus *Megaderma* have their headquarters in the Oriental and Ethiopian Regions; yet the largest species not only of the genus, but also of all known insectivorous bats, namely *M. gigas*, lately described by the writer from Central Queensland, has its nearest ally, not in any of the Oriental species, but in *M. cor* from Eastern Africa. Another very remarkable leaf-nosed bat, the type of my genus *Triænops*, found in Madagascar, Eastern Africa, and Persia, but unknown in the well-searched Oriental Region, has its nearest and only ally in *Rhinonycteris aurantia* of Australia, the type of another very peculiar genus. Finally, Australia agrees much more closely with Madagascar and the Mascarene Islands than with the Oriental Region in the species of the large genus *Pteropus*, for, while species of the section of which *Pt. vulgaris* of Madagascar is characteristic are well represented in the former regions, they are absent from the latter. Furthermore it is noticeable that, while 80 per cent. of the species of the genus inhabit the Australian Region and Madagascar with its islands, a single species only has found its way to the great continent of Hindostan and to Ceylon.

On the Geographical Distribution of the Laridæ (Gulls and Terns) with Special Reference to Canadian Species, by Howard Saunders.

Result of the Investigations of Insular Floras, by W. B. Hemsley.

Some Observations on the Direct Descendants of Bos primigenius in Great Britain, by G. P. Hughes.

On Natural Co-ordination as Evinced in Organic Evolution, by Dr. W. Fraser.

Department of Anatomy and Physiology

On the Presence of Eyes and Other Sense-Organs in the Shells of Chitonidæ, by H. N. Moseley, M.A., F.R.S., Linacre Professor of Human and Comparative Anatomy in the University of Oxford.—The Chitonidæ have hitherto been regarded as characterised by an entire absence of organs of vision, the presence of eyes in the shells of numerous genera having been entirely overlooked by naturalists. The author first discovered eyes in a specimen of *Schizochiton incisus*, dredged by Capt. Chimmo, R.N., in the Sulu Sea, in which species they are larger and more conspicuous than elsewhere, and on examining carefully the shells of certain other forms, found eyes present there also. The eyes are entirely confined to the shells, and to the exposed parts of these, the "tegmenta" not occurring at all on the "articulamenta." They never occur on the girdle or zone, or any other part of the mantle. They appear as bright, highly-refracting, convex beads on the shell-surfaces, encircled by zones of dark pigment formed by the choroid layers. The eyes are usually circular in outline, and very minute, measuring in *Schizochiton incisus* about 1/175th of an inch in diameter, in *Acanthopleura spiniger* 1/350th of an inch, and in *Corephium aculeatum*, in which they are oval in outline, 1/600th of an inch by about 1/400th. In the case of all the intermediate shells the eyes are confined to the areæ laterales, or to the lines of demarcation between the areæ laterales and the area centralis, which latter is usually entirely devoid of them. In some genera of Chitonidæ, such as Acanthopleura and Corephium, the eyes appear to be often destroyed and obliterated in the older regions of the shells by decay and delamination of the tegmental surface, or its destruction by boring Algæ or animals. They are, however, constantly re-formed by the mantle in the process of growth of the shell at the growing margin of the tegmentum, and may be observed in this situation in all stages of construction. In other genera, such as Tonicia, the eyes lie in shallow pits of the shell-surfaces, and thus escape destruction by wear, nearly the entire number which have been formed being thus found present in fully-grown shells. The tubercles and prominences by which the tegments are covered in some forms serve, perhaps, as protections to the eyes from attrition. The entire substance of the tegmentum in the Chitonidæ is traversed by a series of branching canals, which are occupied in the living animal by corresponding ramifications of soft tissue and nerves. The strands of soft tissue are continuous with the tissues of the mantle along the line of junction of the margin of the tegmentum with the upper surface of the articulamentum by means of a series of tubular perforations in the shell-substance. Further, in the intermediate shells of most genera there are a pair of lateral slits (incisuræ laterales), one on either side in each shell in the lateral laminæ of insertion; these slits lead each to a narrow tract in the deep substance of the shell, which follows the line of separation between the area centralis and area lateralis. This tract is permeated by longitudinal canals, into which open a series of five apertures on the under surface of the shell. By these apertures numerous nerves enter the tract from the bed of the shell, and, traversing the longitudinal canals, give off a series of lateral branches on either side from it to the network within the tegmentum. In the cases of the anterior and posterior shells, there are usually a considerable number of slits present in the laminæ of insertion, each connected with a similar nerve-supply to the tegmentum. The network terminates at the surface of the tegmentum all over in a series of elongate cylindrical organs of touch, the plug-like ends of which are somewhat dice-box shaped, and can be protruded beyond the level of the tegmental surface from a series of pores, "macropores," by which this surface is covered. These larger organs of touch give off from their sides five branches of soft tissue, which pass vertically to the surface of the tegmentum, and terminate there in minute plug-like organs like the larger ones, but much smaller, and which are protrusible from a series of smaller pores (micropores) in the shell-substance. These smaller and larger touch-organs, and their corresponding pores, are disposed on the surface of the tegmentum with more or less exact regularity in different genera of Chitonidæ; in many cases in very definite lines and patterns. The eyes are connected with the same network of soft tissue as the touch-organs, and are apparently to be regarded as having arisen in development as special modifications of them. The soft structures of each eye lie in a more or less pear-shaped chamber excavated in the substance of the tegmentum. The stalk of the pear, which forms the canal for the passage of the optic nerve, is directed always towards the free margin of the tegmentum, and here its wall is pierced by a circular aperture, which is covered by the cornea. The cornea is calcareous, resisting the action of strong boiling caustic alkalis, but collapsing at once when treated with acid.

In section it is seen to be composed of a series of concentric lamellæ. Its substance is continuous with the general calcareous substance of the tegmentum at its margins. The pear-shaped cavity of the eye, formed by the shell-substance, is lined by a dark brown pigmented choroid membrane of a stiff and apparently somewhat chitinous texture. This membrane exactly follows the shape of the cavity, but, by projecting inwards beyond the margin of the cornea all round, forms an iris of a less diameter than the latter. A perfectly hyaline, strongly bi-convex lens is placed behind the iris aperture. It is composed of soft tissue, and dissolves in strong acetic acid. The optic nerve at some distance from the retina is a compact strand, but before reaching the latter has its numerous fine fibres separated and loose. The retina is composed of a single layer of rather short but extremely distinct nucleated rods of roughly hexagonal section, with their free ends presented to the light. Immediately behind them is a dense mass of nerve-fibres with numerous nuclei and nerve-cells interspersed. The retina is on the type of that of Helix, and not, as might have been supposed, on that of the dorsal eyes of Oncidium. A large part of the peripheral fibres of the optic nerve do not pass to the retina, but pass outside the eye-chamber by a series of apertures in the choroid round the iris margin, and end at the shell-surface in a zone of touch-organs encircling the eye. The touch-organs are identical in structure with the smaller touch-organs already described as appended to offsets of the larger touch-organs all over the shell. In giving off nerves to a series of such small organs, the eye thus corresponds exactly in structure to these larger touch-organs, and its homogeny with them is thereby clearly indicated. The arrangement of the eyes varies much in the different genera. In *Schizochiton incisus* the eyes are restricted to single rows traversing the lines separating the lateral area from the area centralis, and corresponding in portions with the incisuræ laterales and courses of the principal nerves. There are six rows of eyes, with six marginal slits on the anterior shell, and six on the posterior, and a single pair on each of the intermediate shells, twenty-four rows in all, with an average of about fifteen eyes in each, or, in all, 360 eyes. In *Acanthopleura spiniger* the eyes are irregularly scattered around the bases of the tubercles with which the surface of the tegmentum is covered, and are confined in the specimens examined to the region of the margins of the shells adjoining the mantle. The surface of the older regions of the tegmentum seems in this species especially liable to flake off, carrying the eyes with it, and it will probably be found, when series of examples of various ages are examined, that the eyes are originally more widely extended over the shell surfaces. In *Corephium aculeatum* the eyes are very small, with corneas oval in outline, the long axis of the oval being directed vertically to the shell margin. They are never placed on the tubercles with rows of which the shell-surface is covered, but between the bases of these. The two kinds of pores lodging the organs of touch are arranged in vertical parallel lines with great regularity, the large pores occurring at intervals in the lines of smaller pores. The eyes are present in enormous numbers, the anterior shell alone bearing more than 3000, and the entire eight shells more than 11,500. In *Tonicia marmorata* the eyes are arranged in single straight radiating rows on the anterior and posterior shells. On each lateral area of the intermediate shells there are from two to four similar rows of eyes. In Ornithochiton the eyes are disposed somewhat similarly. In the genus Chiton, eyes appear to be entirely absent, though the touch-organs of two sizes and corresponding pores are present. In Molpalia, Mangilia, Lorica, and Ischnochiton, I have as yet detected no eyes. In Chitonellus there are no eyes, and the supply of touch-organs is scanty and confined to the margins of the tegmenta. The arrangement and structure of the eyes and organs of touch will probably be of great value in the classification of the Chitonidæ, which has hitherto proved so difficult a problem. No traces of any structures resembling the eyes and touch-organs of the Chitonidæ can be detected in the shells of Patella or allied genera. The tegmentary part of the shells of this group appears to be something *sui generis*, entirely unrepresented in other Mollusca. Its principal function seems to be to act as a secure protection to a most extensive and complicated sensory apparatus, which in the Chitonidæ takes the place of the ordinary organs of vision and touch present in other Odontophora, and fully accounts physiologically for the absence of these latter in them. Dr. W. B. Carpenter observed the perforate structure of the tegmentum in Chiton, though he did not examine the nature of the contained soft network. The late Dr. Gray, in his well-known paper on the structure of Chitons, recognised the fact that the tegmentum in the Chitonidæ is something *peculiar* to the shells of this family.

On a Method of Studying the Behaviour of the Germs of Septic Organisms under Changes of Temperature, by Rev. Dr. Dallinger.—Description of a new apparatus invented for this purpose.

A Vegetable Organism which Separates Sulphur, by A. W. Bennett.—Description of *Beggiatoa alba*, an organism found in the effluent water from sewage-works, known as the "sewage-fungus," which has the property of separating sulphur out of the organic matter in the water, or in the salt used in precipitating the sewage, in the form of minute sharply refringent globules.

On the Coagulation of Blood, by Prof. H. N. Martin and W. H. Howell.—The blood of the Slider Terrapin, a turtle easily obtainable in Baltimore, had been used for a number of experiments, the object of which was to determine whether the views entertained by Hammarsten or by Schmidt were most reliable. The general conclusions went to show that the views of Hammarsten were more in accordance with the results of these observers.

Prof. Schäfer asked if the authors had made any experiments with reference to the addition of lecithin and white corpuscles respectively to the blood plasma.

Prof. Martin replied that no experiments had been made with lecithin, but that he had found that the plasma did not clot when entirely free from white corpuscles or a watery extract of them.

On the Blood of Limulus polyphemus, by Francis Gotch and J. P. Laws.—The paper was chiefly interesting, as Prof. Schäfer remarked, on account of its indicating the combination of copper with a proteid replacing the usual iron.

On Vaso-motor Nerves, by Prof. H. P. Bowditch.—He gave an account of some experiments he had been making to determine the need of vaso-motor nerves. He had employed an entirely new method, namely, the use of the plethysmograph.

Demonstration of the Co-ordinating Centres of Kronecker, by Prof. T. W. Mills.—This subject had been previously practically demonstrated to most of the physiologists present. The view, in brief, held by Prof. Kronecker is that there is constituted in the ventricle of the dog's heart a centre which, when injured, is paralysed, and whose function of co-ordinating the muscular movements to form a beat is thus lost, the heart going into what is known as fibrillar contraction, which is wholly insufficient to propel the blood through the body.

Dr. Martin had seen this phenomenon when working on the coronary artery, and thought it due rather to injury of the nerves.

Prof. Schäfer held a somewhat similar view.

Dr. Bowditch asked if, as the injuries referred to were mostly superficial, they did not differ very much from the case in point, which was a deep injury.

Prof. McKendrick thought that if it was merely an injury of a nerve that caused the phenomenon, the heart might be brought back to its natural action; while the fact was a dog's heart, he understood, had never been recovered.

Dr. Mills also stated that Prof. Kronecker would, in consequence of injury of this centre, explain deaths from slight pricks of the heart, sudden death in heart disease in certain cases, and death from chloroform.

Prof. Schäfer thought that from the evidences it was clear electric excitation should not be used to recover hearts suffering from chloroform administration, inasmuch as the phenomenon could itself be caused by the application of an electric current.

Dr. Osler thought the strength of current usually used by physicians in such cases was not so strong as those Prof. Schäfer had in view.

On the Cardiac Nerves of the Turtle, by Profs. Kronecker and Mills.—This communication went to show that in the sea turtle there were nerves whose function was perfectly analogous to that of the vagi and accelerantes in mammals. The course of these nerves varied a good deal in different species and in different individuals. It had also been discovered that the pulsating great veins of the land turtle were under the influence of the vagus.

Prof. Martin had found in the Slider Terrapin a ganglion, apparently answering to the thoracic ganglion of the dog, from which the accelerator nerve passed to the heart.

On the Functions of the Marginal Convolution, by V. Horsley and Prof. Schäfer.—The object of their experiments was to ascertain the effect of stimulation of localised areas of the marginal

convolution in the monkey, and their results filled up a gap in the well-known work of Ferrier in that they were able to show that removal of certain areas, the excitation of which had previously caused movements of muscles of the trunk, &c., on both sides led to paralysis of muscles of the trunk of such a degree that the animal was unable to stand. By removal of the frontal lobes no paralysis of voluntary movements were obtained. These results were in opposition to those of Munk, of Berlin.

Ova of Monotremes.—The President stated that he had a most important announcement to make. He had just received a cablegram from Sydney, from Prof. Liversidge, announcing that Mr. Caldwell, the Balfour Student, who was sent out to Australia to investigate the mysteries in connection with the mammals of that country, had discovered that the Monotremes were oviparous. He did not consider that a more important telegram in a scientific sense had ever passed through the submarine cables before. The Monotremes formed two families characterised by the duck-billed Platypus and an animal which was known to the Australians as the ant-eater. These were the lowest forms of mammals, and it had never been known how they produced their young. The extraordinary discovery was now made that these mammals laid eggs, and that the development of these eggs bore a close resemblance to the development of the eggs of the Reptilia. This discovery proved that these animals were more closely connected with the Sauropsida than with the Amphibia.

On Sensory Nerve-Sacs in the Skin of Amiurus, a Siluroid Fish; and *On the Function of the Air-Bladder in Amiurus, and its Relationship to the Auditory Organ*, by Prof. R. Ramsay Wright.—He referred to the numerous species in North American fresh waters, and their remarkable uniformity, almost all belonging to one genus, Amiurus, while tropical fresh waters teem with many different genera differing extremely from each other in form. All the species, however, live in muddy waters, and, to make up for the want of the powerful eyesight which characterises the salmon, are provided with an exceedingly sensitive skin and with special tactile appendages on the head. The lecturer described the already known forms of sensory organs in the skin, and then pointed out that certain structures recalling the nerve-sacs of ganoid fishes, like the sturgeon and gar-pike, are scattered all over the body from head to tail, and both on the upper and lower surfaces. This diffusion of these organs is of interest as indicating probably an ancient type of their arrangement. The second point touched upon was the function of the air-bladder and its relationship to the auditory apparatus. Prof. Wright believes the fish becomes sensible of alterations in the pressure of the surrounding water in the auditory apparatus, and suggested that the air-bladder is also an important channel through which sounds are communicated to the terminal organs of the auditory nerve.

In the discussion which followed Prof. Alfred Haddon of Dublin confirmed the latter point, and suggested that this particularly delicate apparatus for receiving sounds was present on account of the fact that tropical Siluroids, at any rate, are capable of producing sounds by means of a stridulating apparatus, some forms of which he had himself described.

Section H—Anthropology

Mr. Horatio Hale read an interesting paper *On the Origin of Wampum*. He said that amongst the Indians it represented mammon, or money, and was equally valued. It had once been actually accepted in Massachusetts and New York as legal currency, owing to lack of silver, and was largely used in the Indian trade. Wampum consisted of a kind of bead or shell, but must not be confounded with the cowries of the East. Indians on the sea-coast drove a large trade in this article, and Long Island was a mine of wealth. The word wampum was of Algonquin origin, and meant white. The speaker explained the various uses to which this material was put. It was generally used in strings and belts, and at the great Iroquois ceremonies it was considered indispensable. Black wampum was more valuable than white. Of the many thousands of belts that had been known to exist during the last three centuries, scarcely fifty remained, and Mr. Hale regretted the dull indifference that had been displayed by the Americans with regard to this interesting and valuable material, valuable as forming a chronicle of the tribes who manufactured the belts. Mr. Hale exhibited an historical belt of wampum, composed of white beads, with four black squares, which, he said, represented four towns. This belt, he said, was one hundred and sixty years old. Another and still more remarkable belt was also shown by the speaker, who explained the emblems upon it, which, he said, were intended to represent the signs of the Christian religion. There were three crosses representing the Trinity, a lamb, executed in a primitive manner, and a dove. These objects, Mr. Hale said, had been evidently suggested to the Indian artist, who had done his best to represent them, but he said that his artistic powers should not be judged by this specimen. The speaker also displayed some strings of beads, and said that these were used in the Indian chants, the beads recalling certain verses to the singers. Mr. Hale showed to the Section a photograph of some Indian chiefs of the six nations who had met at Brantford and explained to him the meaning of their wampum belts. Shell beads, he said, were used in large quantities by the mound-builders, and he argued that it was probable that the art of manufacturing this medium had descended to the modern tribes from their more advanced ancestors. Some beads, which had been found in an enormous burial-place in Orillia county by Mr. Hirschfelder, were shown by Mr. Hale, who said that these were undoubtedly used by the Hurons. Crossing the Rocky Mountains, he said that wampum would be found in actual use, the material itself and the labour devoted to its ornamentation making it extremely valuable. Being susceptible of a high polish, it forms very handsome ornaments, and is better adapted for this purpose than for currency, for which it is cumbersome. Speaking of the amount of shell money possessed by the primitive Indians, Mr. Hale said that the average man owned about one hundred dollars' worth, that being, he said, about the value of two women, two grizzly bear skins, twenty-five cinnamon bear skins, or three ponies. Mr. Hale remarked on the districts in which wampum was found, and quoted some sentences from a work of his own with regard to the discovery of wampum in the Kingsmill Islands of Micronesia in the Pacific Ocean. There, he said, he saw strings of alternate wooden and shell beads. He exhibited to the Section specimens of beads from the Kingsmill Islands and from California, some of these having lost their lustre from the long time which they had been buried in a grave. Mr. Hale made some interesting remarks upon the history of Chinese money or "cash," tracing its origin to the tortoise-shell disks used in earlier times. Mock money, he said, was sometimes burnt at sacrifices, as the Californian Indians burnt their shell money at funerals. He traced the passage of this currency between Asia and America, showing how it could have been brought from one district to another. It was used, he said, by Indians in Eastern North America, those in California, the inhabitants of Micronesia, and the Chinese. He thought that the monetary system was indigenous to China, and that by early intercourse it had been conveyed to this continent. He noticed the fact that Chinese junks and Micronesian prows may have been wrecked on the western shores of America, and that their crews may have introduced the system of shell money amongst the Indians.

Major J. W. Powell read a paper on *The Marriage Laws of the North American Tribes*. In the course of his observations, the speaker remarked upon the custom of burying articles with the dead. There were two classes of property amongst the Indians, communal, or that belonging to the tribe, and personal, or that belonging to the individual. In order to prevent controversy the latter was buried with its owner. With regard to the marriage laws, Major Powell said there were many strange customs. For instance, in some tribes, marriages were arranged by officers of the tribe, and the choice of wife or husband was limited to certain groups of persons. Marriage was therefore not by personal choice, but by legal appointment. But marriage could be performed by elopement, or running away, when, if the couple could remain in safety from detection and punishment until after the day of jubilee, or the day when all offences are considered forgiven, then that marriage would be considered legal. Wives could also be obtained by trial of battle, a contest of some kind, when the woman became the helpmate of the victor. There was also marriage by capture. The methods of obtaining a wife were so common that the custom of marriage by legal appointment was much neglected. But though this was the legal and proper method, the others had become legalised by long custom, and now the capture, contest, or elopement were merely simulated.

Mr. C. A. Hirschfelder of Toronto, as representative of the Numismatic and Antiquarian Society of Montreal, read a paper *On Prehistoric Remains in Canada*. The ancient remains of

Canada have, as yet, been by no means satisfactorily examined, and consequently but superficially described; and although we have no stone ruins, still that does not detract from the interest of the prehistoric works, found scattered over various sections of this country, which are well worthy of a thorough scientific examination. The forts, which were built principally of earth, although stone was not unfrequently used to some extent in their construction, are particularly interesting from two points of view—viz. the almost perfect symmetrical shape, and the advantageous positions which were invariably chosen. As to the first-named feature, they bear a striking resemblance to the ancient earthworks of the Western States, by which some writers have endeavoured to prove that the authors of those works must have been advanced in certain sciences. As to the situation of these forts, their ancient builders seem to have carefully studied localities, and to have fully appreciated the advantages to be gained thereby, as the situations chosen were invariably such as either to command a view for a long distance over the country, or, if near the water, to be so constructed that a fleet of canoes could be seen a long distance away, so that sudden attacks by water would be impracticable. The forts were generally made either circular or oval, although one or two surveyed were crescent or semi-circular, the form probably depending upon the lay of the land; and it is very singular that there has not been, to my knowledge, a single fort discovered in Canada which even approaches a square. Entrenchments seem to have been a not uncommon mode of defence, and have every appearance of being anterior to the wall or embankment forts; the largest one surveyed was half a mile in circumference, of a circular form, and, judging by counting the concentric rings of trees growing right in the ditch, which must have grown after the fort was constructed, also by decayed vegetable-matter and other evidences, was computed to be from 800 to 1000 years old. Ancient burial-places may be classed under three heads—mounds, ossuaries, and single graves. Mounds are not of frequent occurrence in Canada, and all which have so far been examined have contained human bones, proving that they were used as burial repositories. These tumuli (if they may be so termed) are not by any means large; they generally measure about 100 feet in circumference, and are only about 5 feet high. The dead seem to have been buried without any regular system, each mound containing from six to twelve bodies. The ossuaries are probably the most interesting remains we have. They consist of round symmetrical holes dug to the required depth, and into which the bodies were promiscuously deposited; some of the larger ones contain the remains of several thousand bodies. The single graves are the most ordinary remains we have, and are generally found on high ground, a hill-top being a favourite site. In dwelling upon sepulture, I trust to be able to show clearly that the burial of articles with the dead was not so much a religious act as a mark of respect to the dead. The archæological relics of Canada have never been fully described, and are deserving of a higher rank, in a scientific sense, than has as yet been accorded them. We have a grand field to work in, and the articles we find well repay us for the trouble taken. The aborigines of America are undoubtedly the fathers of smoking, and the elaborate workmanship which was bestowed upon their pipes shows the important place it took in their every-day life. There are no articles found which so well portray the aboriginal ingenuity as the pipes. Animals, birds, reptiles, and the human physiognomy are all carved upon the bowls and stems with life-like accurateness. Many specimens found would trouble a clever artisan of the present day to duplicate, allowing him all the modern tools to work with, because stones, tools, ornaments of various kinds, &c., were also manufactured with a precision simply perfect; and, strange to say, it seems to have been a matter of little moment whether they worked the hardest or softest qualities. Pottery, shell, and bone were extensively used in the manufacture of articles for their every-day life, whether for ornaments or necessary utensils; copper was also utilised to some extent, principally for tools, ornaments, and sword-blades; the ore was merely pounded into the required shape. Shells, which must have been brought a distance of nearly 2000 miles, are sometimes found in graves, evidencing the extraordinary fact that a trade must have been carried on between the aborigines of the north and those of the south, which, extending over such a vast distance, and with their primitive mode of travelling, must have made the articles exchanged of great value. The wampum was probably nearly altogether carved from these foreign shells.

Major J. W. Powell, U.S.A., read a paper on *The Classification of North American Languages*. Major Powell said that in his remarks he would confine himself to those languages which possessed at least a thousand words. Pointing to a map of the United States on which the distribution of the languages was marked, the speaker said that there were four great distinctive tongues on the continent, the Algonquian, the Shoshonian, the Siouan, and the Athabascan. The classification of these languages was impossible, he said, but we could classify the arts, the habits, the philosophy of the peoples. He remarked on the fact that grammars and dictionaries, books, and even newspapers, were published in some of the Siouan languages, the Dakotan for instance. For the purpose of convenience and study of the North American languages, rules had been drawn up and adopted, which rules were read and commented upon by Major Powell. One of these was that family names should not be recognised if they consisted of more than one word, and another that all tribal names should terminate in "an," as Algonquian and Shoshonian. These were highly necessary to prevent confusion. The speaker described the difficulty he had experienced in classifying the different names during the past fifteen years, and remarked that the affinities of various languages were not yet practically determined. Within a year, the work, he hoped, would be completed, as far as the United States were concerned, but it would take some years before the work for the North American continent was concluded. Four gentlemen were now in the field engaged in collecting vocabularies for this purpose. Remarking on the likeness between the words "kayak" and "caique," Major Powell said that it could be imagined how extremely difficult it was to decide upon such a matter, there being, for instance, eighty languages in North America which possess no affinities with each other. Grammatic affinities might exist, but none closer. He thought that early arts could not be relied upon to connect peoples. Institutions and languages were more valuable and lasting helps to classify nations, the latter especially so. Finally, the speaker said that, as there were eighty different stocks of languages and the same number of mythologies, it would be a long time before their labours were completed.

Mr. Rosefeldt observed that, although he had lived among the Indians for some years, he had never met with an Indian who could pronounce the letter R. In this they were like the Chinese, and therefore might have migrated into America by way of Behring Straits. He related an incident which occurred during his residence amongst the Indians. One of them asking him to what family he (the speaker) belonged, Mr. Rosefeldt replied, the fox, as this animal occurred in his coat-of-arms. The Indian said, "Then I must be your 'pickanniny,'" or son, showing the figure of a snake on his arm, "as the snake is the son of the fox!" This showed that the Indians imagined that they derived their descent from various animals.

Mrs. Erminie A. Smith read a paper *On the Customs and Language of the Iroquois*. Some years ago Mrs. Smith was received into the tribe of the Tuscaroras, and adopted as a sister by one of the chiefs of that nation. An assemblage was held to do honour to this auspicious event, and a handsome bead-work dress was prepared for Mrs. Smith. The chief who adopted her being one of the "Bear" family, she also became a Bear. Mrs. Smith made some interesting remarks upon the costumes and upon the gambling habits of the Indians, and showed some of the silver brooches used by them as stakes in the games. A hair "waterfall," composed of some five hundred scalps joined together, was exhibited, as well as the temperance banner of the Tuscaroras; this bore a rude representation of the American eagle destroying the demon of intemperance, with six stars of the six nations, and figures of the animals which are symbols of the tribes. Noticing the construction of the Iroquoian language, Mrs. Smith said that there were two so-called genders, noble and ignoble; the former comprised God, men, and angels, and the latter demons, the lower animals male and female, inanimate objects, and "women, children, and other chattels."

Mr. F. H. Cushing read a paper *On the Development of Industrial and Ornamental Art among the Zunis of New Mexico*. The speaker's remarks were illustrated by numerous specimens of pottery and other kinds of work done by the Indians. Mr. Cushing said that by adoption of the Zuni language, customs, habits of living, and costume, to the minutest particular, he had been enabled to obtain a vast amount of information regarding these people—descendants, as he said, of the "Pueblo Indians." The word "Pueblo," he explained, was applied to a nation who lived in communal dwellings. He brought forward evidence, linguistic and otherwise, to prove the descent of the Zunis from

these races. He described the causes that led to the architecture of the petty clans, such as a need of protection which induced them to seek the caves in cliffs, and traced the history of the "Pueblo" or communal dwellings. The art of pottery, he said, was practised in the "Pueblo" district to a very great extent. He gave an interesting account of the formation of the Zuni gourds, or water vessels, showing how they were covered with wickerwork in order to preserve them. Basket-work vessels were also used, these latter being covered with a preparation of clay in order to prevent the escape of the contents. Mineral coal was used in the manufacture of earthenware vessels and also upon the corrugated surface given to the bowls. A curious fact with regard to the food utensils of the Zunis was that they regard the bowls they make as possessing something in the nature of life or spirit. They place food and water near the vessel, and as a woman completes it she imagines she has made something like a created being. The different sounds made by the pots as they are struck, or as their contents boil, for instance, are believed to be the voices of the beings which are associated with the vessels. Apertures or blank spaces are left for the escape of this spirit. A Zuni woman, as she closes the apex of a pointed clay vessel, turns her eyes away, and says that it is "fearful" to watch this operation. She thinks that if she knowingly (that is in her sight) closes this orifice, which she regards as a source of life, the source of life in herself may be closed, and that she may be debarred from the privilege of child-bearing. Other evils are also expected to follow if she does not turn away as she completes the vessel's shape by closing the apex. The Zunis, in representing animals, always show a kind of line or passage leading from the throat to the heart, and cannot be induced to dispense with this line in any pictorial representation of animals. In conclusion, the reader of the paper referred to the probable origin of the shapes used in the pottery of America.

Dr. Daniel Wilson then read a paper on *The Huron-Iroquois, a Typical Race of American Aborigines*.—He remarked upon the natural boundaries of countries, and the difficulties they presented to nomadic races. East of the Rocky Mountains the ethnology was comparatively simple. There were but three great races or families, the Iroquois, the Algonquin, and the Athabascan. The Blackfeet were, however, a different race, and possessed different characteristics. West of the Rocky Mountains the subdivisions were more numerous, but not so large. He mentioned the valuable though imperfect vocabulary of Jacques Cartier, which showed something of the language used by the Iroquois or Six Nations. He enumerated the nations of which this confederation was composed, and remarked upon the localities in which they lived. The original native population of this part of Canada, Dr. Wilson said, was the Huron-Iroquois. They were found in the valley of the St. Lawrence by the early explorers. Some of them had been driven out and had returned to Canada at the time of the American Revolution, in one case, he said, bringing with them the silver communion service given to the Mohawk church by Queen Anne, and now used in the Tuscarora church. Dr. Wilson referred to the Indians of Lorette and of Anderdon as representing the ancient type of Hurons. These people, he said, believed that their ancestors came from the neighbourhood of the "great sea" or the Atlantic. The speaker then showed a skull, probably that of a Hochelaga Indian, which had been found near this spot. This, he said, presented all the types of the Huron race. He contended that it was a Huron people that had been found here by Jacques Cartier, though he said that the funeral customs of that nation did not seem to have been practised in this district. These funeral customs, and the ceremony of the "feast of the dead" were described in an interesting manner by the Professor. Dr. Wilson remarked upon the want of knowlege of metallurgy shown by the inhabitants of North America, and the general slow progress in civilisation which was displayed by these people. Copper in large quantities was ready to their hand, but no trace of its being used was found, and the application of fire to the metal seemed not to be thought of. He noticed the earth-works of the Ohio Valley, which he said should be visited by the British visitors before their return to Europe. He concluded by referring to the influence that the half breed population of Manitoba might have in future times upon the inhabitants.

Dr. Tylor, after expressing his thanks to Prof. Wilson for his communication, called upon Mr. Horatio Hale to make some remarks upon the subjects on which the last speaker had touched. This Mr. Hale did, saying that the tradition amongst the Hurons was that their ancestors had moved westward from the districts in which they were found by Cartier. With regard to the question of the language of the Hurons as compared with that of the Iroquois, Mr. Hale read a letter from the Hon. Judge Force, of Cincinnati, who had studied this subject. Mr. Hale also made some interesting observations on the difference of pronunciation between these people, his remarks being listened to with deep attention.

Prof. G. Lawson read a paper on *Food Plants used by the Indians*. The Professor began by remarking on the various berries that were found on this continent, as well as the numbers of nut-bearing trees. He showed that the wants of the aborigines would be supplied by the natural products of the woods and fields, and spoke particularly of the wild potato of Nova Scotia, which was so well known among the Indians. Other plants noticed were the bean, fields planted with this vegetable being found by Columbus and by Jacques Cartier, and maize, which was also much used. Beans were grown among the Indian corn, which formed the main crop. Evidence showed that plants like melons, pumpkins, and others of the same nature were cultivated by the Indians. Columbus, in 1492, found these plants surrounding Indian villages in such a condition as proved that they were cared for.

Lieut. A. W. Greely exhibited a collection of photographs of Esquimaux relics.

Lieut. P. H. Ray read a paper *On the Habits and Customs of the Inn of the Western Shore and Point Barrow*. Many of the natives had been measured, and it was found that the tallest height was 5 feet 10 inches, and the lowest 5 feet 1 inch. This was much higher than the natives of Greenland. Their powers of endurance were wonderful. Marriage laws they had none: the contract was severed at will. They never quarrelled or entered upon any controversy, and were extremely kind to their parents. Lieut. Ray described the manner in which these people prepared their food for travelling, and in which they captured the reindeer and the seal. Though they did not believe in a future existence, they were intensely superstitious, as Lieut. Ray found when he learned their language, and they paid great veneration to the oldest of their women. He thought these people the most primitive that white people had ever come in contact with.

Mr. R. Law read a paper by himself and Mr. J. Horsfall, *On Some Small Flint Implements found beneath Peat on Several Elevated Points of the Pennine Chain lying between Huddersfield and Oldham*.—Mr. Law introduced his subject by saying that, though perhaps of a local nature, it might be interesting. In the course of his paper he said that the flint implements which had been discovered had been submitted to competent authorities, and it was considered that they were the smallest ever discovered in England. They were supposed to have been carving implements, and some of them were not more than one inch in length and a quarter of an inch in breadth, while they were carefully marked and chipped on the edges. The speaker concluded by describing the moorland country and geological character of the soil in which these implements were found.

SCIENTIFIC SERIALS

THE *Journal of the Franklin Institute* for August contains:—Wire triangular truss, by Chas. J. Quetil, C. and M.E. (illustrated).—New British standard wire gauge.—Report on the trial of the "City of Fall River," by J. E. Sague, M.E., and J. B. Adger, M.E., with an introduction by Prof. R. H. Thurston (continued from vol. cxviii. p. 74, illustrated, and with a table).—Tests by hydrostatic pressure, by S. Loyd Wiegand, M.E.—Velocity of approach in weir computations, by A. W. Hunking and Frank S. Hart (with tables).—The earth's ellipticity, by L. D'Auria.—Suggestions for the improvement in the manufacture of glass, by George W. Holley.—Survey of the future water-supply of Philadelphia, by Rudolph Hering, C.E.—Influence of high pressure on living organisms.—Atmospheric changes at Nice.—Bernauf's telescope.—Microscopic organisms on the surface of coins.—Magnetism in Madagascar.—Selective absorption of solar energy.—Use of oxygen as a refrigerant.

Annalen der Physik und Chemie, No. 8, July 1.—On a new method of determining the vapour-densities of bodies with a low boiling-point, by Nik. von Klobukow (10 figures and a table).—On a new method of determining the vapour-densities of bodies with high boiling-points, by Nik. von Klobukow (7 figures).—On the influence of pressure on the viscosity of liquids, particularly of water, by W. C. Röntgen (2 figures and 2 tables).—On the

influence of density on the viscosity of dropping liquids, by E. Warburg and J. Sachs.—On the conductibility of heat of tourmaline, by Franz Stenger (2 figures).—The expansion of crystals by heat, by Eug. Blasius (3 figures).—On the passage of electricity in gas, by F. Narr (with tables).—Remarks on the resistance box of Siemens and Halske, by E. Dorn (4 figures).—On the known dichromatic colour-systems, by Arthur König (1 figure).—On the sensibility of normal eyes for the perception of light of long wave-length, by Arthur König and Conrad Dieterici (1 figure and tables).—Metallic and total reflection of isotropic media explained by means of Neumann's system, by E. Ketteler.—Experimental determination of the wave-length of the invisible prismatic spectrum, by S. P. Langley (5 figures and table).—Demonstration research on the relation between light polarised by reflection and by refraction, by G. Krebs (4 figures).—On a freezing apparatus, by E. Lommel (1 figure).

Journal de Physique théorique et appliquée, August.—On the electric conductibility of very weak saline solutions, by M. E. Bouty (7 parts, 30 pages, with figures and tables).—The influence of heat and magnetism on the electrical resistance of bismuth, by M. A. Righi.—Variation in the physical properties of bismuth placed in a magnetic field, by M. Hurion.—Variation of the resistance of bismuth and some alloys with the temperature, by M. A. Leduc.—On some experiments illustrating an explanation of Hall's phenomenon, by Shelford Bidwell.—Note on Hall's phenomenon, by Herbert Tomlinson.—The explosive wave, by MM. Berthelot and Vieille.—Researches on the compressibility of gases, by E. H. Amagat.—Memoir on the compressibility of air and carbonic acid at 1, 8, and from 20 to 300 atmospheres, by E. H. Amagat.—On a new form of the relation $F(pvt) = 0$, relating to gases, and on the law of the expansion of these bodies at constant volume, by E. H. Amagat.

SOCIETIES AND ACADEMIES

SYDNEY

Royal Society of New South Wales, August 6.—H. C. Russell, B.A., President, in the chair.—Four new members were elected. Donations received consisted of 327 vols. and pamphlets, forty-six anthropological photographs, and a collection of fossils.—A paper was read by Mr. Lawrence Hargrave on the trochoided plane. The paper was explanatory of some models of animal progression exhibited by the author before the Society, and gave in detail the opinions and deductions he had formed from his observations of the natural motions of animals. The author was of opinion that there was evidence to show that Nature almost universally used the trochoided plane for the transmission of force, and that its use by man opened up a wide field for engineers; he asked the opinion of the members whether there were grounds for believing that the trochoided plane was a distinct mechanical power, and if not under what head they classed it.

PARIS

Academy of Sciences, September 29.—M. Rolland, President, in the chair.—Remarks in connection with a work "On the Origin of the Earth," presented to the Academy by M. Faye. The book is described as mainly historical, recording the various theories on the cosmogony of the universe that have prevailed from primitive times down to the present day.—Observations on a preceding communication dealing with the theory of the form of the planets, by M. F. Tisserand.—On the vegetation of the Amaranthaceæ: distribution of the fundamental substances amongst the various parts of this family of plants and its congeners at the various periods of their growth, by MM. Berthelot and André.—A simple process for effecting the separation of cerium and thorium from mixtures in which these elements are found, by M. Lecoq de Boisbaudran.—On the solubility of the prussiate of gallium; rectification of a previous communication by M. Lecoq de Boisbaudran.—On the trinomial linear equation in matrices of any order, by Prof. Sylvester.—Report of the Commissioners, MM. Bouley, Bert, Gosselin, Marey, Pasteur, Vulpian, and Richet, on various communications touching the treatment of cholera. Of the eight communications received since the last report, five are undeserving of mention. The three others are rather theoretical than practical, and that of Dr. Pereda y Sanchez alone seems to contain a few suggestions worthy of further consideration.—On the second experiment made by MM. Tissandier brothers to propel a screw balloon by means of electricity, by M. G. Tissandier. This trial, made on September 26 at Auteuil with improved appliances, yielded all the results that could be expected from a balloon constructed with an exclusive view to experimental study. The vessel proved perfectly stable, obeying every movement of the rudder, and enabling the aëronauts to execute numerous manœuvres in various directions above Paris.—Observations of Barnard's comet and of Luther's planet made at the Observatory of Nice, by M. Perrotin.—Observations of Wolf's comet made at the Paris Observatory (equatorial of the West Tower), by M. G. Bigourdan.—Observations of the same comet made at the Paris Observatory (equatorial *coudé*), by M. Périgaud.—Observations of the same comet made on September 21 at the Observatory of Bordeaux with the meridian circle, by M. Courty.—Note on the group of points in involution marked on a surface, by M. Le Paige.—Description of a new polarising prism presenting some advantages over those of Nicol and of Hartnack and Prazmowski, by M. E. Bertrand.—Note on the products obtained from tellurium acted on by nitric acid, by MM. D. Klein and J. Morel.—On the employment of the sulphate of copper (blue vitriol) for the destruction of mildew, by M. Ad. Perrey. Vines recently treated with this solution in the department of Saône-et-Loire were everywhere distinguished from the surrounding plants by the bright green colour and healthy appearance of their foliage. But this remedy seems to be efficacious only in the case of young vines from four to six years old.—Report on the present climatic conditions and sanitary state of the isthmus of Panama, by M. R. Regnier. The prevailing notions regarding the insalubrity of this region appear to be unfounded. Its temperature varies from 24° to 30° C. in winter, rising to 35° in summer. The climate is hot and moist, with two seasons, summer and winter, the latter being the rainy season and the shorter of the two. Although the climate does not produce the same depressing effect on Europeans as many other tropical countries, certain hygienic precautions should be taken and scrupulously observed. Two large hospitals, one at Panama, the other at Colon, have been erected for the treatment of the men at present employed in the construction of the canal. A health resort has also been established at Taboga, and these various measures are stated to have reduced the mortality almost to a lower rate than in many great centres of industry. It is at present about 2·5 per cent., a proportion not exceeding the average of European countries.

CONTENTS

	PAGE
The Cholera Poison	557
The Sanitary Institute at Dublin	557
Contributions to Phenology	558
Letters to the Editor:—	
The Younger School of Botanists.—W. T. Thiselton Dyer, C.M.G., F.R.S.	559
The Solar (Dust?) Halo.—Prof. E. Douglas Archibald	559
Cole's Pits.—Rev. A. Irving	560
The Flow of Streams.—George Higgin	560
Lepidoptera.—G. Lovell Gulland	560
Animal Intelligence.—Dr. Hyde Clarke	561
Shifting of the Earth's Axis.—W. M. Flinders Petrie	561
To Find the Cube of any Number by Construction.—R. Tucker	561
The Ascent of Water in Plants	561
Natural Science in Tasmania	562
Explorations in Iceland. By Th. Thoroddsen	563
The Connection between Chinese Music, Weights, and Measures	563
Notes	566
Physical Notes	568
Geographical Notes	569
A Gigantic Earthworm. By F. E. Beddard	570
The Action of Ammonia upon some Lepidopterous Pigments. By George Coverdale	571
Scottish Fishery Researches	572
The British Association:—	
Section D—Biology—Department of Zoology and Botany	573
Department of Anatomy and Physiology	575
Section H—Anthropology	577
Scientific Serials	579
Societies and Academies	580

THURSDAY, OCTOBER 16, 1884

HANDBOOK OF BOTANY

Handbuch der Botanik. I. and II. Herausgegeben von Dr. A. Schenk. (Breslau: Verlag von Eduard Trewendt, 1879–1882.)

AS early as 1861 it had become apparent to certain leading German botanists that the limits of their science had been so far extended as to make it impossible for one writer to treat the whole subject with such uniformity and thoroughness as is required in the composition of a standard text-book, including the substance of the facts well ascertained up to the date of its issue. Accordingly Hofmeister, with the assistance of others, and especially of Sachs and De Bary, planned a joint "Handbook of Physiological Botany," and though, owing to the difficulties which are always liable to attend joint authorship, the parts written by the several contributors were issued at various dates from 1865 to 1877; and though some of the parts included in the original scheme never appeared at all, those published are together the result of the most considerable attempt hitherto made to issue a comprehensive and standard Text-book of Physiological Botany. During the twenty years which have followed the adoption of this plan by Hofmeister and his colleagues unprecedented advance has been made in the science, and it is thus still more necessary than before that the task of authorship of a comprehensive handbook should be divided. The "Handbook of Botany," which is in course of issue by Prof. Schenk, and of which two volumes are already complete, is a second attempt, somewhat similar in idea to that of Hofmeister, though differing from it in many points. The staff of authors is larger, and since the space allotted to the several authors is less, greater uniformity in date of issue has been attained; there is, however, in Schenk's "Handbook" no prearranged and well-balanced plan of the ground to be covered, or at least the first two volumes give no clue to any such plan. Each article appears to be independent of its neighbours, and must be regarded as a separate essay on a definitely circumscribed, and in some cases a very limited, branch of the science. Since this is the case, it is clear that the "Handbook" cannot be used by beginners as a text-book of the science; it is suited rather to specialists, and others who may desire special information on the subjects which are treated. To these the book will be of the greatest use and interest, since the articles are written by well-known men, who have made the subjects of their essays their special study.

It will be impossible here to discuss each of the articles in detail, nor indeed will it be necessary to do so, since in more cases than one the articles are in the main useful epitomes of more extended works already well known to the public; in other cases, however, the articles are the result of fresh constructive work. While those of the former category will be merely named, those of the latter order demand more careful attention.

The first article, entitled "Die Wechselbeziehungen zwischen den Blumen und ihre Kreuzung vermittelnden Insekten," is by Dr. Hermann Müller, whose name will be sufficient guarantee of its excellence; while it is written in such a style as to interest those who have not made botany their special study. It is followed by a short article by Prof. Drude on Insectivorous Plants. The essay on the Vascular Cryptogams, by Dr. Sadebeck, is one of the most important of the whole series: the author gives a concise account of the chief facts hitherto ascertained, and has arranged them on a plan which is well suited to their comparative treatment. After a short general description of the cycle of life as found in these plants, he treats in the first section of the spore, germination, the prothallus with the sexual organs, and the embryo; while the second section is devoted to the vegetative organs and the sporangia. Each organ is described successively, as far as it is known, in the various forms of vascular Cryptogams, and thus the comparison of details of structure and development of each organ in various groups is made more easy than is usually the case in other works. Then follows an article by Prof. Frank under the heading "Die Pflanzenkrankheiten"; this may be regarded as a useful abstract of his more extended work on the same subject, which is already well known to botanists. The first volume is brought to a conclusion by an article on the Morphology of Phanerogams, by Prof. Drude. It has been the object of the author to furnish a compendium of the external conformation of flowering plants, and their sexual organs, reference being made to their comparative anatomy and development. At the present day this object is in itself unsatisfactory: to gain a true insight into the morphology of Phanerogams reference must necessarily be made to the lower forms, and the want of such reference and comparison is apparent throughout this article, especially in that part of it which is devoted to the morphology of the flower.

The second volume includes, in the first place, a treatise on Vegetable Physiology, by Detmer, which has laboured under the disadvantage of being published almost simultaneously with the excellent lectures of Prof. Sachs on the same subject. It is followed by Falkenberg's essay, headed "Die Algen im weitesten Sinne," which is one of the most important of the whole series. In the introduction he shows how the classification of the Thallophytes proposed by Cohn in 1872, and adopted by Sachs, led the way to the system of classification proposed by De Bary for the Fungi; this writer, after excluding the Myxomycetes and Schizomycetes, recognises that the various remaining groups of Fungi may be regarded according to their morphological characters as a natural series. Falkenberg treats the Algæ in a similar way; he strips off from the whole series of chlorophyll-containing Thallophytes (to which the term Algæ in its widest sense may be applied) certain outlying groups, viz. the Diatomaceæ, Schizophyceæ, and Florideæ; the remaining Chlorophyceæ and Melanophyceæ together form that series which he terms the *Algæ in the narrower sense.* Adopting this general method, the author has constructed a compendious description of the whole series of Algæ, which will well repay those who read it. The essay on the Muscineæ, by Goebel, is written in a similar spirit to that of the article which precedes it, and can be well recommended as giving the best concise account of the morphology and development of that class hitherto published. The article by Prof. Pfitzer on the Diatomaceæ will be welcomed, as

giving in an accessible form a detailed account of the structure of these plants from the pen of one who has already distinguished himself in this field. The second volume is brought to a close by a treatise by Haberlandt named "Die physiologischen Leistungen der Pflanzengewebe," a subject well suited to one of the Schwendenerian school, to which its author belongs. Anatomical facts, many of which are already well known, are here placed before the reader in the light of the anatomico-physiological method, which the pupils of Schwendener claim as having been initiated by him in 1874.

From what has been already said, it is clear that this "Handbook" will, by the individual worth of many of its articles, take a prominent place among standard botanical works, and will undoubtedly be of great service to advanced students. Further volumes are still in progress, and the appearance of their successive numbers will be looked forward to with interest. F. O. B.

OUR BOOK SHELF

A Synopsis of the British Mosses. By C. P. Hobkirk, F.L.S. Second Edition. 8vo, 240 pages. (London: L. Reeve and Co., 1884.)

THIS is a new edition of a work that appeared originally in 1873. There is no other recent handbook of British mosses, so that it has had the field entirely to itself, and has had a large circulation amongst our home collectors. It is a cheap working handbook, something on the scale of Babington's "Manual of the British Flowering Plants and Ferns," without any figures, but with full diagnostic characters of all the indigenous genera and species. Britain is exceptionally rich in mosses, and in this new edition 129 genera and 576 species are enumerated and described, with a short notice of locality.

Mr. Hobkirk is well known as an excellent practical bryologist of many years' experience. He has not attempted either in this or the previous edition to introduce any novelty in classification. In the first edition he followed Wilson closely, and Wilson in his turn deviated but little in arrangement, nomenclature, and the circumscription of genera and species from the great standard work on the mosses of the whole of Europe, the magnificent "Bryologia Europea" of Bruch and Schimper, which contains elaborate figures of every known species. In this second edition Mr. Hobkirk has altered his classification to correspond with that of Jaeger's "Adumbratio Muscorum," a change which we consider of very doubtful utility, as it has the effect of making the preliminary synopsis much more elaborate and more difficult for a beginner to understand and use.

An illustrated work on British mosses brought up to the standard of Bruch and Schimper has been greatly wanted. Now, Dr. Braithwaite is bringing out in parts a work of this character, with admirable original drawings and detailed descriptions. At the present time this is about one-third completed, and it is greatly to be hoped he may have health and strength to finish it. For any one needing a cheap working handbook we can cordially recommend the present book. It contains a brief glossary of terms. Only the names that are adopted are given, without any synonyms. One fault in the preliminary key that will puzzle a beginner is the want of definitions for the two primary divisions—Saccomitria and Stegomitria. Another point that without explanation will likely puzzle students is that the authorities cited for each species are those of the author who first used the specific name, taken quite independently of the genus under which it is now placed, so that, for instance, Linnæus is cited as the authority for *Eucladium verticillatum*, when the genus Eucladium was first characterised by Bruch and Schimper half a century after Linnæus died. The orthodox plan is to cite the authority for genus and species combined.

J. G. BAKER

Our Insect Allies. By Theodore Wood. 8vo, pp. 1-238. (London: Society for Promoting Christian Knowledge, 1884.)

WRITERS on popular entomology are hard driven nowaday to find titles for their works, or subjects that have not already been worn to shreds by previous authors. To be successful they must possess the same talent that enables a *chef-de-cuisine* to contrive an *entrée* from the same materials, so disguised by name and sauces as to lead his patrons to consider they are partaking of a new dish. The author of this nicely got up little book has evidently felt himself in such a position, but on the whole he has succeeded very well, the more so because there are fewer errors than ordinarily exist in popular entomological works. He takes as his standpoint the fact that very many insects are indisputably serviceable: some by ridding the world of putrid or unhealthy organic matters, both animal and vegetable; some by destroying other insects undoubtedly noxious. The result is that we get here a series of histories of individuals or groups detailed in popular language, often from personal observation, and for the most part well illustrated by woodcuts. The author evidently feels himself most at home in dealing with the *Coleoptera*, and, as we think, judiciously takes up the position that bark-beetles and wood-borers are scavengers, seeking to devour what is already morbid, and are not the *cause* of decay in the trees in which they are found. We fail to follow his account of the mechanism by which the click-beetles (p. 207) perform that acrobatic movement so familiar to our childhood in the shape of the "jumping frog"; to our mind the "mucro" that is the chief agent in this action is not "elastic." Why are the *Aphis*-parasites known as *Aphidius* stated to be *Chalcididæ* (p. 168)? Why is a *Syrphus* larva figured (p. 160) as that of a "Golden-Eye," or "Lace-Wing"? The introductory remarks and the concluding notes contain some very judicious reasoning on the aim and purpose of entomological studies, and we sincerely wish we could agree with the author (p. 236) that collectors, as opposed to students, are "now in a very small minority"; a vast improvement towards this end has undoubtedly taken place latterly, but the time for congratulation has not yet arrived. The Society under whose auspices this little book is published has done much towards popularising natural history in this country; this work may be classed amongst the best of the series, and no doubt in a second edition the author will revise it and rectify a few palpable errors.

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.*]

Shifting of the Earth's Axis

HAVING quoted the Greenwich observations so often, and with all respect, during the last twenty years, in my several Great-Pyramid publications, as showing that there is a slow shifting of the earth's axis going on, with the effect of altering the latitude of places minutely from age to age (see more especially p. 81 of fourth edition of "Our Inheritance in the Great Pyramid"), I cannot remain unconcerned when the present energetic Astronomer-Royal comes out so very positively with the statement that the Greenwich observations of the last forty-seven years (which he confines himself to) show nothing of the kind, and that there is no such movement of the earth's axis going on.

At least so I understand his letter in NATURE, vol. xxx. p. 536. If that statement or conclusion is perfectly correct, I must of course allude to it in the next edition of my Pyramid book, and adopt its corrections, whatever they may lead to; so that it is well at once to ask any further questions which seem demanded for full trust and credibility.

That the observations made at Greenwich during the last forty-seven years, when computed as the said Astronomer-Royal has computed them, do not show any change of latitude during that space of time, no one is more ready to allow most honourably than myself. But before we can admit that that result, pure and simple, absolutely establishes the non-shifting of the earth's axis of rotation, two more things at least must come about, viz. :—

First, the Astronomer-Royal must attack and demolish the observations and calculations made at the great Russian Observatory of Pulkowa, which show that such a change, at the rate of about one foot *per annum*, has been going on through the last quarter of a century, and are even believed in America to be more accurate than the Greenwich observations. And

Second, he must take up, and similarly destroy, the testimony of the earlier Greenwich observations themselves, before these last forty-seven years of his own computation began.

Now those earlier Greenwich observations were so remarkable for what they did indicate in their own time, that I may freely mention now, seeing that all the parties are dead, that somewhere about 1836, Sir Thomas, then Mr. Maclear, at the Royal Observatory, Cape of Good Hope, received a private letter from Thomas Glanville Taylor, Honourable East India Company's Astronomer at Madras—and earlier an assistant at the Royal Observatory, Greenwich—stating his belief that the latitude of the British National Observatory was continually decreasing; and he gave a list of latitudes, as determined by Greenwich observations, so far back as they went, but condensed into three epochs, to prove the point.

The matter was kindly communicated to me by my then chief, Sir Thomas Maclear, and was of course deemed interesting and curious at the time; but had quite gone to rest in my mind, until twenty-nine years afterwards, when I fell across the same effect, in the same direction and at nearly the same rate, but through a longer period of time and to a much larger accumulated quantity, at the Great Pyramid of Geezeh in Egypt. The datum for the latitude of 4000 years ago, to compare with the present observed latitude of the same spot—though exactly that which the learned Dr. Hook desired so much, but in vain, to find anywhere 200 years ago—is not perhaps so purely and perfectly scientific as the high-class practical astronomers of our times will always condescend to notice. But in the accompanying feature of change of azimuth, so creditably brought to the front by Mr. Flinders Petrie, there is a testimony of modern observation to ancient accuracy of so respectable a character—if I may be allowed so to say—that it ought not to be entirely ignored; and it was first mentioned thus.

While I was at the Great Pyramid in 1865, and just after I had there measured the azimuths of the entrance-passages of the Great and Second Pyramids on successive evenings by reference to the six-hour elongations of Polaris, there came a letter from a retired civil engineer in Edinburgh, a man of long Batavian experience in his day, and gifted with remarkable powers of modern science and originality of mind,—in which letter he was pleased to run down all the presumed object of my work out there on the Geezeh Hill. Especially too was he pungent on the point that even the best of the ancients had not that triumph of modern civilisation, "the manufacturing principle," in them; "for," said he, "they could not make two things alike."

Whereupon I sent him the azimuths of the entrance-passages of those two grand pyramids, so many hundred feet apart, and pointed out, that, though they showed an error of azimuth for modern date of nearly five minutes, yet the one pyramid exhibited so very nearly the same identical quantity as the other,—that they were, angularly, nearer together, or more exactly alike, than were the two halves of one and the same azimuth circle I was observing with. And yet that circle was by so celebrated a maker of modern times as Troughton, and the instrument a choice one specially made by him to be presented to the celebrated Prof. Playfair, by his admiring students in the University of Edinburgh; and by Playfair's executors, again, presented after his death to the Royal Observatory, Edinburgh, where it is still preserved in honour. C. PIAZZI-SMYTH

15, Royal Terrace, Edinburgh, October 10

The Sky-Glows

IN reply to Mr. Backhouse's question (p. 511) as to where the context of Mr. Neison's remarks can be seen, I can only say that I do not know. I came across the portion quoted relating to these phenomena at the end of the Astronomer-Royal's Report upon the Weather of 1883. Like Mr. Backhouse, I have been on the look-out for solar halos, or big rings round the sun as we call them, for the last thirty years, more with a view to be prepared for squalls, &c., when boating, than anything else. But for some years there has been so much haze about the sun, and the weather has so often cried "Wolf," so to speak, with no responding gale or squall, that of late I have ceased to take much note of such warnings. I may here mention that the rosy corona, when visible, as it so often is now, can be well seen by looking towards the place of the sun, but standing in the shadow of some high building; or at times by totally eclipsing the sun with a hat held between him and the eye.

As far back as January 1, 1884, in a letter to the *St. James's Gazette*, I ventured to predict that we had not seen the last of what were then spoken of as the "Recent Sunsets"; there was a very remarkable after-glow ten days after this, reaching the zenith, seen even in London. In the same letter of January 1, I suggested some increase in solar energy as the cause of these phenomena.

For some time, though feebler repetitions of the glows continued to be seen up to the end of March, there was nothing strong enough in the way of colour worth noting. But from what I continued to see in the shape of vapour, together with that strange warm colour by day about the sun, I felt sure that whatever might be the cause of these phenomena must still be going on, and in a short note dated April 12, I again spoke of their probable early reappearance. A graphic account of these after-glows, written by an observer at Smyrna, appeared in the *St. James's Gazette* of February 25, in which he pointed out what I have often since noticed, viz. that with excess of moisture all colour disappears.

This was at times very remarkable in the early part of July this year, when we had some of the strangest white sunsets I have ever seen. The sky around and above where the sun had set, looking almost ceiling-like in its opacity, upon which soon appeared numbers of weird small cloud forms, at times very regular, like ripple-marks in sand, or the bones of some great fish or saurian embedded on a slab of stone.

Against these pale sunsets all buildings and trees told like black velvet, while the clouds would rest almost stationary for a long time. Years back such a sky would have betokened a hurricane; but evening after evening they were repeated, and no storm of any importance followed. For many years past, but notably during the summer of 1883, I had observed a steady increase in a white luminous glare about the sun, so much so that I wrote about it in the year 1882 to my brother in India. I was not therefore surprised altogether when as the sunsets increased in colour, which they mostly do in autumn, that this glare last winter was followed by something more than usual in the way of colour; and here I should like to say that, as far as I have seen, and I have missed very few chances of watching them, that though last winter twilights often increased up to a certain time in strength, yet they did not exceed in duration the time allotted to twilight in the almanacs. This letter is already too long, but I cannot help asking, in conclusion, whether it may not be possible that we have been all along muddling up cause and effect, and that the eruption at Krakatoa, the recent earthquakes and waves, as well as the strange atmospheric phenomena, which are still about us, cannot all be traced to one cause, viz. actual increase of sun power?

Southampton ROBERT LESLIE

THIS evening after sunset I noticed a column of yellowish light over where the sun had set, and moving with the sun. I have seen the same before. Can it be the zodiacal light? I have frequently noticed during the present year, while the sun was much too high for any sunset colours, a pinkish colour in the sky. This has been observed by others, but I do not know whether it has been seen outside the British Islands. It must be connected with the sunset-glows which several of your correspondents have described. JOSEPH JOHN MURPHY

Belfast, October 12

Circular Rainbow

IN the notice given in NATURE (Sept. 11, p. 465) of the beautiful circular rainbow that is seen in the spray of the Montmorenci Falls near Quebec, the expression in the heading, "seen from a hill-top" will convey an erroneous idea without some explanation. The complete circle is only seen by getting down in the spray to the edge of the low rocks, within a few inches of the level of the water, and the circular bow then passes down to the feet on each side; it is indeed most perfectly seen by turning round and stooping down to look back between the legs, when the complete circle is seen without interruption from the feet. The bow is small in diameter, and is a narrow band, appearing nearer to the eye than an ordinary spray rainbow. I had the pleasure of seeing it on August 25, on the occasion of the British Association Canadian visit. WILLIAM P. MARSHALL

15, Augustus Road, Birmingham, October 13

To Find the Cube of any Number by Construction

PROF. KARL PEARSON has kindly referred me for a *simple* graphical construction for any positive or negative power of any rational quantity whatever to Egger's "Grundzuge einer graphischen Arithmetik." This method, he informs me, is reproduced in Cremona's "Il calcolo graphico." I was of course aware that there were several simple constructions. I was induced to write upon the subject owing to the unexpected discovery that there was a line in the geometry of the triangle which enabled one to obtain the cube of a number.

October 14 R. TUCKER

EXPLORATIONS IN ICELAND[1]

THE LAVA DESERT OF ÓDÁÐAHRAUN

ON July 25 we set out for the southern Dyngjufjöll, in order to examine Askja. All previous explorers of that volcanic locality have taken the northern route from Svartárkot, but no one has hitherto approached it from the east, from Herðubreið, any advance from that side having been deemed impracticable. This I wanted to test for myself, and shaped my course from the tent (pitched, as before said, to the south of Herðubreið) in a direct line on the wide gap that opens in Askja to the east. The whole intervening country was one continuous succession of lavas, so effectively covered with pumice and scoriæ from the great explosion of 1875, fortunately for us, that the whole was really one scoriac plain, the pumice boulders measuring generally one to two cubic feet, some more, some less. If it had not been for this scoriaceous cover, these lavas would have proved pretty certainly utterly impassable for horses. We took good care to keep to the crests of the thickest pumice-drifts, and though such travelling is rough enough for horses, yet they sustain no great harm, because the pumice is so light and brittle. Under the south-eastern spurs of Dyngjufjöll we came upon a lake, shallow, but of considerable magnitude, of the existence of which there was no previous knowledge. About midway between Herðubreið and Dyngjufjöll the country begins to rise up towards the aforementioned gap in Askja. Askja is a cauldron-shaped valley in the centre of Dyngjufjöll, which is an enormous complex of mountains 4500 feet high. This valley contains innumerable craters which have erupted at various periods; the sides of this valley rise to between 700 and 800 feet, but out of the aforementioned gap lavas have flowed over the lower country outside all the way down to Ódáðahraun, forming an enormous oval of an average incline of 4° 33'. When we came close up to the gap, the scoriæ ceased, and at once the lava became exceedingly difficult to pass. But by aid of frozen snowdrifts filling dips and dints in the slopes, we managed to thread our way along, and thus actually to get into the valley; only one single tongue of lava we had to cross without the aid of snowdrifts—one which, though very narrow, we had the greatest difficulty in getting our ponies over. Having at last succeeded in this, we rode along frozen snowdrifts under the southern slopes of the Askja valley, and thus reached actually on horseback the craters which exploded here in 1875. Previous visitors to Askja have entered the valley through a pass in the mountains inclosing the valley from the north, outside which pass they have had to abandon their horses and to reach the craters on foot over an almost impassable lava-stretch in the bottom of the valley, taking four to five hours in passing the distance from the pass to the craters. From our tent by Lindaá it took us nine hours to reach the craters, but the return route we accomplished in seven. We now left our ponies provided with their fodder beside the large eruptor of 1875, and set off on foot to examine the locality in every direction, spending for that purpose the whole of the bright night and a portion of the next day. So over-covered was Askja with snow that journeying along here was like journeying in the heart of winter. The whole mass of Dyngjufjöll is made up of palagonite breccia interspersed with layers of basalt. Into this mass Askja sinks in the shape of a shallow basin, and may derive its present form partly from certain stretches of it having sunk down in consequence of eruptions, partly from that natural dint or basin-formation of valleys which is so strikingly common to tufa mountains in Iceland. But the supposition that the whole of this valley, about sixteen square miles English, is one crater, the result of one great volcanic explosion, is unwarranted. In the great eruption of 1875 a very considerable extent of ground "fell in" in the south-eastern corner of the Askja valley round the craters, and the vertical precipice of the fractured crust of the earth on the side of the Askja valley measures, according to Prof. Johnstrup's survey, 740 Danish feet; that at the opposite side in the mountains is at least double in thickness. The vertical walls of the precipices exhibit in a clear manner the successive layers of lava which fill the bottom of the Askja valley. In the earth-slip thus created there was, in 1876, a small lake of dull-green colour, circular, and measuring about 4000 feet in diameter. This lake now fills the whole bottom of the slip and measures 10,000 feet in length. In 1876 the temperature of the water was 22° Celsius (71°·6 F.), but has now fallen to 14° C. (57°·2 F.). The crater, which by its explosion covered the east country with pumice and scoriæ in 1875, is situated in the north-eastern brim of the fissure, and is 300 feet in diameter and 150 feet deep; its outer circumference flat, and built up of scoriac ashes, its inside cylindric and perpendicular. In 1876 this crater only emitted steam, now it has turned into a boiling cauldron of clay, the clay mud at the bottom being gray with an admixture of bluish green tint, boiling and wallopping incessantly; through the south-eastern part of its bottom there issues by a subterranean vent a thick column of steam with loud roars and reports, and all around this column smaller fissures issue thinner jets of steam and fumes. Interspersed with the scoriæ in Askja and on the eastern side of the surrounding mountains are found small glazed grayish-blue pieces of trachyte thus formed by the last eruption: among these there are some found of which one-half, or a portion, is reduced to pumice, while the remainder retains its trachytic constituency. In the south-eastern corner of the dip right up from the water are also found a number of craters from which radiate rents and gulfs honeycombed with innumerable fumaroles and crater-tubes from which clouds of steam roll up high above the crests of the mountains, the roar and boom from which are heard to a great distance, resembling the rumbling sound of steam let off from many boilers at once. Deposits of sulphur are already visible round a number of the fumaroles, and yellow-green patches of sulphur show all about the precipices, where every chink and rupture lets off sulphurous fumes. In the eastern part of the slip the scoriaceous layers

[1] Continued from p. 565.

have recently been rent asunder by a rift 150 to 200 feet deep, reaching from the summit of the mountain all the way down to the water. Across this rift there is no way of passing, and, in order to reach the south-eastern corner of the slip, it is necessary to scramble up to the top of the mountain, so as to get round the crevasse. It is difficult to form any adequate conception of the titanic grandeur of Nature at this spot. He who has once had the opportunity of viewing it from the precipice of the earth-slip will never forget the impression. Having finished my survey here, we returned to our tent the same way we had come, glad of rest, exhausted with fatigue and want of sleep as we were, after thirty-six hours' continuous travel.

On July 28 I set out on my return journey to Mývatn, taking a direct course across the northern part of Ódáðahraun to the farmstead of Grænavatn, on the southern side of the lake (Mývatn). This I did with a view to rediscovering the whole of the old highway, the eastern end of which I had already traced. First we shaped our course directly for the northern end of Herðubreiðarfjöll, guided by the beacons to which I have alluded already. We crossed a pass, dividing the easternmost neck of the mountains from the main range, in the eastern approach to which an excessively rough lava, split by innumerable rifts, had to be traversed, in which we succeeded by the mode of scrambling. On the verge of one of the rifts in this lava we came upon a dilapidated beacon, and again upon another on the western defile from the pass, from where we threaded our way along the skirts of a recent and very rough lava, directing our course for the central peak of Herðubreiðarfjöll. Here we were intercepted by two enormous rifts, 100 to 150 feet deep, divided by an earth-slip one mile broad, and twenty miles long. With the exception of Almannagjá and Hrafnagjá, near Thingvellir, these are the largest rifts in Iceland. Having succeeded in bringing our caravan over the eastern brim down alongside the spurs of an isolated "fell," we charged the western brim in vain for a long time until we came upon a sort of steep pass, up through which we brought our ponies, and found upon the verge three dilapidated beacons, which showed that we were still on the traces of the old highway. From this spot beacons may be still traced in a straight direction for Fremri Námur, but recent rifts and lavas have destroyed the road, which, though I now knew its direction, I could pursue no farther. Here, namely, we thought we had overcome all difficulties, but found soon to our cost that we were mistaken. Some distance to the east of Fremri Námur there is a quite recent-looking lava, very long, but narrow, which evidently has welled out of a lava fissure here in 1875, when, besides Askja, Mývatnsöræfi also were in a state of volcanic activity. This lava is not connected with the well-known more northerly lavas of 1875, wherefore its existence has been overlooked hitherto; and when Johnstrup constructed his map of the lava of Mývatnsöræfi, he was not aware of the fact that the same rift which gave birth to the northern lavas of 1875 had, further to the south, given existence to this, which measures fully one-half of the others. To the east of this lava the earth is all cut up by bottomless cracks, over which it was truly a breakneck business to pass. Across some we had to urge our ponies to jump, others we passed by means of natural bridges of loose boulders, which frequently gave way. This was travelling with one's life in one's hand, and to me it is the greatest wonder that no harm resulted to man or beast. To attempt crossing this new lava was entirely out of the question, so we had to bend our way southward along its eastern skirts until we might get round its southern spur. At this end of the lava I observed a peculiar rift not more than thirty to forty feet long and three to four inches broad, on which twelve craters were situated, in every way formed and shaped as large craters are generally, but of such miniature dimensions, that they looked as if they had been intended for toys for children; the aperture of most of them was only four to five inches in diameter, that of the largest two feet. These had, however, squirted forth dashes of lava to the distance of sixty feet. When at last we had reached the southern end of the lava, a new trouble intervened in the shape of what appeared to be an endless rift, and utterly impassable. We had therefore to make up our minds to spending the night, or whatever time might be required, in finding a passage across this barrier; and after five hours' weary struggle we at last managed to scramble across where the main crack split up into smaller ones. This was hard work for our ponies, languishing with thirst and with hardly anything to eat; and perhaps only a degree less arduous for us, who in the matter of food and drink were no better off. Having crossed this serious barrier, we came upon a much more even tract of lava, and presently, to our intense relief, struck a pool of water under a snowdrift in a dent in the lava, where, having watered our horses, we treated them to the last scanty remainder of their fodder, and then went on our way. In the early morning we reached the valley called Heilagsdalr in Bláfjöll, where we were obliged to pitch our tent in order to give the exhausted animals the benefit of the scanty pasture which a few plots of grass offered. After a few hours' welcome sleep we broke up hastily, a gale of wind with rain and sand-drift having burst upon us in the meanwhile. Our course now lay across the spurs radiating to the eastward from Bláfjöll, but such was the violence of the hurricane that it was well nigh impossible to sit on horseback without being blown away, and equally difficult to guard against the despairing animals being blown out of our hands into the howling wilderness. After some really considerable trouble and hardship, we managed to scramble down a precipitous gorge into the upland plateau on which the Lake of Mývatn has found its bed. After having more than once lost our bearings on these lower lava wilds, we succeeded at last in striking the homestead of Grænavatn, exhausted with our exertions, and were glad of a grateful rest in good beds, after having spent a fortnight in a tent, with our saddles for pillows.

TH. THORODDSEN

Reykjahlíð, near Mývatn, August 4

STORAGE BATTERIES

THE importance and desirability of an efficient and economical storage battery have been very widely recognised, but it is at the present time pretty generally felt that no existing form of storage battery is perfect, and that they are on the whole extravagant and wasteful to an extent sufficient to more than compensate for their undeniable convenience. It is perfectly certain that their employment has not become at all general, and that they have failed to realise the somewhat sanguine hopes of their early promoters.

It seems worth while to examine into the causes of this partial failure, and to inquire how far the evil opinion held by many practical men concerning our present method of storing electrical energy is justifiable.

One of the main objections is that storage involves a loss of some 50 per cent. of the whole. Now all methods of storing and transmitting energy involve some loss. To say that any particular method involves a loss of 50 or even 90 per cent. is not to condemn it utterly. There are many cases when the convenience of storage outweighs the evil of waste altogether; three principal ones may be specified.

(1) When the power of the source would be otherwise so completely wasted that every fraction of it stored is clear gain. This is the case of much terrestrial water power. The energy of the tides or of Niagara is enormous, and wholly wasted so far as human activity is con-

cerned; if 50 or even 10 per cent. could be stored in such a way as to be conveniently available, it would be of considerable value, and any arrangement capable of effecting this storage could only with injustice be stigmatised as wasteful. The solar energy of the Carboniferous epoch has most of it been wasted; but a small fraction—probably not a millionth per cent.—has been saved and stored in the Coal-measures. It is possible to abuse the coal for not having stored more, but we find it a useful modicum nevertheless.

(2) A second case when the advantage of storage overbalances the loss is when regularity and continuity of supply is needed, and when the source is irregular and fitful. Wind and wave power illustrate this kind of source; it is manifest that wind power has not been so largely used as it would have been, had it been steady and dependable. A practicable method of storing up its energy and giving it out as wanted would gradually cause it to be very largely employed. This case is also illustrated faintly by a gas-engine or jerky motor of any kind, and the regularity and dependableness of a storage cistern may very well make it desirable to put up with some waste provided it be not excessive. Mechanical devices for approximating to regularity, such as the use of slack driving belts, undoubtedly give rise to a waste of power, and so does any form of regulator. But in the utilisation of artificial forms of power like this, questions of economy become almost pre-eminent; and wastefulness is here a most serious objection, and, it may be, prohibitive defect. At the same time, if the engine is liable to stop, or if it is not always working, some mode of storing energy may be absolutely necessary, whether wasteful or not.

(3) Another case, and to some extent the converse of the last, is when the available source is weak, though continuous, while the power is only needed for a short time, but during that time is required to be great. This is exemplified in the operation of pile-driving, where energy is stored in the slowly-raised weight to be suddenly expended on the head of the pile, also in the operation of drawing a bow; or again when a small waterfall or steam-engine, running continuously, is to be utilised for lighting during five or six hours each day: the obviously right plan in such circumstances as these is to store the energy during the hours it is not wanted, and thus virtually to double or treble the power of the source while it is actually in use. Unless, however, the loss occasioned by storage were reasonably small, there would be but small gain in attempting the process in this third case.

It is plainly advantageous to devise a method of storing that shall give out the greater part of what is put in; but we see by these examples that a reasonable loss may be more than compensated by convenience, regularity, availability, and dependableness. Again, when energy has to be transmitted over great distances, it is in practice difficult or impossible to make the expenditure of energy at one end depend upon and be regulated by its consumption at the other; and so, without some system of storage, great waste will ensue during intervals of small consumption. Looking to the immense development which the transmission of energy may be expected to undergo in the course of the next few decades, a convenient and manageable method of receiving large quantities of transmitted energy, and of holding it in readiness until wanted, must be of prime importance.

It was in view of such applications as these that the invention of the storage battery by Faure was hailed with enthusiasm by the highest scientific authority in Great Britain; while the public, jumping to the conclusion that a thing for which so many uses could be instantly found must needs be a profitable investment, hastened to provide money, not for commencing careful experiments and perfecting the arrangement, which would have been wise, but for manufacturing tons of apparatus in its first crude, immature, and untried form. Some day it may perhaps be recognised that because it can be shown that a thing will be extremely useful when perfect it does not follow that it has already attained that perfection, that indeed probabilities based on historical developments are enormously against such abnormal and instantaneous maturity, and that the careful nursing and rearing necessary to healthy maturity are better given in the seclusion of laboratory and study than in the excited and heated atmosphere of the Stock Exchange. It is doubtless recognised already that all preliminary operations are better conducted on a scale smaller than the wholesale manufacturing one. In developing a new industry there are scientific difficulties to be overcome, and there are manufacturing difficulties. By scientific difficulties we mean such as the determination of weak points, the best ways of strengthening them, and generally the discovery of theoretically the best modes of effecting the object in view: manufacturing difficulties begin with questions of expediency and economy—how most cheaply and satisfactorily to carry out the indications of theory, to obtain this or that material—and include the organisation of a system of manufacture, of division of labour, of machine tools, which shall enable the work to be done with economy, security, and despatch. Over-haste in the preliminary stages causes both these sets of difficulties to be tackled together, and so throws a grievous burden on both adviser and manager. All these untoward conditions have storage batteries experienced; and to say they have not fulfilled the hopes of their early promoters is no more than to say that those hopes were untimely and unreasonable. The period of maturity has been undoubtedly delayed by injudicious treatment, but its ultimate attainment seems to us inevitable; and it is at present a matter of opinion how nearly it has already been reached: certainly great steps towards it have been made. Let us inquire what some of the difficulties encountered have been, and it will be seen that, formidable as some of them are, they belong essentially to an infantile stage, and are not suggestive of constitutional debility.

The first form of manufacture consisted in rolling up sheets of lead and composition, with trousering to keep them separate. The difficulties found were that the coatings would not adhere, but became detached in large flakes; that the trousering got corroded through and permitted short circuiting; and that free circulation of fluid being impossible, the acid became exhausted in some places and concentrated at others, and thus every sort of irregularity began. Now regularity or uniformity is of the most vital and fundamental importance in any form of battery. If any part of a plate is inactive, that part is better away; if any plate in a cell is inactive, it is better away; and if any cells of a battery are inactive, they are infinitely better away. The rolling or coiling up of the sheets being found awkward in practice and liable to detach the coatings, flat plates came to be used, then perforated plates, and then cast grids; these last having such large hole space that they held enough composition, and held it securely enough, to enable the trousering or intermediate porous material to be dispensed with. This was an evident step in advance: free circulation of the liquid became possible, and could be assisted by stirring; there was nothing to corrode except the plates themselves, and the composition, being in the cells or holes of the grid, might be reasonably expected to adhere. So far expectation was not altogether belied. The adhesion was not perfect, it was true, and pieces of composition sometimes fell out of the holes, especially if too powerful currents were passed through the cell, but still it was much better than it had been; and if the plates were well filled, properly formed, and fairly treated, the composition adhered extremely well and securely. The circulation of the liquid was not automatically perfect either, but mechanical agitation could be readily applied; without it the acid near the bottom of the cells tended to become more concentrated than that near the top, not by reason of gravitation

undoing diffusion, which is impossible, but because during each charging fresh acid is formed, and in great part falls to the bottom in visible streams. Another great advantage was that some amount of inspection of the plates became possible, and experience as to the actual behaviour and appearance of the plates, began to be accumulated. And painfully varied that experience was. Every variety of extraordinary behaviour which could be suggested as probable, and a good many which no one could possibly have imagined beforehand, made their appearance. The hundreds of tons of batteries made at this period doubtless enabled these unpleasant experiences to be more rapidly acquired than would have been done on a small scale, but it was a costly series of experiments. However, the experiments were made, the public involuntarily assisted in the acquisition of experience, and, caring less for knowledge than for marketable commodities, they expressed dissatisfaction at the result. Many of these incipient difficulties are now overcome by the manufacturers, but the great dislike of the public to involuntary experiments, and the shock which their confidence underwent on being unexpectedly called upon to participate in research, have not yet altogether abated.

The main difficulty now experienced was how to keep the plates from touching. They might be put in wooden frames, or elastic bands might be stretched round each of them, and if they would only keep flat it was impossible they should touch unless the composition should drop out of the holes. Sometimes the composition did drop out of a hole, and bridge across the interval between two plates, but the more common and more fatal experience was that the plates would not keep straight. In few months the positives were found to swell, and as they swelled to buckle—to buckle and twist into every variety of form, so that elastic bands, wooden frames, and every other contrivance failed altogether to prevent short-circuiting. The cause of the buckling is of course irregular and one-sided swelling, and the cause of the swelling is apparently the gradual peroxidation and sulphating of the material of the bars of the lead grid, which occupy less room as metallic lead than as oxide or salt. As the bars swell, they press on the inclosed composition, occasionally driving it out, but more frequently, and with properly made and treated plates universally, distending themselves and stretching the whole medial portion of the plate. The edge or frame of the grid is stronger than the middle bars, and is not so easily stretched; in a good and uniformly worked plate it does stretch, and an old positive plate is some quarter of an inch bigger every way than a new one, but if one face of the plate is a trifle more active than the other, it is very plain that the most active side will tend to become convex; and buckling once begun very easily goes on. To cure it two opposite plans have been tried: one is to leave the plates as free and unconstrained as possible, hanging free it may be from two points, thin, and with crinkled or crimped margins to allow for expansion; the other is to make them thick and strong, with plentiful ribs for stiffness, and besides to clamp them up one to another as tightly as may be, and thus in mechanical ways to resist buckling and distortion. I do not know that any one could say for certain beforehand which of these two plans would be likely to answer best, but practice is beginning to reply in favour of the latter, and well braced plates of fair thickness show no unmanageable tendency to buckle. It must be remembered that no material can buckle with a force greater than that necessary to restore it to flatness, and this force in the case of lead is very moderate. Hence it may be fairly hoped to overcome and restrain all exuberances by suitable clamps and guides arranged so as to permit flat and even growth, but to check all lateral warpings and excrescences.

Uniformity of action is still essential, especially if all the plates in a cell are clamped together. Plates mechanically treated alike ought to be electrically so treated also, and it is impossible to keep a set of plates working satisfactorily together unless the contact of each is thoroughly and equally good, so that each may receive its fair share of current. Defects of contact have been a fruitful source of breakdown and irregularity. Clamps and screws of every variety have been tried, but the insidious corroding action of nascent oxygen exerted through the film of acid which by spray and creeping forms and concentrates on the lugs—this corroding action crawls between the clamped surfaces, gradually destroys all perfect contact, and sometimes produces almost complete insulation. Contacts on the negative plates give but little trouble; contacts on the positives have taxed a great amount of patience. Lead contacts "burned," *i.e.* melted, not soldered on, are evidently less liable to corrosion than brass or copper fittings, or than any form of clamp, but they are apt to be somewhat clumsy if of sufficient conductivity, and moreover they are awkward to undo again, and somewhat troublesome to do. However they have proved themselves so decidedly the best that now no other contacts will be used, and their re-introduction has been followed by a marked improvement in the behaviour of the cells. So long as contact with one plate was better than with another, a thing quite possible to happen without any difference being perceptible to the eye, so long was it possible for one or two plates to remain almost wholly inactive while another one or two received far more than their share of current, and became distended, warped, overcharged, and ultimately crumbled away. If one or two plates in a cell are black, and giving off torrents of gas, while the rest are brown and idle-looking, it is pretty fair evidence of irregular and insufficient contact, or else of some great discrepancy in the age or make of the plates. This point also is one that was not attended to in the early stages of manufacture; plates were made for stock, and cells were made up with plates of all ages selected at random from the store. Directly uniformity is perceived to be essential, this is recognised as obviously bad. Plates intended to work together should be of the same age and make, and inasmuch as keeping does not improve them, the best plan is not to make for stock, but to keep material ready, and then quickly make up as wanted. Plates in work deteriorate slowly, but they are wearing out in the fulfilment of their proper function; plates in idleness deteriorate as quickly, and they are rusting out in fulfilment of no function at all. Worn-out plates, however, are by no means valueless. Lead material has a well recognised price, and if attention were given to the subject, it is probable that decrepit and useless plates might be made to yield a very large percentage, if not the whole, of their original lead. For it must be remembered that plates deteriorate not by waste but by accretion: an old plate contains as much lead as a new one, but it contains it with the addition of oxygen and sulphion; no longer a tenacious coherent frame, but a crumbling mass of incoherent powder.

The age of plates is a point of vital interest, though but little is known as to the possibilities in this direction at present. A year may be regarded as a fair average age at the present time; but this is a low rather than a high estimate. Thick plates are found to last far longer than thin, which is only natural when it is remembered that the wearing out is due to corrosion, that corrosion proceeds mainly from the surface inwards, and that the internal portions of a thick plate are to a great extent protected by the mass of superincumbent material. If it can be shown, as we understand it can, (1) that the cost of materials is far more than the cost of manufacture; (2) that the worn-out material has a market value not incomparably less than the original; and (3) that the frequency with which plates have to be renewed is not such as to cause much inconvenience; then we hold that the first stage of the durability difficulty has been over-

come. Much more may be hoped for in this direction as experience increases, and it is not extravagant to hope that a well-ribbed, properly-clamped, and fairly-treated thick plate may last as long as five years before it becomes disintegrated.

It is evident, however, that in a region where pure experiment is pre-eminent, and where the units of time are months and years, instead of hours and days, the accumulation of experience is a slow and tedious process. It is no use making statements involving periods of five years when no one has had the present improved form in use for so much as six months. Nevertheless it is possible to see that the present cells are better than their predecessors; and as their predecessors have lasted in good condition for a year and more it is not presumptuous to indulge in well-founded hopes. Many of the difficulties connected with the early forms of battery were aggravated by Utopian notions concerning internal resistance and compactness. The internal resistance of a cell was so beautifully small, that the manufacturers were tempted to diminish it still further by putting the plates far too close together. An eighth or tenth of an inch interval is well enough if the plates had been hard rigid slabs of perfect flatness; but it was madness to pack flexible lead plates full of composition certain to swell and liable to drop out so near together as this. Security and dependableness were sacrificed to a natural desire for sudden and Utopian perfection. We may hope that these lessons have been profited by, and that the manufacturers perceive that confidence and security are the first conditions of success, and that minutiæ as to the number of noughts before the significant figures in the specification of resistance begin, though those also are of importance in their turn, are yet of quite secondary consideration. Moreover, this packing of the plates so closely did not really do much to secure the result desired; the greater part of the resistance of half run-down cells is not in the liquid between the plates, but in the surface or scum separating each plate, and especially each negative plate, from the liquid, and hence putting the plates a safe distance, say a quarter or one-third of an inch, apart exerts an effect on the total resistance which is certainly far more than compensated by the ready opportunity thus afforded for access by both sight and touch. The old opaque boxes chock full of plates, with slight india-rubber bands between them, were started and left to Providence. No one could see what went on, nor could one readily get at anything to rectify what was wrong. In the present glass boxes properly arranged on accessible shelves with only plugs or studs between the plates, clear vision through the cell in any direction is easy, and accidental obstruction not only very seldom occurs but if it does it can without difficulty be seen and removed. But it must be granted that these boxes are less compact than their predecessors, and for some purposes, such as locomotion, compactness is of the first importance. Most true, for some purposes. It is not to be supposed that one type of cell will answer every possible demand. A dynamo to be highly efficient must have a large and massive field magnet, but in some places bulk and weight are fatal objections, and in these places smaller and more compact dynamos may be more suitable: something, however, must be given up to secure the required lightness and compactness, some sort of compromise must be effected. Just so with cells: we can point out what is theoretically the best form, and this form may, for large stationary electric light or power installation, be actually the most suitable; but we may also see that for boats, for tramcars, and for fish torpedoes, some very different and far more compact form may be quite essential.

Efficiency, Durability, Economy, Compactness: it may not be possible to attain all these at once—if it were, there would be small room for discussion—but sometimes one and sometimes another will be the pressing necessity, and manufacturers of storage batteries, like manufacturers of dynamos, must be prepared with forms suited to various needs.

We have spoken mainly of difficulties connected with the positive plates, and have said nothing concerning the negatives. It is not that these are not susceptible of improvement, but their faults have been of a less imperious and obtrusive nature. They are not perfect, but they do fairly well, and there has been little need to worry much about them, until the extraordinary behaviour of positives had been taken in hand and checked. The time is coming to attend to these also. They fail not from exuberance, but from inertness. As they grow old, they do not swell, and warp, and burst, and crumble, like the positives, but they grow quietly hoary, and serenely decay. The composition in a worn-out negative consists of white sulphate through and through, but the frame remains intact, and it consequently never falls to pieces, nor does it swell. Impurities in the acid used tell upon a negative plate—nitric acid is fatal. Acid much too weak or very much too strong is also deleterious, and idleness is bad. The difficulties connected with negatives mostly depend on their aggravating property of always requiring a quite opposite treatment to positives. The less a positive is formed and overcharged the better. A negative delights in complete formation and frequent overcharge. In recognition of this it is now customary to form them separately, and to give the negative a thorough dose of hydrogen without commencing the corrosion of the positive by an overdose of oxygen. When the discharge from a cell begins to flag, it is the resisting scum of sulphate that has formed over the negative plate which is responsible for the flagging. The true E.M.F. of a cell is wonderfully constant throughout the whole discharge; but the internal resistance is all the time increasing, at first very slowly, ultimately, towards the end, with a rush. One such run-down cell in the midst of a lot of others therefore obstructs the current terribly. If only a series of cells could with certainty be made to work together uniformly, if a series could behave as well as some of the cells in it, no one would have cause to complain.

Through the whole history of the manufacture, from the very beginning, a few cells here and there have always exhibited astonishing efficiency;—the aim of manufacturers may be said to be to bring all cells up to the level of a few. Much progress in this direction has been made, and it may be very fairly expected that, as uniformity is gradually attained, a series of cells subjected to the same treatment may behave in the same manner. Whenever this is certainly accomplished, there will have been reached a high stage of efficiency, beyond which further progress need be only in the improvement of comparably insignificant minutiæ.

The subject of the electrical storage of energy is really one of national importance;—it is comparatively a small matter whether this or that form of storage, or this or that company of manufacturers, succeeds in bringing out the permanent form. It sometimes unfortunately happens that enterprising pioneers only clear the way, and retire just in time for other men to come in and reap the fruits of their labours. So much capital and so much labour have been already expended in the effort to bring storage batteries to perfection, so great progress has been made, and so apparently small are the steps which yet remain to be accomplished, that we may surely fairly hope that some of the original believers in their great, and as it seems to us inevitable, future may yet live to see their faith justified and their patience rewarded, and may even taste some of that so-called "substantial" reward without the hope of which great commercial enterprises would never be undertaken, and modern civilisation would have scarcely yet begun.

O. J. L.

METEOROLOGY OF THE LOWER CONGO[1]

... work Dr. Danckelman has made a valuable ...ibution to the meteorology of Africa. The ...ns, which are printed *in extenso*, were made at ... 35' S., long. 13° 52' E., at a height of 374 feet, ...1882 to August 1883. The hours of observa... 7 a.m., 2 p.m., and 9 p.m., and to these were ... the six months ending May 1883 observations ... and 8 a.m., which thus furnish important data ...ng the march of diurnal phenomena for the first ... hours after sunrise. The full details which are ...en of the instruments employed, their exposure, and the methods of observing are particularly satisfactory. While the instrumental observations are very complete, no less care has been taken to make the non-instrumental observations of weather equally complete, and these have been planned and carried out to aid in discussions affecting both local and general meteorology.

In resuming and discussing these sixteen months' observations, Dr. Danckelman has conjoined with the results obtained for Vivi the results of observations made at St. Thomas, Gaboon, Chinchoxo, Loanda, and Melange, these places roughly representing the west of Africa from near the equator to about lat. 10° S. At all these places the annual minimum pressure occurs in February or March and the maximum in July, with a small secondary maximum in January. At Vivi atmospheric pressure at 32° and sea-level is 29·932 inches in February, 30·117 inches in July, and 29·997 inches for the year.

At Vivi the mean annual temperature is 76°·4, the lowest monthly mean being 70°·5 in August, and the highest 79°·5 in February. The highest observed temperature was 97°·2 on November 5, 1882, and the lowest 53°·8 on July 29 of the same year. A noteworthy feature of the climate of Vivi is the relatively low temperature from June to September; during the other eight months the means vary only from 77°·4 to 79°·5. This feature is common to the whole of this region of West Africa; and it corresponds to the dry season of the year, which, as regards the Lower Congo, is characterised by Dr. Danckelman as undoubtedly the most agreeable and the finest, as well as the healthiest, season of the year. On the other hand, on the elevated plateaux of the interior, the heat is very great during the day, and many maladies prevail among the natives, numbers of the ill-clad blacks succumbing to the diseases caused by exposure to the low temperature of the nights. The temperature of the Congo was observed at intervals during the year, the observations being made at a part of the river where the current was rapid. The results give a mean annual temperature of 81°·8, being thus 5°·4 higher than that of the air.

Of the winds observed at Vivi the percentages are south-west, 39; west, 15; west-south-west, 9; north, 8; and calms, 18; winds from any other direction being of rare occurrence. Thus of the 82 per cent. of wind-directions observed, 63 per cent were from the south-west quadrant. During the whole year south-west winds predominate in the afternoon, but during the dry season the wind frequently veers to west towards evening, so that at 9 p.m. west and west-south-west winds are more frequent than south-west, whilst south and south-south-west winds very rarely occur. This striking predominance of south-westerly winds has important bearings on the climatology of the whole of the Lower Congo as respects humidity, cloud, and rainfall. A striking peculiarity of the climate are the strong winds which often set in late in the afternoon and evening, and which are carefully recorded in the journal of the observations. The following are the number of times such winds have occurred each hour from 3 p.m. to 11 p.m.,—6, 11, 24, 28, 30, 32, 22, and 4, the hours of greatest frequency thus being from 5 p.m. to 10 p.m. During the other hours of the day they seldom occur. The degree to which this prevails is seen from the fact that the mean force of the wind is greater at 9 p.m. than at 2 p.m., the latter hour being the time about which the wind generally attains its maximum diurnal velocity over the land.

Thunderstorms are of frequent occurrence from November to May, but none were recorded from June to October. As regards their distribution during the day, scarcely any occurred from 11 p.m. to noon, the period of maximum frequency being from 1 p.m. to 8 p.m.; but particularly from 4 p.m. to 6 p.m., 29 per cent. of the whole having occurred during these two hours. During the rainy season heat lightning is of frequent occurrence in the south, east, and north horizon, but rarely in the west. When the wind shifts from the ordinary south-west direction into east, the change is almost invariably followed by a thunderstorm, or by thundery-looking clouds, which indicate a thunderstorm not far off. Thunderstorms most frequently advance from the east. During the sixteen months the number of storms which advanced from an easterly direction was fifty-three, whereas only fourteen came from a westerly direction. The severest thunderstorms come from the north-east. They are intimately connected with the rainfall, which being wholly dependent on the thunderstorm, the diurnal periods of the two phenomena are the same. The rainiest months at Vivi were November, 11·34 inches; December, 8·94 inches; April, 9·10 inches; and March, 5·67 inches. The annual amount was 42·56 inches. No rain fell from June to September, and the fall in October was very small. During the dry season, however, when no rain falls, the hygrometer not unfrequently indicates an atmosphere highly charged with vapour, and occasionally a light drizzle sets in which the Portuguese call "Cacimbo," but the amount falling is too small to be measurable. These results show, in an unmistakable manner, the powerful and beneficial influence of the prevailing south-westerly winds from the Atlantic on the climate of this extensive region in the continent of Africa.

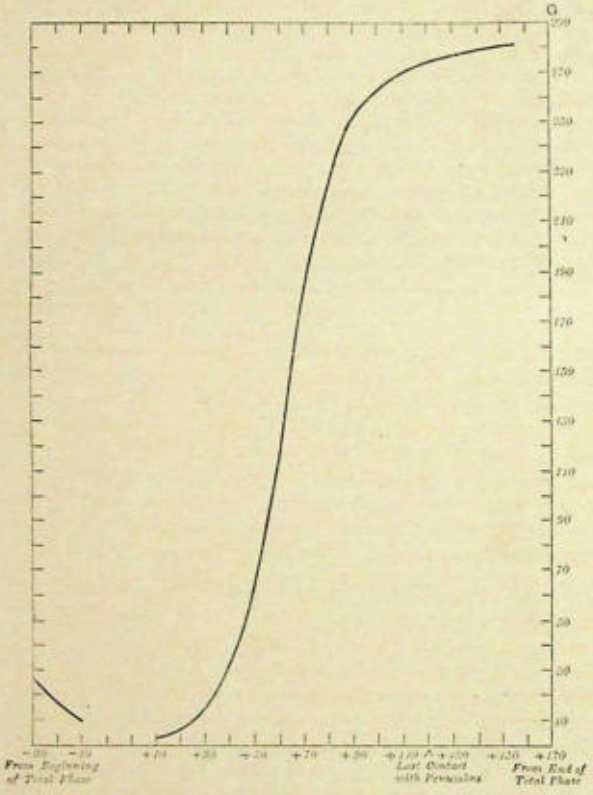
[1] "Mémoire sur les Observations Météorologiques faites à Vivi (Congo Inférieure), et sur la Climatologie de la Côte sud-ouest d'Afrique en général." Par Dr. A von Danckelman. (Berlin, 1884.)

THE RECENT ECLIPSE OF THE MOON

WE have received the following communications with reference to the recent lunar eclipse:—

THE total eclipse of the moon on Saturday, October 4, was of particular importance as it was—since the one in 1877, which was practically lost through bad weather—the first opportunity of measuring the changes which the heat radiated by the moon undergoes with the proceeding eclipse. And indeed on Saturday evening at six o'clock it appeared highly probable that the fate of this eclipse would be the same as that of its predecessor, the sky being thickly covered with misty clouds, with hardly any motion whatever. Suddenly, however, as if by magic, thirty-two minutes before the beginning of the total phase, they all disappeared, and left a most perfect and exceptional clearness behind them, which not only lasted during the remainder of the eclipse, but also through the two following days and nights. Thus I was enabled to carry out the greater part of my programme in every detail. The apparatus used was the same which the Earl of Rosse described in his communications to the Royal Society in 1869, 1870, and 1873; it condenses by means of two small concave mirrors alternately on two thermopiles the rays of the moon collected by the 3-foot telescope, and the currents thus created are measured by the aid of a galvanometer with mirror and scale. The time of exposure was 1 min. sid. time for each pile, and the observations were throughout the eclipse carried on with only two interruptions of eight and nine minutes, the former caused by my examining the condensing mirrors for dew, the

latter by the re-winding of the driving-clock of the telescope. Thus I took altogether 211 readings of the galvanometer, which were taken together in groups of ten for the formation of reliable mean values. It is these means—without the application of the still necessary reductions—which form the ordinates of the preliminary curve inclosed, the abscissæ of which are the times before the beginning and after the end of the total phase. It will be seen that no observations were made during the total phase, as I could not make certain that the moon's image was actually on the condensing mirrors; besides the readings of the galvanometer on near approach to the total phase became so unsteady and irregular that it was plain that the effect, if any, fell below the sensitive-



Curve showing the change of the lunar radiant heat as measured by thermopiles and galvanometer during the total eclipse of the moon on October 4, 1884, at Birr Castle Observatory, by Otto Boeddicker.

ness of the instrument and the unavoidable errors of observation. This is much to be regretted, as the few observations obtained before the total phase began show plainly that the minimum of the radiated heat takes place later than that of the moon's light. Indeed, so slowly did the readings of the galvanometer increase again that about twenty minutes after the total phase was over the almost entire absence of any effect led me to think that the small condensing mirrors must be covered with dew, an apprehension which was happily not verified. I should add that the galvanometer readings here given are not comparable with those published in 1873.

OTTO BOEDDICKER

The Earl of Rosse's Observatory, Birr Castle, Parsonstown

THIS eclipse was seen from here (height above sea 530 feet) to great advantage in a cloudless sky, with the stars very brilliant and the air calm.

For some minutes before the actual contact a faint smoky look was visible, and this had the effect of flattening the edge of the moon on the side towards which the shadow was approaching. At 8h. 16m. there was [illegible] but very perceptible shadow, about a fourth of the [illegible] diameter in advance of the dark shadow, and [illegible] minutes later the eclipse just entered the n[illegible] 8h. 44m. the margin of the dark shadow, which [illegible] along an edge of a woolly and irregular appea[illegible] now decided streaks in advance of it. The e[illegible] moon on the opposite side from the base to wit[illegible] the apex was marked by a rim of intense br[illegible] Ten minutes later the blue margin was less brilli[illegible] narrower, and the woolly appearance before mer[illegible] was more decided, but less streaky. At 8h. 58m. the [illegible] had contracted in length both at the base and apex, and gradually assumed a greenish shade. The cusps of the moon were elongated and more drop-like than continuous. At 9h. 18m. the shadow had almost covered the moon, which showed a faint glow beneath, though the circular appearance was not visible to the naked eye. A minute later, as the last point of light disappeared, a dense blackness of irregular form appeared on the opposite portion of the moon, extending over nearly a third of the surface. At 9h. 39m. the moon was scarcely perceptible to the naked eye. Through the telescope a faint luminosity at the apex could be discerned. At 9h. 47m. to the naked eye the moon seemed like a blurred star, very indistinct and considerably reduced in apparent size, and of no definite form. At 10h. 2m. the faint luminosity at the apex had almost gone, and the outline of the moon was more apparent through the telescope. The blurred, star-like appearance to the naked eye was still unchanged. At 10h. 9m. there was a thin luminosity on both horizontal sides of the moon. The apex of the moon was very indistinct. At 10h. 20m. a broader belt of light appeared on the northern side, but that on the opposite side was indistinct. There was still the same indistinctness to the naked eye, though every now and then a faint crescent-like appearance could be seen. At 10h. 38m. a somewhat broader crescent. At 10h. 43m. a bright light like that of the moon was visible to the naked eye at the apex, and four minutes later the moon reappeared. At 10h. 57m. the tip of a mountain was lit up near the moon's apex. At 11 p.m. the upper cusp extended further than the lower one. At 11h. 15m. a slight haze formed a burr about the moon, which was somewhat kidney-shaped. At 11h. 22m. the burr still visible, but much rounder in form. The eclipse ended at 11h. 45m.

Having previously observed a number of lunar eclipses, I was specially struck with that of to-night; the density and blackness of the shadow was far greater than any previous one that I had seen, especially throughout the period of totality. In all previous eclipses I have been able to trace the outline; in the present case this was quite impossible. Usually the outline is more or less plainly seen, and not unfrequently there is a strong reddish light. The last total eclipse of the moon was seen from this place, and it had a copper-coloured appearance, and there was no difficulty in tracing the outline. In the present eclipse the moon's outline was invisible for some time to the unaided eye, and the apparent size so much diminished that it had more the appearance of a large star whose light was just able to pierce through a dense haze. Some of the valleys of the moon were left for a time in great darkness after the light had travelled beyond them. I may mention that all the above appearances were also seen by Major A. E. L. Lowe and Mr. H. L. P. Lowe, who were using other telescopes.

E. J. LOWE

Shirenewton Hall, near Chepstow, October 4

IT is to be hoped that the unusual phenomena attending the late eclipse of the moon may lead to a discussion which will throw some light upon the great differences observed on different occasions in the visibility of the eclipsed moon—differences which have not hitherto, so far as I know, been adequately explained.

In the late eclipse, as viewed from this station (where the sky was not only perfectly cloudless, but free from the least suspicion of haze), the obscuration of the moon was carried to a degree far beyond anything witnessed in the eclipses of recent times. For some time before and after the middle of the eclipse (that is, about 10 p.m.) the only trace of our satellite that remained in the sky was a faint dingy-brown nebulous spot, to which it was impossible to assign any definite form or dimensions, but which certainly did not approach the moon in point of apparent size. So inconspicuous was it that it was quite invisible through the window of a room in which lights were burning; and in the open air, if one had not known exactly where to look for it, one might have searched for some little time without discovering it. I speak of course of the naked-eye appearances. With an opera-glass the nebulous spot was resolved into a well-defined disk of the proper dimensions, but still very faint and dingy, the hue being a kind of reddish-brown. It was further remarked that the illumination was uniformly distributed over the disk, at least so far as this, that there was no preponderance of light in the direction of any one part of the moon's edge. This is what should naturally have followed from the central character of the eclipse, but it seems desirable to note the circumstance with reference to a theory presently to be mentioned.

The most obvious explanation of the unusual obscurity of the moon would be its unusually deep immersion in the earth's shadow, but this view seems to be clearly disproved by a comparison with the phenomena observed in a former eclipse. Referring to a note which I made at the time of the eclipse of August 23, 1877, I find the following remark:—"The moon, even in the middle of the total phase, was a conspicuous object in the sky, and the ruddy colour was well marked. In the very middle of the eclipse the degree of illumination was as nearly as possible equal all round the edge of the moon, the central parts being darker than those near the edge." Now the duration of totality in that eclipse was 1h. 44m. In the late eclipse it was 1h. 32m. The immersion of the moon in the earth's shadow must therefore, I presume, have been at least as deep on the former occasion as on the recent one. It may be mentioned as an additional argument against this explanation that in the late eclipse the visibility of the eclipsed portion was observed to be much less than usual even before the eclipse was complete. In fact it was not until within a few minutes of the total phase that the eclipsed portion could be certainly distinguished with the naked eye.

Another obvious suggestion in the way of explanation has reference to variations in the condition of that portion of the earth's atmosphere through which the sun's rays would pass to reach the moon. This explanation is not without interest in connection with the remarkable sunset effects of last winter, and, in a less degree, of the present autumn. But there are serious difficulties in the way of accepting it, for, in order to account for the observed phenomena, it would be necessary to suppose that an entire ring of the earth's atmosphere was uniformly affected. A want of uniformity in this respect would not cause merely an uneven illumination of the moon's disk, which some observers seem to have noted, and which may very well be set down to the actual differences on the surface of the moon; the effect would be specially marked upon some part of the moon's edge, and would be similar to what is observed soon after totality has commenced and shortly before it ends. Nothing approaching to this appearance was to be seen in the late eclipse at the time when the obscuration was greatest.

Is it possible that the surface of the moon may be in some small degree self-luminous, and that a variation (from unknown causes) in the degree of this self-luminosity may account for the difference observed in the visibility of the moon in two eclipses, in both of which the solar light was equally at its minimum?

Clifton, October 7 GEORGE F. BURDER

ON the occasion of the total eclipse of the moon on Saturday, October 4, the Director of the Pulkowa Observatory, near St. Petersburg, issued a circular to a number of other observatories suggesting the use of the opportunity to fix the exact diameter of the moon, the mean value of the true diameter not being known to a second. Even as regards a probably existing depression of the surface of the moon, we know only that it cannot be very great. The circular also requested observers to watch attentively all stars, even those of the tenth magnitude, eclipsed by the moon, and their egress on the other side, which is only possible during a total eclipse. In order to make these observations exact, Prof. Döllen, of the Pulkowa Observatory, calculated the number of such stars covered by the moon on that date, which he finds were 116, most of which are of the ninth and tenth magnitude and only one of the sixth. He has, moreover, for the use of observers, calculated the exact position of these during the eclipse for no less than sixty observatories from Pulkowa to the Cape, which is expected to give the desired result.

NOTES

OUR readers will hear with sincere regret that Prof. Huxley, under the orders of his medical advisers, left England yesterday for some months of absolute rest. When it is remembered how many functions Prof. Huxley has to fulfil, we need hardly say that the cause of his enforced retirement for a time is overwork. His presence in England will certainly be missed during the coming winter, and he may feel assured that he carries with him the sympathies of many friends, known and unknown. Prof. Huxley goes in the first instance to Venice.

WE heartily support the suggestion which has been made in the *Gardeners' Chronicle* that it would be most appropriate that some memorial of the late Mr. Bentham should, subject to the consent of the authorities, be placed in the Royal Herbarium at Kew, to which he was such a benefactor, and in connection with which his life-work was for very many years carried on. Official etiquette would probably preclude any steps being taken by the authorities at Kew in the matter; and, indeed, it is a subject that would more gracefully and appropriately be dealt with by outsiders.

SIR WILLIAM HARCOURT is always happy when he touches on science, either to point a political shaft, or, as on Tuesday at Derby, when descanting directly on its progress and bearings. He showed himself well versed—as one bearing the honoured name of Harcourt ought to be—in the history of scientific progress, and in the high importance of science apart from its utilitarian uses. Scientific study, in his conception, is above all others "the most useful and the most ennobling." "Depend upon it," he concluded, "if I may turn for a moment to the utilitarian view, these are not days in which we, as a people, can afford to be idle or to be ignorant. There is an immense competition going on in the world in all departments of trade. Remember you have the competition of countries where education of this character is of a more complete character, far more complete than anything we have in this country. If you go into Germany you will find in every small town that there are institutions where the severest education is given in all departments of technical knowledge. The old days when people could afford to go on in an easy, happy-go-lucky sort of manner are gone by. You may depend upon it, in the race which we have to run in the world, a training of the severest description is requisite, so that we may hold our own." We trust Sir William will bear his admirable Derby

utterances in mind when as a legislator he has to consider the relation of science and of scientific workers to the Government and the country.

PROF. HUGO GYLDÉN, Director of the Observatory at Stockholm, and well known for his studies during recent years of the eight great planets, has been offered and has accepted the Professorship of Astronomy at the Göttingen University.

HIS MAJESTY the King of Italy has conferred the decoration of Knight of the Crown of Italy upon Deputy-Surgeon-General Francis Day, formerly Inspector-General of Fisheries in India, and lately Commissioner of the Indian Section in the great International Fisheries Exhibition.

DR. SOPHUS TROMHOLT having returned to Bergen after a lengthened sojourn in Iceland, whence we have from time to time received accounts of his researches, intends for the next few years to devote his time to the production of a great catalogue of all the auroræ seen in Northern Europe from the earliest times. The Norwegian Government have granted a not inconsiderable sum towards this gigantic undertaking. As this labour and the imminent production of his new work, "Under the Rays of the Aurora Borealis," will occupy all his time for some while, the distinguished *savant* announces his inability to issue for the coming winter such sheets for the recording of auroræ as he has for some years been in the habit of distributing over all parts of Northern Europe. He trusts, however, that observers may continue to note the phenomena as heretofore on the lines laid down by him, and forward the same to him with as little delay as possible. His address is Bergen.

CHANDA SINGH, a blind student of St. Stephen's College, Delhi, is, according to the account given in *Allen's Indian Mail*, a prodigy. He cannot read or write, but possesses such a strong memory as to be able to repeat all his text-books, English, Persian, or Urdu, by rote, and to work out sums in arithmetic with remarkable rapidity. The unusual intensity of his mental powers is shown by his ability to multiply any number of figures by another equally large. At the last University examination he was examined *viva voce* by order of the Director of Public Instruction of the Punjaub, and he stood twenty-seventh in the list of successful candidates. On the recommendation of the same official, the judges of the local court have allowed him to appear at its law examination. Memory, as is well known, is wonderfully developed in Orientals, owing to the system of education which has obtained amongst them; but cases like Chanda Singh must be very rare even in the East.

DURING the last week of September the Thüringo-Saxon Verein für Erdkunde held its annual meeting at Kösen under the presidency of Herr Dunker (Halle). Amongst a number of interesting papers read we note the following:—On Baku and its naphtha and petroleum wells, by Herr Eberius (Döllnitz); on the scientific and economical importance of Cameroon, by Prof. Kirchhoff; on the limits between the High and Low German on the eastern side of the Elbe, by Dr. Haushalter (Rudolstadt); on the salt and fresh-water lakes between Halle and Eisleben, by Prof. Kirchhoff; on ancient places of worship in Northern Thüringia, by Dr. Rackwitz (Nordhausen).

THE thirty-second annual meeting of the German Geological Society took place at Hanover in the last week of September under the presidency of Herr von der Decken. Among the papers read we note the following:—On the limits of the Dyas formation, by Prof. Geinitz (Dresden); on the geology of North-Western America, by Prof vom Rath (Bonn); on the Brachiosaurus occurring in the Hessian limestone, by Prof. Credner Leipzig); on the geology of the Harz Mountains, by Herr Langsdorff (Klausthal); on the occurrence of dolerite in the Vogelsberg, by Prof. Streng (Giessen); on Tasmanian tin ores, by Herr Gordaek (Klausthal); on new Devonian Bryozoa, by Dr. Bornemann (Eisenach). The next place of meeting will be Darmstadt.

WRITING on a subject of some interest at the present time, viz. the orthography of the names of the better known Chinese places, a correspondent of the *Tablettes des deux Charentes* says that *Tonquin* is more correct than *Tonkin* (and we presume also than *Tongking*, *Tonking*, &c.), for this is how the name is pronounced. He thinks that French pronunciation generally approaches that of the Chinese more than the English. Thus the Chinese have the nasal sound of *n* and a sound of *u* which we in England do not possess. We cannot always reproduce these Chinese sounds, while the French can do so easily. To represent the nasal sound the English add a *g* to the *n*, but they do not always pronounce it. The French borrow the English orthography, but they pronounce the *g* which the former have added, and thus completely disfigure the names. Thus (the correspondent goes on) the French pronounce *Shangai* instead of *Shanhai*, and *Hongue-Kongue* in place of *Hon-Kon*. The most curious instance is that of *Canton*. The English call the province *Kwang-toung;* all the French journals follow this orthography, and yet it is Canton pure and simple. If the *k* is to be employed at all it should be written *Ton-Kien*, for we write *Fo-Kien* as the name of the province in which Foochow is situated, and the *Kien* is the same in each instance. The truth appears to be that all Far Eastern names have been transliterated haphazard, and almost in every case by people who knew nothing of the native languages. The older orthographies, such as Canton, Whampoa, &c., we owe to masters of ships, supercargoes, and the like, who visited the place in the last or beginning of the present century. In some cases they are not good attempts at reproduction, but little practical inconvenience has ever been found in adhering to them. According to the writer whom we have quoted the French are in a worse plight than ourselves; our orthography was at least an honest attempt to reproduce the names as they sounded to Englishmen. The French adopt this orthography, and then give the letters their French pronunciation; in other words the transmutation is (1) Chinese as it sounded to an Englishman; (2) that Englishman's Chinese as it sounded to a Frenchman! Little wonder then that there are hopelessly irreconcilable methods of spelling Chinese names of places.

THE Japanese Commissioner to the Health Exhibition writes that the omission of the names of the foreign authors of certain scientific works in the Japanese Section was quite unintentional. He adds that three of these works are by Japanese assistant professors. The omission, on which we commented last week in noticing the Catalogue, coupled with the statement that the English volumes were translations, was certainly calculated to leave an erroneous impression as to the authorship of the works in question.

THE second document just issued (Brockhaus, Leipzig) in connection with the "Riebeck'sche Niger Expedition," is like the first, which dealt with the Fulah language, mainly philological. The chief contents are: "Specimens of the Language of Ghât in the Sahara, with Haussa and German Translations," by the learned leader of the expedition, Herr Gottlob Adolf Krause. The Ghât being merely a variety of the Mashagh (Berber, or Western Hamitic), no special grammar was needed of a language which has already been somewhat fully elucidated by Barth, Hanoteau, Prof. Newman, and Stanhope Freeman. But these texts in the Arabic and Roman characters with interlinear German translations, and free Haussa and German versions, will be accepted as a boon by students of the languages of Sudan and North Africa. The accompanying "Anmerkungen" throw

considerable light on many obscure grammatical points, besides bringing into still closer relationship the Semitic and Hamitic groups, whose fundamental affinity is daily becoming more and more obvious. The widespread relations of what Herr Krause calls the "Haussa-Musukanische Sprach-Stamm" (Haussa-Musgu linguistic family) are also elucidated, and the curious principle of vowel harmony prevalent in this group for the first time clearly explained. It differs entirely from the Bantu, which is initial, and also from the Finno-Tatar, inasmuch as in the latter the vowels of the agglutinated postfixes conform to that of the root, which is never modified, whereas in Haussa-Musgu the root-vowel conforms to that of the postfix, and is consequently subject to constant change. Thus: *a-dara* = he loves; *e-diri-kini* = he loves you, where the preceding pronominal and root-vowel *a* has been throughout modified to *e* and *i* by the influence of the following *i* of the pronominal suffix *kini*. The introduction contains many interesting details on the history of the Ghāt oasis, which most of our readers will learn for the first time was incorporated in the Turkish Empire some ten years ago. Here also some fresh light is thrown on the origin of the national or imposed names Mashagh (Imoshagh), Tuarek, Berber, Moor, Tibu, Fezzan, and Ghāt. For his munificence in undertaking the publication of these "Mittheilungen" without the remotest prospect of any pecuniary returns, Dr. Emil Riebeck has earned the lasting gratitude of the scientific world.

In the June number of *Timehri*, a journal steadily growing in scientific importance and general usefulness, the accomplished editor, Mr. E. F. Im Thurn, continues his valuable "Notes on West Indian Stone Implements." The title of these papers is now enlarged by the additional words, "and other Indian Relics," so as to include all objects, whether of stone, shell, bone, or clay, which are often found associated together in such a way as to render their separate treatment almost impossible. This enlargement of the subject cannot fail to be appreciated by ethnologists, who will here find much instructive matter lucidly arranged, and illustrated by eleven plates containing thirty-five fac-similes of stone and shell implements, and twenty-one of Carib pottery. The first group of objects belong to Sir Thomas Graham Briggs, of Barbados, who has placed his fine collection at the disposal of Mr. Im Thurn, at the same time generously providing the means for the due illustration of the series. The second group forms part of a quantity of native (Carib) pottery recently discovered on the Enmore Plantation, west coast of Demerara. The urgent necessity of encouraging collections of this sort before all have disappeared, like the natives themselves, before the advance of civilised man, is made evident by the statement that a large heap of shell implements lately found in the parish of St. James, Barbados, were carted away "to macadamise a road." Other attractive papers in this number are: "Bush-Notes of a Huntsman," by M. McTurk; "The Mountains of the West Indies," by T. P. Poter; and "Essequibo, Berbice, and Demerara under the Dutch" (continued), by the Editor.

The following announcements are made by Mr. Edward Stanford:—"A Parliamentary County Atlas of England and Wales," containing maps of all the counties engraved on a uniform scale. This atlas includes as a distinctive feature a series of physical, statistical, and administrative maps of England and Wales and of London. The rainfall, barometric pressure, temperature of the air and of the seas around our coasts are shown for every month of the year; a river basin map, with an accompanying table giving the area of each river basin and the length of the chief water channel in each basin; an orographic map, indicating by colours the plains, hills, and mountains, with much other information of interest. A short description of each county accompanies the maps. "A Trigonometrical Survey of the Island of Cyprus," executed by command of His Excellency Major-General Sir R. Biddulph, K.C.M.G., C.B., R.A., High Commissioner, under the direction of Major H. H. Kitchener (Captain R.E.), Director of Survey, assisted by Lieut. S. C. N. Grant, R.E. The map is drawn to a scale of one inch to one statute mile = 1:63,360, the scale of the Ordnance Survey of the United Kingdom; it has been engraved on fifteen copper plates, and will be printed on imperial sheets, forming, when bound, an atlas measuring 15 inches by 22 inches, or, when mounted together, one map measuring 12 feet 6 inches by 7 feet. "A School Map of British Colonies and Possessions," drawn on a uniform scale, and agreeing in style, size, and price with the other maps of Stanford's Series. Also a second and much enlarged edition of the "Geology of Weymouth, Portland, and the Coast of Dorset," with coloured geological map, section, and photographic frontispiece; "The Countries of the World," the fifth and concluding book of the Geographical Readers, by Charlotte M. Mason, containing Asia, Africa, America, and Australasia; the concluding volume of Stanford's "Compendium of Geography and Travel—Europe," by F. W. Rudler, F.G.S., and G. G. Chisholm, B.Sc., edited by Sir Andrew C. Ramsay, LL.D., F.R.S., with ethnological appendix by A. H. Keane, M.A.I., illustrated with fifteen maps and numerous cuts; "The Monuments of Athens: a Historical and Archæological Description," by Pomagistes G. Kastromenos, translated from the Greek by Agnes Smith, author of "Glimpses of Greek Life and Scenery"; "The Visitor's Guide to Orvieto," by J. L. Bevir, M.A., Assistant Master at Wellington College.

E. and F. N. Spon have in the press "Candles, Soap, and Glycerine," a practical treatise on the materials used and processes involved, by Mr. W. Lant Carpenter, B.Sc.; "A Text-Book of Tanning," embracing the theory and practice of preparing and dyeing all kinds of leather, by H. R. Procter, of Lowlights Tanneries, Examiner in Tanning to the Guilds Institute; "On Portable Railways," by Mr. Paul Decanville, M.I.M.E.; "History and Description of the Manchester Water-Works," by J. F. La Trobe Bateman, F.R.SS. Lond. & Edin., Past President of the Institution of Civil Engineers, F.G.S., &c.; "An Electrical Supplement to the Pocket-Book of Engineering Formulæ," by G. L. Molesworth, M.I.C.E., M.I.M.E., Consulting Engineer to the Government of India for State Railways; "On the Analysis of Iron and Steel," by T. Bayley, author of "The Chemist's Pocket-Book"; a new edition of "The Modern Practice of Sinking and Boring Wells," by Mr. Ernest Spon, Assoc. Mem. Inst. C.E.; Spon's "Mechanics' Own Book," a manual for handicraftsmen and amateurs; "Sanitary Protection," a course of lectures delivered in the Theatre of the Royal Dublin Society, 1884, by W. Kaye Parry, M.A.

Phylloxera is making steady progress in the Rhenish vineyards it seems. The pernicious insect has now been found on the right bank of the river, in the vineyards of Castle Ockenfels near Linz, where over 100 acres are infected. State aid has been asked for at Berlin, as the occurrence of the pest near Linz is far more serious than that in the Ahr Valley.

A tunnel, measuring about 5000 feet in length, and constructed at least nine centuries before the Christian era, has just been discovered by the Governor of the island of Samos. Herodotus mentions this tunnel, which served for providing the old seaport with drinking water. It is completely preserved, and contains water tubes of about 25 centimetres in diameter, each one provided with a lateral aperture for cleansing purposes. The tunnel is not quite straight, but bent in the middle; this is hardly to be wondered at, as the ancient engineers hardly possessed measuring instruments of such precision as those constructed nowadays.

The *Globus* reports the discovery of the ruins of an ancient city near Samarkand. They are situated upon a hill, which was

doubtless a fortress formerly. Remains of utensils and human bones have also been found. According to Arabian sources the large city of Aphrosiab existed there in the time of Moses; it was the royal residence, and the king's castle stood on the hill, and was provided with subterranean corridors. The result of the excavations show that the ruins are indeed those of a very ancient city. The various depths, however, differ widely; in the lower ones fine glass objects are found, which are quite absent from the upper ones; the lowest layers contain remains of a very primitive nature, *i.e.* coarse implements of clay and flint. The excavations are being continued. News from Turkestan announces the discovery of another ancient city, Achsy, on the right bank of the Amu Darya. Remains of brick walls and other buildings are said to be visible in considerable numbers.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus* ♂) from India, presented by Mr. A. F. M. Smith; a Brown Capuchin (*Cebus fatuellus*) from Guiana, presented by Mr. G. S. Malet Barrow; a White-backed Piping Crow (*Gymnorhina leuconota*) from Australia, presented by Mr. F. Larkworthy; two Loggerhead Turtles (*Thalassochelys caouana*) from the Mediterranean, presented by Mr. Allan McGregor; a Common Chameleon (*Chamæleon vulgaris*) from North Africa, presented by Mr. A. R. Rogers; a Horned Lizard (*Phrynosoma cornutum*) from Texas, presented by Capt. H. Mends; a Brown Mud Frog (*Pelobates fuscus*), European, presented by Mr. Claude Russell; a Sulphur-breasted Toucan (*Ramphastos carinatus*) from Mexico, a Macaque Monkey (*Macacus cynomolgus* ♂) from India, a Robben Island Snake (*Coronella phocarum*) from South Africa, deposited; a Collared Fruit Bat (*Cynonycteris collaris*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

THE APPROACHING APPEARANCE OF ENCKE'S COMET.—It may be hoped that, as at the last return of this comet in 1881, an accurate ephemeris for its reappearance, which is now at hand, may be issued from the Imperial Observatory at Pulkowa. According to the mean motion, assigned by the calculations of Dr. Backlund at perihelion passage in 1881, the comet would be again in perihelion (perturbations neglected) about March 7·5 G.M.T., 1885, so that as the effect of planetary attraction will be small during the actual revolution, the comet's track in the heavens will not greatly differ from that it followed in 1852, when the perihelion passage occurred on March 14. It was first observed in that year by Dr. Vogel, at Mr. Bishop's Observatory in the Regent's Park on the evening of January 9, a refractor of 7 inches aperture being employed; at this time its distance from the sun was 1·35, and that from the earth 1·55, so that the intensity of light expressed in the usual manner was 0·23. At the return in 1875, when the perihelion passage took place on April 13, the comet was detected at the Observatory of Marseilles by M. Stephan, on the evening of January 27, distant from the sun 1·50, and from the earth 1·98, the theoretical intensity of light being therefore 0·113, or only half that at the comet's discovery in 1852. There appears to be a probability that with the large instruments now so comparatively common in observatories, the comet may be observed at a greater distance from the sun than in that year, and possibly during the absence of moonlight in November. If we assume March 7·5 for the date of perihelion passage, and bring up the longitudes in Dr. Backlund's orbit of 1881 to the beginning of 1885, we shall have the following positions of the comet at Greenwich midnight:—

1884	R.A. h. m.	N.P.D. ° ′	Distance from Earth	Distance from Sun	Intensity of Light
Nov. 5	23 2·1	82 24	1·310	2·643	0·140
9	22 57·4	83 4	1·318	2·000	0·144
13	22 53·4	83 40	1·328	1·957	0·148
17	22 50·1	84 13	1·340	1·913	0·152
21	22 47·4	84 42	1·352	1·867	0·157
25	22 45·4	85 7	1·365	1·821	0·162

Encke did not continue the ephemeris in 1852 beyond the date of perihelion passage, but if we calculate from his elements for April 19·5 (the day of the new moon), we find the comet's place to have been in R.A. 342° 55′, N.P.D. 109° 22′, its distance from the sun 0·89, and from the earth 0·95, or the intensity of light 1·41; it would rise at the Cape about 14h. 1m., and must therefore have been readily observable. We may expect that in 1885 observations will be made in the southern hemisphere after perihelion passage.

VARIABLE STARS.—Mira Ceti is now close upon a minimum, a phase of which there are not too many observations: its magnitude is usually about 8·5 on Bessel's scale. χ Cygni will probably be at minimum about November 15: the mean of the last five periods, according to the observations of the late Prof. Julius Schmidt, is 408·2 days, and 1880 May 31·2 may be taken as a mean maximum epoch. A maximum of the fiery-looking variable R Leonis may be expected about December 10. R Leporis will probably be at minimum at the beginning of January.

SOUTHERN BINARIES.—There are two southern double-stars which appear to deserve much closer observation than they have yet received on the score of their probable binary character and rapid motion. They are:—

	R.A. h. m. s.	N.P.D. ° ′
h. 5014 ...	17 59 22 ...	133 24·2
h. 5114 ...	19 18 32 ...	144 33·2

The positions are brought up to 1885·0 from the Paramatta Catalogue.

ON THE SEAT OF THE ELECTROMOTIVE FORCES IN THE VOLTAIC CELL

AT the Montreal meeting of the British Association a discussion on the above subject was opened by Prof. O. J. Lodge. Copies of the following notes were distributed to the members present by the opener of the discussion, together with the accompanying letter. As it has been suggested that their reproduction here would be of service, we willingly give them a place.

University College, Liverpool, July 29th, 1884

The following set of statements are privately issued by me solely with the object of securing attention to definite points in the discussion on Contact Electricity, at Montreal, which I have been instructed by the Sub-Committee to open. They are numbered for convenience of reference. I have no authority whatever for appending the names I have appended to some of the statements; and in general the whole thing is merely a statement of my own personal belief. At the same time the wording is carefully chosen and is intended to be correct in detail, and the views indicated I have held with greater or less clearness for some seven years. I should have small hesitation in believing these views to be true, were it not that I fear they are at variance with those of Sir Wm. Thomson. It is in no spirit of presumption, but simply in order more easily and distinctly to elicit the truth, that I have ventured thus to record them, and I am very willing to modify all or any of them on ground shown. It may be hoped that the discussion at Montreal will result in a substantial basis of agreement with regard to this elementary and long-debated matter. OLIVER J. LODGE

I.—ORTHODOX STATEMENTS BELIEVED BY O. J. L. TO BE TRUE IN THE FORM HERE SET DOWN

A.—Volta

1. Two metals in contact ordinarily acquire opposite charges; for instance, clean zinc receives a positive charge by contact with copper, of such a magnitude as would be otherwise produced under the same circumstances by an E.M.F. of ·8 volt.

2. This apparent contact E.M.F. or "Volta force" is independent of all other *metallic* contacts wheresoever arranged, hence the metals can be arranged in a numerical series such that the "contact force" of any two is equal to the difference of the numbers attached to them, whether the contact be direct or through intermediate metals. But whether this series changes when the atmosphere, or medium surrounding the metal, changes is an open question: on the one side are experiments of De la Rive, Brown, Schultze-Berge; on the other side, of Pfaff, Pellat, von Zahn. It certainly changes when the free metallic surfaces are oxidised or otherwise dirty. And in general

this "Volta force" is very dependent on all non-metallic contacts.

3. In a closed chain of any substances, the resultant E.M.F. is the algebraic sum of the Volta forces measured electrostatically in air for every junction in the chain; neglecting magnetic or impressed E.M.F. [Verified most completely by Ayrton and Perry.]

B.—Thomson

4. The E.M.F. in any closed circuit is equal to the energy conferred on unit electricity as it flows round it.

[Neglect magnetic or impressed E.M.F. in what follows.]

5. At the junction of two metals any energy conferred on, or withdrawn from, the current, must be in the form of heat. At the junction of any substance with an electrolyte, energy may be conveyed to or from the current at the expense of chemical action as well as of heat.

6. In a circuit of uniform temperature, if metallic, the sum of the E.M.F. is zero by the second law of thermodynamics; if partly electrolytic, the sum of the E.M.F. is equal to the sum of the energies of chemical action going on per unit current per second.

7. In any closed conducting circuit the total intrinsic E.M.F. is equal to the sum of the chemical actions going on per unit electricity conveyed ($\Sigma . f\theta$), diminished by the energy expended in algebraically generating reversible heat.

8. The locality of any E.M.F. may be detected, and its amount measured, by observing the reversible heat or other form of energy there produced or absorbed per unit current per second. [This is held by Maxwell, but possibly not by Thomson, though its establishment is due to him.]

II.—Statements believed by O. J. L. to be false though orthodox

9. Two metals in air or water or dilute acid, but not in contact, are practically at the same potential. [Sir Wm. Thomson, Clifton, Pellat.]

10. Two metals in contact are at seriously different potentials (*i.e.* differences of potential greater than such milli-volts as are concerned in thermo-electricity). [This is held by nearly everybody.]

11. The contact force between a metal and a dielectric, or between a metal and an electrolyte, is small. [Ayrton and Perry, Clifton, Pellat, and probably Sir Wm. Thomson].

III.—Statements believed by O. J. L. to be true though not orthodox

12. A substance immersed in any medium tending to act upon it chemically will (unless it is actually attacked) be at a different potential to the medium in contact with it, positive if the active element in the medium is electro-positive, negative if the active element is electro-negative.

13. The above difference of potential can be calculated approximately from the potential energy of combination between the substance and the medium, the energy being measured by compelling the combination to occur and observing the heat produced per amount of substance corresponding to one unit of electricity.

14. In addition to this contact force, due to potential chemical action or chemical strain, there is another which is independent of chemical properties, but which seems to be greatest for badly-conducting solids, and which is in every case superposed upon the former contact force, the two being observed together and called the Volta effect. Very little is known about this latter force except in the case of metals; and in these it varies with temperature, and is small. In the case of non-metals it is often much larger than the chemical contact force.

15. The total contact force at any junction can be experimentally determined by measuring the reversible energy developed or absorbed there per unit quantity of electricity conveyed across the junction. [Practical difficulties, caused by irreversible disturbances, being supposed overcome.]

16. In a chain of any substances whatever, the resultant E.M.F. between any two points is equal to the sum of the true contact forces acting across every section of the chain between the given points (neglecting magnetic or impressed forces).

17. In a closed chain the sum of the "Volta forces," measured electrostatically in any (the same) medium, is equal to the sum of the true contact forces, whether each individual Volta force be equal to each individual true force or not.

18. Wherever a current flows across a seat of E.M.F., there it must gain or lose energy at a rate numerically equal to the E.M.F. multiplied by the strength of the current.

Development of the above and Special Application to Metals.

19. A metal is not at the potential of the air touching it, but is always slightly below that potential by an amount roughly proportional to its heat of combustion, and calculable, at any rate approximately, from it. For instance, clean zinc is probably about 1·8 volts below the air, copper about ·8 volts below, and so on. If an ordinary oxidising medium be substituted for "air" in the above statement it makes but little difference.

20. Two metals put into contact reduce each other instantly to practically the same potential, and consequently the most oxidisable one receives from the other a positive charge, the effect of which can be observed electrostatically.

21. There is a slight true contact force at the junction of two metals which prevents their reduction to *exactly* the same potential, but the outstanding difference is small, and varies with temperature. It can be measured thermo-electrically by the Peltier effect, but in no other known way. It is probably entirely independent of surrounding media, metallic or otherwise.

22. If two metals are in contact the potential of the medium surrounding them is no longer uniform: if a dielectric it is in a state of strain, if an electrolyte it conveys a current.

23. In the former case the major part of the total difference of potential is related closely to the difference of the potential energies of combination, and is approximately calculable therefrom. In the latter case the total E.M.F. is calculable accurately from the energy of the chemical process going on, minus or plus the energies concerned in reversible heat effects.

24. There are two distinct and independent kinds of series in which the metals (and possibly all solids) can be placed; one kind depends on the dielectric or electrolytic medium in which the bodies are immersed; the other kind depends on temperature. The one is something like the Volta series, but it is really the Volta series minus the Peltier; the other is the Peltier. To reckon up the total E.M.F. of a circuit we may take differences of numbers from each series and add them together.

IV.—Brief Summary of the Argument

25. Wherever a current gains or loses energy, *there* must be a seat of E.M.F.; and conversely, wherever there is a seat of E.M.F., a current must lose or gain energy (that is, must generate or destroy some other form of energy, chemical, thermal, or other) in passing it.

26. A current gains no energy (*i.e.* destroys no heat) in crossing from copper to zinc, hence there is no appreciable E.M.F. there.

27. When a current flows from zinc to acid, the energy of the combination which occurs is by no means accounted for by the heat there generated, and the balance is gained by the current; hence at a zinc-acid junction there must be a considerable E.M.F. (say at a maximum 2·3 volts).

28. A piece of zinc immersed in acid is therefore at a lower potential than the acid, though how much lower it is impossible to say, because no actual chemical action occurs. [If chemical action does occur, it is due to impurities, or at any rate to local currents, and it is of the nature of a disturbance.]

29. A piece of zinc, half in air and half in water or acid, causes no great difference of potential between the air and the water (Thomson, Clifton, Ayrton and Perry, &c.), consequently air must behave much like water.

30. If the air were slightly positive to the water, as it is (Hankel), it might mean that the potential energy of combination of air with zinc is slightly greater than that of water, or it might represent a difference in the thermo-electric contact forces between zinc and air, and zinc and water, or it might depend on a contact force between air and water. [If such a contact force between air and water exists, it is obviously of great importance in the theory of atmospheric electricity, for the slow sinking of mist globules through the air would render them electrical.]

31. Condenser methods of investigating contact force no more avoid the necessity for unknown contacts than do straightforward electrometer or galvanometer methods; the circuit is completed by air in the one case and by metal in the other, and the E.M.F. of an air contact is more hopelessly unknown than that of a metal contact.

32. All electrostatic determinations of contact force are really determinations of the sum of at least three such forces, none of which are knowable separately by this means.

33. The only direct way of investigating contact force is by the Peltier effect or its analogues. [Maxwell.]

34. Zinc and copper in contact are oppositely charged, but are not at very different potentials: they were at different potentials before contact, but the contact has nearly equalised them.

[Certain portions of these statements which may appear wildly hypothetical, such as 13, are to be justified by figures. The justification is not complete, for lead and iron are untractable, but it does not affect the main position.]

THE AMERICAN ASSOCIATION

WE are indebted to the courtesy of the Editor of *Science* for the following reports of the Sectional proceedings of the American Association.

In the Section of Physics a paper was read on "The Relation of the Yard to the Metre," by Prof. William A. Rogers, who has given his life to perfecting the construction and the testing of standards of length, and the result of this his latest investigation is that the metre is 39'37027 inches in length. One of the most important physical measurements is that of the wave-length of light of any given degree of refrangibility, and this determination is best made by means of the diffraction grating. On account of the extensive use of the magnificent gratings constructed by Prof. Rowland for this purpose, Prof. Rogers instituted an investigation to determine the coefficient of expansion of the speculum-metal used in the construction of these gratings. He also noted that from its homogeneity, fineness of grain, and non-liability to tarnish, this speculum-metal is peculiarly suitable for constructing fine scales, though its extreme brittleness is an objection to its use for large scales.

Prof. Rowland stated that he proposed to construct scales on his ruling-engine which would enable the physicist at any time, by purely optical means, and without knowing the coefficient of expansion of the metal or its temperature, to obtain the value of the length of the scale in terms of the wave-length of any given ray of light. These scales were simply to be straight pieces of speculum-metal ruled with lines just as an ordinary grating, except that the length of the lines is to be only about one centimetre, every one-hundreth line being somewhat longer than its neighbours: the whole ruled slip is to be one decimetre in length. From the manner of ruling, it will be easy to count the whole number of lines in the length of the strip, and then by a simple use of the scale as a grating, in a suitable spectrometer, the whole length may be immediately found at any time in terms of any specified wave-length of light. In some forms of telephones and in the microphone the action depends on the change in resistance of a small carbon button on being subjected to pressure. There has been much discussion as to whether this diminution of the resistance with pressure is due to a change in the resistance of the carbon itself, or simply to the better contact made between the carbon and the metallic conductor when the pressure is applied.

Prof. Mendenhall has carried out some experiments to determine the question; and one of his methods of experimenting—that with the hard carbons—appears to point conclusively in favour of the theory that the resistance of the carbon itself is altered by pressure. The experiments made by him on soft carbon are open to criticism, though they also point to the change taking place *in* the carbon. Prof. Mendenhall finds that the resistance is not simply proportional to the pressure, and thinks that by increasing the pressure a point of maximum conductivity would be reached where there would be no change in resistance for a small change in pressure.

Prof. A. Graham Bell, the inventor of the telephone, read a paper giving a possible method of communication between ships at sea. The simple experiment that illustrates the method which he proposed is as follows:—Take a basin of water, introduce into it, at two widely-separated points, the two terminals of a battery circuit which contains an interruptor, making and breaking the circuit very rapidly. Now at two other points touch the water with the terminals of a circuit containing a telephone. A sound will be heard, except when the two telephone terminals touch the water at points where the potential is the same. In this way the equipotential lines can easily be picked out. Now, to apply this to the case of a ship at sea: Suppose one ship to be provided with a dynamo-machine generating a powerful current, and let one terminal enter the water at the prow of the ship, and the other be carefully insulated, except at its end, and be trailed behind the ship, making connection with the sea at a considerable distance from the vessel; and suppose the current be rapidly made and broken by an interruptor; then the observer on a second vessel provided with similar terminal conductors to the first, but having a telephone instead of a dynamo, will be able to detect the presence of the other vessel even at a considerable distance; and by suitable modifications the direction of the other vessel may be found. This conception Prof. Bell has actually tried on the Potomac River with two small boats, and found that at a mile and a quarter, the farthest distance experimented upon, the sound due to the action of the interruptor in one boat was distinctly audible in the other. The experiment did not succeed quite so well in salt water.

Prof. Trowbridge then mentioned a method which he had suggested some years ago for telegraphing across the ocean without a cable; the method having been suggested more for its interest than with any idea of its ever being put in practice. A conductor is supposed to be laid from Labrador to Patagonia, ending in the ocean at those points, and passing through New York, where a dynamo-machine is supposed to be included in the circuit. In Europe a line is to extend from the north of Scotland to the south of Spain, making connection with the ocean at those points; and in this circuit is to be included a sensitive galvanometer. Then any change in the current in the American line would produce a corresponding change in current in the European line; and thus signals could be transmitted.

Mr. W. H. Preece then gave an account of how such a system had actually been put into practice in telegraphing between the Isle of Wight and Southampton during a suspension in the action of the regular cable communication. The instruments used were a telephone in one circuit, and in the other about twenty-five Leclanché cells and an interruptor. The sound could then be heard distinctly; and so communication was kept up until the cable was again in working order. Of the two lines used in this case, one extended from the sea at the end of the island near Hurst Castle, through the length of the island, and entered the sea again at Ryde; while the line on the mainland ran from Hurst Castle, where it was connected with the sea, through Southampton to Portsmouth, where it again entered the sea. The distance between the two terminals at Hurst Castle was about one mile, while that between the terminals at Portsmouth and Ryde amounted to six miles.

A few years ago Mr. E. H. Hall, then a student at the Johns Hopkins University, taking a thin strip of gold-leaf through which a current of electricity was passing, and joining the two terminals of a very sensitive galvanometer to two points in the gold-leaf, one on one edge, and the other on the other, choosing the points so exactly opposite that there was no current through the galvanometer, found that on placing the poles of a powerful electro-magnet, one above and the other below the strip of gold-leaf, he obtained a current through the galvanometer, thus indicating that there was a change in the electric potential, due to the action of the magnet. Mr. Hall explains this change by supposing the rotation of the equipotential lines in the conductor about the lines of magnetic force. This explanation has been brought into question by Mr. Shelford Bidwell, who attempts to explain the action thus: the magnetic force acting on the conductor carrying the current would cause the conductor to be moved sideways, were it free to move; but, since it is held by clamps at the ends, the magnetic force acting upon it brings it into a state of strain, one edge being compressed and the other stretched; and Mr. Bidwell supposes the whole Hall effect to be due to thermal actions taking place in consequence of this unsymmetrical state of strain. Prof. Hall, who is now at Harvard, has made some careful experiments to test this explanation of Mr. Bidwell. He used not only gold-leaf, but strips of steel, tinfoil, and other metals, and clamped them sometimes at both ends, sometimes in the middle, and sometimes only at one end; and in all cases the action was the same, with the same metal, irrespective of the manner of clamping. This was strong evidence against Mr. Bidwell's position.

Sir William Thomson suggested, as a further test to bring about the state of strain, which Mr. Bidwell supposes to be the primary cause of the action, by purely mechanical means, bring-

ing pressure to bear on one side or the other, and seeing whether the action obtained is at all commensurate with the action found by Mr. Hall.

Prof. Hall then discussed an experiment by which Mr. Bidwell had obtained a reversal of the effect, and showed that the reversal was only apparent, and that when carefully examined the results of Mr. Bidwell's experiments were best satisfied by the theory of the rotation of the equipotential surfaces about the lines of magnetic force.

Sir William Thomson spoke of the discovery of Mr. Hall as being the most important made since the time of Faraday. He favoured Mr. Hall's explanation, though he considers Mr. Bidwell's suggestion as very important, and thinks that it will very likely be found that both the Hall effect and thermal effects have a common cause, rather than that one is to be taken to explain the other. He showed also that the mathematical examination of the subject indicates three relations to be investigated,—first, the relation of thermal force to the surfaces of equal rate of variation of temperature; second, the relation of electric current to the equipotential surfaces; third, the relation of the thermal flow to isothermal surfaces. The second of these is that investigated by Mr. Hall, who has found that under the conditions mentioned the lines of flow are *not* perpendicular to the equipotential surfaces. There remains, therefore, "work for two more Halls," in either proving or disproving the existence of the analogous actions in these other two cases. Sir William Thomson also suggested the following exceedingly interesting mechanical illustration or analogue of Hall's effect. Let us be living upon a table which rotates uniformly for ever. A narrow circular canal is upon this table, concentric with the axis of rotation of the table, and nearly full of water. After a while the water will acquire the same velocity of rotation as the table, and will come to a state of equilibrium. The outer edge of the water in the canal will then stand a little higher than the inner edge. Let us now apply a little *motive* force to the water, and by means of a pump cause it to flow in the canal in the same direction in which the table is already rotating: it is evident that it will stand higher on the outer edge, and lower on the inner edge of the canal, than before. But, should we cause it to flow in the opposite direction to the motion of the table, it will stand lower on the outer edge, and higher on the inner edge, than in its position of equilibrium. The experiment made by Mr. Shelford Bidwell may also be illustrated by putting a partition in the canal so as to divide it into two circular concentric troughs, and make a little opening in the partition at some point; then taking two points near the opening in the partition, one in one trough and one in the other, if they are very close to the partition, the point in the outer trough will be at a *lower* level than that in the inner one; but if they are not close to the partition, but one is taken close to the outer edge of the outer trough and the other close to the inner edge of the inner trough, then the point in the outer trough will be at a *higher* level than that in the inner trough, though the difference in level will be only about half of what it would have been had there been no partition separating the canal into two troughs.

Prof. Forbes called attention to the fact that the classification of the metals according to their thermo-electric qualities gives not only exactly the same division into positive and negative, but that the very *order* obtained in that way corresponds to that obtained by classifying according to the Hall effect, except *possibly* in the case of aluminium.

In the Section of Mathematics and Astronomy the first paper read was by Prof. E. C. Pickering, upon the colours of the stars. The need of exact photometric measurement of different parts of their spectra was first pointed out, and the author then described a very ingenious method of accomplishing this. In the telescope tube, a little beyond the focal plane, is a direct-vision prism, so set as to give a spectrum extended in declination; and on the preceding side of this prism is placed a piece of plane glass, whose edges are so ground that, when a small portion of the following side of the cone of rays falls upon it, it gives a small white ghost, just preceding the spectrum and always opposite the same wave-length. In the focal plane is one of Prof. Pritchard's neutral-tint wedge photometers, and behind it a thin metal diaphragm with four long, narrow slits parallel to the equatorial motion; so that, when the spectrum transits behind them, four little stars—a red, yellow, blue, and a violet—shine through these slits, and the time of the disappearance of each, as they move towards the thicker edge of the wedge, measures its brightness. From these times may be deduced the magnitude and colour curve of the star. To fix the same wave-lengths for each observation, the little white ghost is adjusted upon one of two parallel wires which project out beyond the preceding side of the diaphragm. For a succeeding transit, the ghost is adjusted upon the other wire, half a slit-interval distant, and thus eight points of the spectrum are photometrically measured.

Prof. Young of Princeton spoke very highly of the ingenuity and effectiveness of the device, especially for the systematic measurement of a large number of stars. He pointed out, however, what might be a source of error, viz. the different sensitiveness of different observers' eyes to different colours, so that they would probably observe the times of disappearance of the four coloured stars slightly relatively different.

The next paper, by Prof. Daniel Kirkwood, discussed the question whether the so-called "temporary stars" may be variables of long period, referring to the sometimes-claimed identity of the temporary stars 945 and 1264, with the well-known Tycho Brahe's star, which blazed forth in Cassiopeia in 1572, and whose position is pretty closely known from his measures. The conclusion reached was, that on account of the sudden apparition of the temporary stars, the short duration of their brightness, and the extraordinary length of their supposed periods, they should be considered as distinct from variables.

Prof. Mansfield Merriman, the author of the well-known treatise on "Least Squares," proposed a criterion for the rejection of doubtful observations, founded upon Wagen's demonstration of the law of frequency of error, which was simpler than Pierce's or Chauvenet's. It involves, however, a determination of what is the unit of increment between errors of different sizes, a thing difficult to determine in very many cases.

Prof. Pickering then read another paper upon systematic errors in stellar magnitudes, showing, without any question, that the magnitudes of all the star-catalogues, from that of Ptolemy down to the great work of Argelander in the *Durchmusterung*—all depending upon eye-estimates—are systematically affected by being in, or close to, the Milky Way; they all being estimated too faint, and the error amounting to about half a magnitude in the Milky Way itself. This arises from the brightness of the background upon which the star is viewed. In the Harvard photometry measures, this source of error is avoided, since, in the comparison of each star with the Pole-Star, the two fields are superposed, and their added brightness affects both stars alike.

Prof. M. W. Harrington, Director of the Ann Arbor Observatory, read a paper upon the asteroid ring. He showed that the representative average orbit would be an ellipse of small eccentricity, with semi major axis equal to about 2·7 times that of the earth, and inclined to the plane of the ecliptic about 1°; and that, in the progressive discovery of these small bodies, the average mean distance had gradually increased, but now seemed to have reached its limit. On the assumption that the surfaces of all the asteroids have the same reflecting power as Vesta, Prof. Harrington reaches the conclusion that the volume of Vesta is about 5/17 that of all these 230 bodies put together, and that Vesta and Ceres together form almost one-half the total volume.

Prof. Rogers, of the Harvard College Observatory, read two papers. The first, upon the magnitude of the errors which may be introduced in the reduction of an observed system of stellar co-ordinates to an assumed normal system by graphic methods, showed a great amount of laborious research, and was a good illustration of the vast amount of monotonous work necessary in the present stage of astronomical observation in order to reach the highest degree of accuracy attainable by the search for and elimination of minute systematic errors. His next paper was upon the original graduation of the Harvard College meridian circle *in situ*. This described a method of turning a meridian circle through any desired constant arc up to about 30° without any dependence upon the circle and reading microscopes, effected by means of an arm swinging between fixed stops, and clamping to a circular ring on the axis by an electro-magnetic clamp. With this Prof. Rogers claimed to be able to set off a constant arc through as many as five thousand successive movements of the clamping arm. The ingenious method suggested and carried out by Mr. George B. Clark, of the firm of Alvan Clark and Sons, of grinding the clamping circle to a perfect circular form while the telescope was swung round in its Y's was

fully described, and also Prof. Rogers' method of arresting the momentum of the telescope at the stops by water-buffer plungers. The great advantage of thus being able to set off a constant arc independent of the circle and microscopes was pointed out, with especial reference to the investigation of division errors and flexure of circle, and also to the division of the circle itself *in situ*; *i.e.* mounted on its axis and turning on its pivots.

Prof. Young called attention to the necessity of guarding against expansion and contraction of the bar holding the stops, due to radiation from the observer's body.

Mr. S. C. Chandler, Jun., of the Harvard College Observatory, gave the results of observations and experiments with an "almucantar" of four inches' aperture, a new instrument devised by Mr. Chandler, which seems to be of remarkable accuracy, and promises to furnish an entirely new and independent method of attacking some of the most important problems in exact observational astronomy. The instrument consists of a telescope and vertical setting-circle, which can be clamped at any zenith-distance, and is supported on a rectangular base which floats in a rectangular trough of mercury, the whole turning round a vertical axis so as to observe in any azimuth; these observations being simply the times of transit of any heavenly body over a system of horizontal wires in the field. The observations thus far have been entirely upon stars, and all at the apparent zenith-distance of the pole. After some very small periodic variations in the zenith-distance pointing had been traced to changes of temperature, and had been removed by sawing through the wooden bottom of the mercury trough, the instrument showed an astonishing constancy in this zenith-distance pointing, extending over weeks at a time, and far exceeding the constancy of the corrections to the best fundamental instruments of our observatories.

A paper was read by Mr. Chandler, upon the colours of variable stars. Showing, first, that most of the variables were *red*, he described some fairly satisfactory methods which he had used to measure the *degree* of redness of all the periodic variables; and then, plotting a series of points whose abscissæ represented the *length* of the periods, and ordinates the *degree of redness*, their agreement with a curve making a very decided angle with the axis of abscissæ brought out without question the remarkable law that *the redder the star the longer is its period of variability*. In discussing any theory of variable stars, Mr. Chandler pointed out that Zöllner was the only one who had thus far taken into account two laws already known, viz. (1) that they are generally *red*; (2) that they *increase* in brightness *much more rapidly* than they *decrease*; and now, in any further theory, this new third law must have a place, viz. that the *redder* they are the *longer* is their period.

Dr. R. S. Ball, Astronomer-Royal for Ireland, read a paper upon the ruled cubic surface known as the cylindroid, whose equation is

$$z(x^2 + y^2) - 2mxy = 0.$$

Mr. W. S. Auchencloss of Philadelphia exhibited a balancing machine for finding the centre of gravity of any number of different weights distributed along a line, which seemed to be of excellent construction, extremely easy and rapid in manipulation, and quite sensitive. In connection with a time-scale of 365 days at one side, it was shown how rapidly a complicated system of business accounts could be settled, and how it could be applied to various engineering problems.

Prof. J. H. Gore, of the U.S. Geological Survey, read a paper upon the geodetic work of the U.S. Coast and Geodetic Survey.

The next paper was by Mr. J. N. Stockwell of Cleveland, upon an analysis of the formula for the moon's latitude as affected by the figure of the earth. In this Mr. Stockwell claimed that Laplace's formula for expressing this was wrong; the question turning upon an approximate integration of a differential equation, which he claimed to show was wrong by separating into two terms a single one which expressed the difference of two effects, which, thus evaluated separately, became either indeterminate or of an impossible amount.

Prof. J. C. Adams of Cambridge, England, made some comments upon Mr. Stockwell's paper, speaking in high terms of the general work which Mr. Stockwell had done in the difficult subject of the lunar theory; but from such conclusions and methods as those brought forward in this particular case he said he must express his total dissent. He then pointed out that this equation was, to begin with, only an approximation; that, before it could be treated at all as a rigorous one, many other small terms must be included; that, further, its integration was only an approximation; and that in this case any separation into terms, which, on a certain approximate assumption, became either indeterminate or very large, was of no value as a test of the equation.

Prof. Ormond Stone, Director of the Leander McCormick Observatory of the University of Virginia, gave an elaborate description of that Observatory, now approaching completion, and to be devoted entirely to original research. The telescope, which will soon be mounted, is the twin in size of the Washington 26-inch, and like it in most of its details, except that the driving clock is like that of the Princeton 23-inch, with an auxiliary control by an outside clock, and that it has Burnham's micrometer illumination. The Observatory has a permanent fund of 76,000 dollars as a beginning, and 18,000 dollars have been expended in Observatory buildings, and 8000 dollars for the house of the Director. Situated 850 feet above the sea, and on a hill 300 feet above surroundings, the main building, circular in shape, is surmounted by a hemispherical dome 45 feet in diameter. The brick walls have a hollow air-space, with inward ventilation at bottom and outward at top.

Mr. Warner, the builder of the dome, gave an interesting description of the ingenious method of adjusting the conical surfaces of the bearing-wheels, so that they would, without guidance, follow the exact circumference of the tracks; and then of the adjustment of the guide-wheels, so that the axis of this cone should be exactly normal to the circular track. The framework of the dome consists of thirty-six light steel girders, the two central parallel ones allowing an opening six feet wide. The covering is of galvanised iron, each piece fitted *in situ*, and the strength of the frame is designed to stand a wind-pressure of a hundred pounds per square foot. There are three equal openings with independent shutters, the first extending to the horizon, the second beyond the zenith, and the third so far that its centre is opposite the division between the first and second. The shutters are in double-halves, opening on horizontal tracks, and connected by endless chain with compulsory parallel motion of the ends. The dome weighs twelve tons and a half, and the livering one ton and a half, and a tangential pressure of about forty pounds, or eight pounds on the endless rope, suffices to start it. If this ease of motion continues as the dome grows old, it is certainly a remarkable piece of engineering work.

In the discussion following, Prof. Hough thought he should prefer the old style of single opening extending beyond the zenith.

Prof. Stone could not agree with him, the greater extent of opening making it less probable that the dome would have to be moved so far in turning from star to star, and at the same time furnishing better ventilation, and the opportunity for cross-bracing adding strength to the dome. He stated that he should first take up the remeasurement of all the double stars of less than 2″ distance between 0° and − 30°.

The Rev. Father Perry, the Director of the Observatory at Stonyhurst, England, gave the result of late researches on the solar surface, with special reference to evanescent spots.

Mr. Lewis Swift, Director of the Warner Observatory at Rochester, N.Y., read a paper upon the nebulæ, in which he described his method of search for new nebulæ. One very interesting statement of Mr. Swift, to the effect that there had not been a first-rate clear sky since the red glows appeared a year ago following the Krakatoa explosions, bears out the general experience of workers in other observatories, especially those who try to see stars near the sun in the daytime.

An interesting discussion arose as to the much-disputed existence of the nebula round the star Merope in the Pleiades; the general drift of it being that the nebula no doubt existed, but in order to see it a clear sky was necessary, and a very low power and large field, so that the nebula might be contrasted with darker portions of the same field; that a large telescope was not necessary, in fact the smaller the better, provided the optical qualities were relatively as good. Mr. Swift said he could always see it under favourable conditions; and Mr. E. E. Barnard, of Nashville, Tenn., the discoverer of the latest comet, said that before he knew of its existence at all, he picked it up as a supposed comet.

Prof. Adams of Cambridge, England, read a paper upon the general expression for the value of the obliquity of the ecliptic at any given time, taking into account terms of the second order. The difficulties of obtaining a formula for this quantity, on

account of the many varying elements upon which it depends, were clearly explained by a diagram, and the results given of an approximation carried much further than ever attempted heretofore.

Prof. Harkness, in paying a high compliment to the celebrated mathematician and astronomer for these laborious and valuable researches, also expressed a wish that some of the *n*-dimensional-space mathematicians would follow the example of Prof. Adams, and apply some of their superfluous energy to the unsolved problems in the solar system, which have some direct practical bearing.

Prof. Newcomb, in remarking upon the mass of the moon used in this problem, expressed the opinion that this could be obtained most accurately by observations of the sun, in determining the angular value of the radius of the small circle described by the earth about the common centre of gravity of earth and moon, since this, in his opinion, seemed to be the only constant which could be determined by observation absolutely free from systematic errors, and hence was capable of an indefinite degree of accuracy by accumulated observations; and he asked Prof. Adams's opinion on this point.

The latter replied that he thought the quantity too small for certain accurate determination, almost beyond what could be actually seen by the eye in the instruments used.

Prof. Newcomb admitted, in the case of absolute determinations, the general impossibility of attempting to measure what cannot be seen, but, in the case of differential or relative determinations in which there was no supposed possibility of constant or systematic errors, he advanced the theory, which he had some thought of elaborating more fully at some time, that such determinations might be carried by accumulated observations to a sure degree of accuracy far beyond what can be seen or measured by the eye absolutely.

Prof. Adams hoped he would more fully elaborate and publish this idea, since there was in it an element well worth careful consideration.

Prof. Harkness doubted the sufficient accuracy of meridian observations of the sun, on account of the distortions produced by letting the sun shine full into the instrument; and spoke of the difficulties in the transit of Venus observations from this cause.

Prof. Newcomb replied that he would have to show that this would be periodic with reference to the moon's quarters in order to affect this constant systematically.

Prof. Adams then presented another note upon Newton's theory of atmospheric refraction, and on his method of finding the motion of the moon's apogee.

In the Section of Chemistry papers were read by C. F. Mabery of Cleveland, O., on chloropropiolic acid and some derivatives of acrylic and propionic acids; and by C. W. Dabney on anhydrobenzamidosalicylic acid.

Dr. Springer of Cincinnati exhibited some improved torsion scales and balances. One of these had been used by Prof. F. W. Clarke, and its action was spoken of as being very satisfactory.

Messrs. L. M. Norton and C. F. Presscott read a paper on continuous etherification; and Prof. Monroe detailed results of analyses of an efflorescence on the bricks of some new buildings. It was chiefly sodium sulphate.

Mr. Clifford Richardson, in a paper on the chemistry of roller-milling of wheat, stated that the dark colour of northwestern hard winter wheat could be overcome by using steel rollers run at different speeds.

Prof. Atwater has examined the nutritive value of different fish. He finds flounder to be the least value, and salmon the highest, and in invertebrates the oyster takes the lowest place as a food-stuff.

A lengthened discussion took place on the subject of valence in chemistry. Prof. Clarke remarked that it was especially useful in organic chemistry in explaining isomerism and in synthesis. It was also used in mineralogy; and he mentioned as examples of isomerism the three minerals kyanite, andalusite, and fibrolite, giving the structural formula for each. He then took up the questions of variable valence, invariable valence, and maximum valence as points that might be discussed. He remarked, further, that valence was an attempt to explain the arrangement of the atoms in a molecule, and spoke of the drawback of being obliged to represent them on a plane surface, space of three dimensions being much nearer the true state of affairs.

Prof. B. Silliman remarked that the last statement of Prof. Clarke was the key to the whole difficulty about valence. A plane surface is insufficient to explain the facts. He testified to the great utility of valence, and spoke of the chaotic condition of organic chemistry before this question of valence was appreciated. It was a working hypothesis, a scaffold without a building, but not the building. Hypothesis is not always the truth.

Prof. W. Ramsay said that the difficulties about valence could be traced to Lavoisier, who worked upon stable compounds, as oxides, chlorides. He also thought that a study of the heat of formation of many compounds would be a key to the valence of the elements; and said that the difficulties of conceiving of the motions of the atoms was well illustrated in Sir William Thomson's effort to explain them in complicated vortex evolutions.

Mr. A. H. Allen called attention to the failure of chemists to recognise the value of the work of John Newlands, in the periodic classification of the elements usually ascribed to Mendeléeff.

Prof. Greene remarked that it was best to consider the cause of valence.

Prof. Ira Remsen testified to the utility of valence. He remarked that there were two ways of teaching: one by giving all the principal theories first, and the other giving the facts and then the theories—which latter he considered the best method. He had come to the conclusion that valence should never be mentioned until all the important properties of a compound are known. In regard to its value to young students, he thought its use was dangerous until they fully understood its meaning. He believed that the value of valence had been magnified, and that it was better to study the reactions of compounds, and the methods for their synthesis, and the manner of breaking up.

Mr. A. H. Allen said that many formulæ that showed the structure of compounds according to the valence of the elements do not give any idea of the true constitution of these compounds as ascertained from a knowledge of their properties. He gave, as examples of his meaning, potassic dichromate and fuming sulphuric acid.

Prof. Dewar, of Cambridge, England, maintained that the graphical method and structural formulæ were most useful, but they are often presented in a way that shows an incomplete knowledge of the ideas of the person who devised the formula. He remarked that the text-books contained too many pictures of graphical formulæ, and that he considered it better to follow the historical method for developing theory.

Prof. Atwater thought that some idea of valence should be given at the beginning, as it assisted the student's memory.

Prof. W. Ramsay said that he was satisfied of the utility of making the student perform experiments that brought out facts to illustrate the theory of valence, so that he could thus understand its meaning from his own work.

Prof. Caldwell said that he could not get along with students in chemical analysis who had not obtained some idea of the theory of valence.

Prof. Remsen thought that the theory of valence might be some good as an assistance to the memory; but such assistance was of doubtful value, and too empirical.

Prof. J. W. Langley, Vice-President, said that valence, or chemism, may be a force emanating from the atom, or it may be a force outside the atom; it is static, or dynamic, and a knowledge of it was more a physical than a chemical problem. From the educational view he thought it better to use the theory of valence in connection with the history of the theories concerning atoms and molecules. As a further step, the language and figures of magnetism might be used.

Prof. Stewart described a process of making leather by treating hides with sulphurous acid under pressure.

Prof. Atwater has grown pease in washed sea sand, and found them to gain from 35 to 50 per cent. more nitrogen than they contained originally, and refers this increase to nitrogen directly absorbed from the air.

Dr. Springer, in a paper on fermentation, showed that a ferment exists in the stems of tobacco plants which decomposes nitrates and forms butyric acid from sugar solutions.

Prof. Dewar spoke of the density of solid carbonic acid, which he finds to be 1·58 to 1·60.

Other short communications were made by Prof. Munroe on deliquescence; on human milk, by Prof. Leeds; on gas analysis, by Dr. Elliott; and on fish oils, by Mr. Allen.

The most interesting discussion was on educational methods in laboratories and chemical lectures, by Prof. Remsen, who remarked that in Germany the student does not go into the laboratory until he understands reactions, while in England and the United States he is placed there at the beginning of the course. Prof. Remsen follows an order of instruction in which the student becomes first acquainted with apparatus and methods of manipulation. He next makes gases, and repeats lecture experiments. He then experiments on oxidation and reduction. Next follows the quantitative analysis of air. Then come alkalimetry and acidimetry, with success. This practical work and the lectures occur simultaneously, and by the time the lecturer has reached the metallic elements, the students are ready to take up test-tube reactions with profit. During the first year the student should only just begin analysis. After the general properties of the metals are known, let the student devise methods of separation. The course of instruction in our colleges Prof. Remsen regards as too short and superficial. Lecture-experiments should never be made for show. Æsthetics and chemistry are entirely distinct.

Prof. Atwater said that chemistry is taught now, as a rule, after the student has acquired the methods of the classics and has never been taught to observe facts. Chemists must show that their science will give what is called "liberal culture," or it will not find a place in our educational institutions. Present methods are not doing this, as they fail to make the student think for himself.

In the Section of Geology and Geography no paper was greeted with more interest or closer attention than that by Prof. J. E. Hilgard, Director of the U.S. Coast Survey, on the relative level of the Gulf of Mexico and the Atlantic Ocean, with remarks on the Gulf Stream and deep-sea temperatures. Its two most essential points are:—(1) The discovery by a most careful series of levels, run from Sandy Hook and the mouth of the Mississippi River to St. Louis, that the Atlantic Ocean at the former point is 40 inches lower than the Gulf of Mexico at the latter point; and (2) that ocean-water at all depths exceeding 1000 fathoms possesses a temperature of nearly 35° F., because this is the temperature consistent with its greatest density. Should the water become either cooler or warmer, it must expand; which it cannot do on account of the superincumbent pressure.

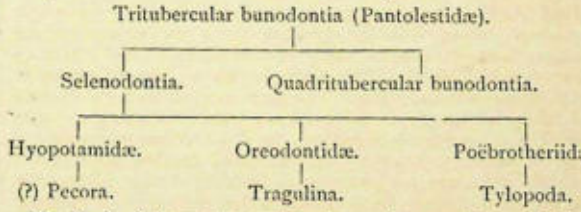
Prof Henry S. Williams, of Cornell University, in a paper on the influence of geographical and physical conditions in modifying fossil faunas, introduced the exceedingly important subject of the extent to which palæontological evidence is to be regarded as an absolute guide in correlating strata in different regions. Prof. Williams explained a series of sections, principally in Chemung and Catskill rocks, taken from a number of localities across New York State, and adduced from them abundance of proof that faunas in Devonian times, as at present, changed not only geologically in sequence of time, but also geographically according to the areas of their distribution. The influences which brought about a change in the character of the sediment deposited also manifested themselves in altering the forms of the organisms inhabiting these sediments.

Prof. Alexis Julien of New York communicated the results of a very extended study of the *Eozoon canadense* from nearly all the localities where it has thus far been found, adding other localities of his own discovery. The result of his investigations led him to decide in favour of the inorganic nature of the so-called fossil, although his ideas in regard to the mode of its formation differ considerably from any heretofore advanced. He noticed as universal in all localities, that the calcium and magnesium carbonates were very unequally distributed in the Eozoonal limestones, and that there was a large development of pyroxene where the dolomite was least abundant. He moreover observed the constant tendency on the part of pyroxene to be arranged in layers alternating with either calcite or apatite, as well as abundant evidence that pyroxene passed by hydration into serpentine, a process which could be seen in every stage at any of the localities visited. From these data it was assumed that siliceous waters, permeating limestones originally evenly dolomitic, would cause the local development of pyroxene by the change of the magnesium carbonate into the corresponding silicate. Were it the case, as so often occurs, that this pyroxene was developed in layers, its subsequent alteration to serpentine or loganite would readily account for all the appearances exhibited by the Eozoon, without the necessity of appealing to organic agencies.

A large number of papers (forty-three in all) were presented before the Section of Biology; but we regret that in our limited space we can give merely the briefest outlines. The first we may mention was a paper by Mr. D. C. Beyer, on the influence of oxygenated and unoxygenated blood, as well as of blood in various degrees of dilution, on the heart of the frog and terrapin. The paper aimed to prove that it is not concentrated mammalian blood which produces the greatest amount of work either in the heart of the frog or that of the terrapin, but that a certain degree of dilution is necessary.

Dr. C. S. Minot read a paper on biological problems. The author opposed the trinomial system, and considered the present mode of determining species entirely unscientific, and thought that the species should be based on a statistical study of all the variations that are known to occur. Individuals are not always homologous. The only fixed units are (1) cells; (2) the whole series of generations of cells from a single ovum—a cell-cycle. An individual may be almost any fractional part of a cell-cycle. Roughly speaking, the higher the organism the fewer the number of individuals it comprises. The author considered the ovum to be homologous with the encysted protozoon, the radial zone being equivalent to the capsule or cyst of the protozoon, and the contents also homologous.

Prof. E. D. Cope in a paper on the phyllogeny of the Artiodactyle mammals derived from American fossils, considered the derivation of the selenodont dentition from the bunodont as established from a mechanical point of view. The oldest American Artiodactyl (Pantolestes) is bunodont. The modification proceeded as in other ruminants on the lines of the co-ossification of the bones of the legs and feet. The peculiar structure of the carpus in the Oreodontidæ shows them to be, without doubt, the ancestors of the Tragulina. The following table represents the present views of the author on the subject:—



Mr. H. F. Osborne presented observations on the amphibian brain, containing results of microscopic study upon the frog, Menobranchus, Menopoma, and Amphiuma. His method of study was by making series of sections, in their different planes. The relative position of gray and white matter was the same as that found in the spinal cord of these and other vertebrates. The courses of the principal nerve-fibres in their course from the medulla forward to the hemispheres was described, showing the course of the transverse commissures, and pointing out a commissure in the roof of the third ventricle hitherto overlooked. This demonstrated that each brain-segment had its own dorsal commissure. The differences of the cerebellum in the Anura and Urodela were pointed out, and the resemblances of the latter to the mammalian brain were dwelt upon. The pia blood-vessels are all sent in upon the anterior face of the pituitary body. The pineal elements were shown to consist of certain very inconspicuous foldings of the epithelium of the roof of the third ventricle, which have been generally overlooked. These foldings represent what remains of the stalk of the pineal gland.

Mr. S. Garman's paper on Chlamydoselachus, the frilled shark, treated of the internal anatomy of this peculiar shark. The nearest forms are Notanidæ, Hexanchus, and Heptanchus. Hind and fore brain resemble that of fœtal sharks; the cartilage is soft: the lateral line is open as in fœtal sharks, and continued to the end of the tail. The pelvis is twice as long as broad: the nearest resemblance to this is seen in the fœtal Heptanchus. According to the author, the Chlamydoselachus may be a sub order of the Galei.

The next paper was by Prof. E. D. Cope, on the mammalian affinities of Saurians of the Permian epoch, and referred to the detection of mammalian resemblances between Thesomorphus and reptiles of the Permian epoch. Resemblances in the pelvic and scapular arch were pointed out. The quadrate bone was discussed, referring to the theory of Albrecht. The genus

Clepsydrops shows that it has the mammalian number of bones in its tarsus, and the resemblance was nearest to that found in *Platypus anatinus*.

Dr. C. H. Merriam read a paper on the hood of the hooded seal (*Cystophora cristata*), describing it as an inflatable proboscis overhanging the mouth, and extending posteriorly to a point behind the two eyes, lined with nasal mucous membrane, and divided longitudinally by two cartilages. It is not noticeable until the male has reached its fourth year.

In a paper on some points in the development of pelagic teleostean eggs, Mr. G. Brook, Jun., first considered non-pelagic eggs, instancing those of trout, in which the hypoblast originates as an involution of the lower layer upon itself, the space between the layers being quite distinct. In pelagic eggs the process is quite different. Sections of the eggs of *Trachinus vipera* at this stage show that the parablast of Klein, the intermediate layer of American authors, is made up of a large number of free cells, and nuclei are absorbed from the yolk, which contribute to a very great extent to build up the hypoblast. In this case there is no true invagination. In *Motella mustela* the origin of the hypoblast is similar to that of Trachinus; but the resulting cells, instead of being quite similar to the original ones, as usual in teleostean eggs, are very much larger, and hexagonal, so that they cannot be derived directly from the lower layer of cells. The author sustained the views of Ryder as regards the segmentation cavity in pelagic eggs. He also holds that there is no circulation in pelagic embryos before hatching.

Mr. G. Macloskie, in a paper on the dynamics of the insect's test, commenced with a general description of the chitinous skeleton with its in- and out-growths, &c. The tracheæ have spinal crenulations, which have been hitherto misunderstood and supposed to be threads; these tracheæ transmit gases directly to the tissues, and the blood is not used for this purpose. The tracheæ are not directly controlled by muscles, their action depending on the successive production of a partial vacuum, and condensation of air around them.

Prof. A. Hyatt read a paper on the larval theory of the origin of tissue, stating that the building-up of the tissues of the Metazoa is due to a quick and rapid division of cells. Minot's theory that the origin of the sexes is due to the difference in cell elements was supported. The author considered the Planula a more primitive form than the Gastrula. In another paper Prof. Hyatt presented objections to some commonly-accepted views of heredity, asserting that heredity has no need of the gemmule hypothesis or pangenesis, but that it can be equally well understood upon the supposition that the nuclei of cells are the immediate agents of the transmission of characteristics. The author presented the case of a man in Maine, who resembled his mother on one side of his body and his father on the other side, as an illustration of his theory, and he contested the position of Prof. Brooks as regards heredity. In a paper on the structure and affinities of Beatricea, the same author stated that this fossil has had many positions assigned to it in almost all the groups of the Invertebrata, though he himself now thought it a Foraminifer. Thin sections were examined, the structure being found to consist of cells joined by a stolon.

Dr. C. S. Minot presented a paper on the skin of insects. The skin consists of three layers—externally the cuticula, overlying an epithelium, which lies in turn on a sheet of connective tissue; the epithelium is homologous with the epithelium of other animals, and should be so called instead of hypodermis; and dermis, which should be applied to the connective tissue, as it is the homologue of that of vertebrates. The cuticle of caterpillars has not yet been fully described: it consists of two layers, a thick one and a thin one.

In a communication on the development of Limulus, Mr. J. S. Kingsley stated that the account begins after the formation of the blastoderm. At this time there is a single layer of cells surrounding the yolk, in which are scattered nuclei. The mesoblast arises as a single sheet on the ventral surface. Its cells come largely from the blastoderm, but some arise from the yolk nuclei. The mesoblast soon forms two longitudinal layers, one on each side in the neighbourhood of the limbs. The cœlom is formed by a splitting of the mesoblast, and at first consists of a series of metameric cavities extending into the limbs. The supra-œsophageal ganglion arises by an invagination of the epiblast. The heart arises as two tubes in the somatophore, which later unite. The mesenteron does not appear until after hatching. The amnion of Packard is the first larval cuticle, and bears no resemblance to the amnion of the tracheata. A second cuticle is formed and moulted before hatching. The eyes appear on the dorsal surface at the same time that the limbs appear on the ventral. In these characters Limulus agrees essentially with the Tracheata, and has nothing in common with Crustacea.

Prof. B. G. Wilder, in a paper entitled, "Do the cerebellum and oblongata represent two encephalic segments, or only one?" remarked that most writers had considered two segments to exist. The cephalad of these segments is held to include the cerebellum, together with the portion of the "brain-stem" immediately connected herewith and the latter part of the oblongata. The only writers that have admitted of a single segment caudal of the mesen are Balfour, A. M. Marshall, Owen, and Spitzka. The views of Spitzka were then discussed, concluding with the opinion that sufficient evidence to settle either side was insufficient, and that the question was still open.

Dr. J. A. Ryder presented a paper on the morphology and evolution of the tail of osseous fishes. The caudal fin of fishes is developed in the same way as the median or unpaired fins, from a median fin-fold. After the protocercal stage of the larva is passed, a lower caudal lobe grows out, which is probably the homologue of a second anal fin. The hypotheses which grow out of a consideration of the facts of the development of the tails of fishes are the following:—(1) Whenever heterocercality manifests itself, there is a more or less extensive degeneration of the caudal end of the chordal axis, which began to be somewhat manifest far back in the phylum in such forms as Holocephali, Dipnoi, and Chondropterygians. (2) With the outgrowth of the lower lobes (second anal) the energy of growth tended to push the tip of the chorda upward; the lobe itself arising, probably in consequence of the localisation of the energy of growth and the deposit of organic material at the point, according to the demands of use and effort. (3) Local use and effort, acting as constant stimuli of local growth, carried the heterocercal condition and its accompanying modification of degeneration and reduction still further, as is shown by a study of the homologous elements in the tails of fishes; while use and effort would also continue to augment heterocercality, until the inferior and superior lobes were of about the same length and area, when the morphological characters of the caudal fin would become approximately stable for any one species, as may be shown by measurements of a simple mechanical illustration, in which the interaction and composition of the faces which are brought into action are demonstrated. (4) The mechanical demonstration alluded to above, taken together with the fact that the primitive or ancestral form of the tail, which is typified by a temporary condition in fish larvæ, when the myocomata are rudimentary, but still symmetrical, amounts almost to a demonstration of the principles first laid down by Lamarck, then elaborated by Spencer, and more recently applied to special cases by the author and Prof. Cope.

In a communication on growth and death, Dr. C. S. Minot gave the results of 10,000 measurements of weight of growing guinea-pigs and other animals from birth to maturity. The rate of growth was found to steadily diminish from birth onward; so that the loss of power begins at once, and continues until death. The common views of death were discussed, and the current conceptions of animal individuality were attacked. The author then referred to the bearing of our present knowledge of senescence upon the theory of life, and the relation of life to a material substratum.

A paper on the osteology of Oveodon was read by Mr. W. B. Scott, in which this genus was said to belong to the Artiodactyla, although there are some strong resemblances to the Suidæ. The vertebræ are ruminant, markedly in the case of the axis. The thoracic vertebræ have long prominent spines, and small bodies slightly amphicœlus. The lumbars, probably five in number, are heavy, with short spines and broad flat transverse processes. The sacrum contains two vertebræ which touch the ileum. The tail is long and slender, and the legs proportionally long. There are a short head and short metapodials, giving the animal a wolf-like appearance. The radius and ulna are distinct. The carpus consists of eight bones, including the pisciform. There are short unanchylosed metacarpals. The ungual phalanges are long and pointed, as in Hyopotamus. A rudimentary pollex is present, this being the only Artiodactyl with one.

Mr. J. Struthers, in a paper on finger muscles in *Megaptera longimana*, and in other whales, records rudimentary flexor and extensor muscles in these animals, and shows that they are more or less used, as the muscular fibres are red and not degenerated.

Dr. G. M. Stemberg described his experimental research

relating to the etiology of tuberculosis. The author repeated the inoculation experiments of Koch, with similar results. The experiments of Formad to induce tuberculosis in rabbits by introducing into the cavity of the abdomen finely powdered inorganic material, have also been repeated with entirely negative results. The author held that Koch's bacillus was an essential factor in the etiology of tuberculosis.

Dr. C. E. Bessey, in a paper on the adventitious inflorescence of *Cuscuta glomerata*, stated that the examination of young plants shows that the inflorescence is developed from numerous crowded adventitious buds, and not by the repeated branching of axillary flowering branches as commonly stated.

In a paper on the hitherto unknown mode of oviposition in the Carabidæ, Prof. C. V. Riley records habits of *Chlænius impunctifrons*, traced from the eggs up. The eggs are laid singly, in cells made of mud or clay, on the under surface of leaves.

Mrs. A. B. Blackwell read a paper on the comparative longevity of the sexes. The study was exhaustive, and made on statistics from all parts of the world; and the greater longevity of woman over man was established. In old countries the females preponderate, while males lead in newly settled ones. Up to eighteen years the males are in excess of the females: later the females predominate in numbers.

THE PRIME MERIDIAN CONFERENCE

THE Prime Meridian Conference at Washington on Monday adopted the Greenwich line as the universal prime meridian. Only one vote—that of St. Domingo—was given against its adoption; but the representatives of France and Brazil declined to vote.

The following details of the session are from the *Times* Correspondent:—

To the American resolution for adopting the Greenwich line, Mr. Fleming (Canada) moved an amendment to the effect that the Conference should adopt the 180th degree of longitude east from Greenwich as the prime meridian; but the other British delegates opposing the proposition it was lost. Señor Valera, the Spanish Minister, said that he had been instructed by his Government, in voting for the meridian of Greenwich, to say that it hoped the metric system of weights and measures would be adopted by England, the United States, and the other nationalities there represented, as recommended by the Conference at Rome. Gen. Strachey (Great Britain) said that he was authorised to state that his country had asked to be allowed to join the Metrical Convention, and that the metric system was already recognised by the laws of Great Britain, and was in use for scientific purposes. He could not, however, say that it would be adopted in any circumstances as a popular system of weights and measures throughout England. M. Lefaivre (France) said the Greenwich was not a scientific meridian, and that it implied no progress in any science, but was merely a commercial standard. Since, therefore, nothing would be gained to science by adopting Greenwich, France could not make a sacrifice of her own meridian, and incur the vast expense consequent upon the adoption of a new one, because she would thereby gain no advantage whatever. Sir William Thomson, who was present as a guest, by the invitation of the Conference, spoke in favour of the choice of Greenwich. He said that it was purely a matter of convenience, and that Greenwich answered the world's convenience better than any other standard meridian. Sir Frederick Evans (Great Britain) presented a statement showing that the shipping tonnage controlled by the Greenwich standard of longitude was about 14,000,000 tons, and that controlled by the Paris one only 1,735,000 tons. From the statement of chart sales, &c., to nations outside England, he showed how largely the Greenwich measure was used.

The resolution recommending the choice of Greenwich was then adopted, the ayes being 21, and there being but one nay—San Domingo. France and Brazil abstained from voting.

Mr. Rutherford (United States) moved that from the Greenwich meridian the longitude be counted in two directions, up to 180°, the east longitude being "plus," and the west "minus." The Russian Minister advocated this proposal, but Count Lowenhaupt (Sweden) moved the adoption of the fourth resolution of the Roman Conference for counting longitude continuously through the whole 360°. Herr von Alvensleben (Germany) said that this was a matter of detail, and therefore he should not vote upon it. The British delegates agreed with the German Minister that this was a matter of detail, and held that it would not make any difference which method was adopted. Señor Juan Pastorian (Spain) stated that he favoured the plan of counting longitude westward continuously round the world.

The discussion was here adjourned.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

OXFORD.—The beginning of Michaelmas Term shows that the University and Colleges have not been idle in erecting new buildings for the accommodation of students. The new buildings of Magdalen—to be called the Waynflete Buildings—are ready for occupation, and will be used this term. No one can deny that the most beautiful of Oxford Colleges has added a new ornament to the city in the Waynflete Buildings. The new buildings of Trinity College are rapidly approaching completion. Stretching back from quaint old Kettle Hall in Broad Street, they extend to near the beginning of the Lime Walk in the College Garden. The open space in front of the College—known as Trinity Green—will now be bounded on the east by these new buildings. The Green will thus become one of the largest "quads" in Oxford. On the north side of the University Museum the new Physiological Laboratory is rising. Its situation is one of the pleasantest in Oxford. That Prof. Burdon-Sanderson is attracting pupils to physiology is a patent fact in Oxford, and one that will be received outside that city with the strongest feeling of satisfaction.

Since last Term we have to deplore the loss of Mark Pattison, Rector of Lincoln College. Mr. Merry, Public Orator in the University, and Fellow and Tutor of the College, has been elected his successor.

The following scheme of lectures and classes has been agreed on by the Board of the Natural Science Faculty:—

In the Department of Physics Prof. Clifton will lecture on the Galvanometer and Methods of Measuring Electric Currents, and on Thermo-Electricity. Prof. Price will lecture on Optics, Physical and Geometrical. Prof. Clifton and Mr. Walker give instruction in Practical Physics in the Clarendon Laboratory. Mr. Walker will give a course on Questions incidental to the Practical Study of Mechanics and Heat. Mr. Baynes will give a course of lectures at Christ Church on Thermodynamics, and form a class for practical instruction in Magnetic and Electrical Measurements. Mr. Dixon will give a course of experimental lectures, on Elementary Heat and Light, at Balliol College. Prof. Pritchard will lecture on Spherical Astronomy, and form a class for practical work in the University Observatory.

In the Department of Chemistry Prof. Odling will give a course of lectures on 3-carbon and 4-carbon compounds. Mr. Fisher will lecture on Inorganic, and Dr. Watts on Organic, Chemistry. At Christ Church Mr. Vernon Harcourt will form a class for Volumetric Analysis. Practical instruction in Chemistry is given daily in the Museum Laboratory, and in the Chemical Laboratories at Christ Church and Balliol College. Prof. Gilbert will complete his course on the Constitution of Plants, and will then lecture on the Effects of Manures, Exhaustion and Variations of Season on the Amounts of Produce and on the Composition of Wheat.

In the Morphological Department Prof. Moseley will begin his course of Comparative Anatomy; each lecture will be followed by special demonstrations on the subject of the lecture. Dr. Hickson gives a course on the Morphology of the Vertebrata, each lecture to be followed by special demonstrations. Mr. Barclay Thompson lectures on the Anatomy of the Mammalia; Mr. Jackson on the Fundamental Principles of Comparative Embryology; Mr. Poulton on the Distribution of Animals; Mr. Morgan on Odontography and on Human Osteology. Prof. Westwood will lecture on the Insect Skeleton.

In the Department of Physiology Prof. Burdon-Sanderson will lecture on the Physiology of Circulation and Respiration. Practical instruction will be given in the Laboratory by the Professor, Dr. Dixie, and Dr. Gotch.

Prof. Bayley Balfour will give a course of lectures in the Botanic Garden, on the General Morphology of Plants.

Prof. Prestwich will lecture at the Museum on the Principles and Elements of Geology. Dr. Tylor will lecture on the Intellectual Development of Mankind.

During the course of the present Michaelmas Term, Scholarships will be awarded in Natural Science at the following Colleges:—At Balliol College, without limitation of age; at

Christ Church, limited to persons under nineteen; at Magdalen College, limited to persons under nineteen years on July 2, 1885.

Mr. J. N. Dobie has been elected to a Natural Science Scholarship at Exeter College in Biology and Chemistry.

CAMBRIDGE.—Mr. G. F. Harmer, B.A., of King's College, has been appointed Demonstrator of Comparative Anatomy. Mr. Harmer was placed in the first class of the Natural Sciences Tripos in 1883, being distinguished in Zoology and Comparative Anatomy.

An examination for Entrance and Foundation Scholarships will be held at Gonville and Caius College, beginning on January 9 next. Six Entrance Scholarships, varying in value from 40*l.* to 80*l.*, may be awarded. The successful candidates must come into residence in October 1885. They may be awarded for Classics, Mathematics, or Natural Science, separately or combined. They are tenable for a year, when the holder will be eligible for a Foundation Scholarship. The scholarships may be increased or diminished each year, according to the scholar's performances in the College or University Examinations. Those who distinguish themselves in the Triposes may have their scholarships prolonged after their degree. A successful candidate, who after the examination enters for competition at another College, forfeits *ipso facto* any scholarship for which he may have been recommended. Candidates must be under nineteen years of age on the first day of examination. Undergraduates of the College may at the same examination compete for scholarships, in which case there is no restriction of age. Candidates in Natural Science will be examined in Physics, Chemistry, Biology, and Animal Physiology, and will be expected to show proficiency in at least two of these subjects, of which chemistry must be one. The Rev. A. W. W. Steel, Senior Tutor, will furnish fuller particulars.

Lectures and Demonstrations on Physics and Chemistry in Michaelmas Term: Prof. Stokes, short course on Double Refraction and Polarisation; Mr. Atkinson, Heat and Hydrostatics; Mr. Glazebrook, Electricity (el.), also Advanced Physics; Mr. Shaw, Physics, Elementary and Advanced; Mr. Hart, Mechanics and Heat (1st M.B.); Electricity (Nat. Sci. Tripos, Part 1); Practical Physics, Demonstrations and Practical Work at Cavendish Laboratory.

Chemistry: Prof. Liveing, General Course; Prof. Dewar, Dissociation and Thermal Chemistry; Mr. Main, Elementary Organic Chemistry; Mr. Pattison Muir, General Principles, and Elementary Chemistry, especially Metals; Mr. Heycock, General Principles (non-metals).

Demonstrations in Spectroscopic Analysis, Prof. Liveing; Special Demonstrations for Medical Students, Mr. Sell and Mr. Fenton; also Special Demonstrations for Nat. Sci. Tripos, Part 1; Mr. Robinson, Demonstrations in Analysis of Food and Water; Practical Work at the University, St. John's, Caius, and Sidney College Laboratories.

Prof. Lewis, Mineralogy and Crystallography; Demonstrations on Minerals, by Mr. Solby.

Prof. Stuart, Mechanism and Applied Mechanics; Mr. Lyon, Rigid Dynamics. The Mechanical Workshops are open from 8 to 1 and 2 to 6 daily.

Geology: Prof. Hughes, Economic Geology and Geological Surveying; Tides, Mr. E. Hill; Stratigraphy, Dr. R. D. Roberts; Palæontology, Echinoidea, Mr. T. Roberts; Constituents of Rocks, Mr. A. Harker. Field Lectures will be specially announced.

Botany, Elementary, with Practical Work, Dr. Vines; Physiology of Plants, Advanced, Dr. Vines.

Zoology and Comparative Anatomy: Prof. Newton, Evolution in the Animal Kingdom; Elementary Morphology (Invertebrata, Mr. Sedgwick; Advanced Invertebrata, Mr. Harmer; Mammalia, Living and Extinct, Osteology, Strickland Curator (Dr. Gadow).

Physiology, Elementary Course, with Practical Work, Prof. Foster; Chemical Physiology, Advanced, Mr. Lea; Advanced Course of Physiology and Histology, Mr. Langley; Preparation for 2nd M.B., Mr. Hill.

Human Anatomy, Muscular System, Prof. Macalister; also Demonstrations of Visceral Anatomy; General Pathology, Prof. Roy; also Practical Class in Morbid Histology.

Advanced Mathematical Lectures: Prof. Stokes, Optics; Prof. Cayley, Recent Developments in Analysis and Geometry; Prof. Darwin, Theoretical Astronomy; Mr. Forsyth, Higher Algebra, Binary Forms; Mr. Hobson, Higher Dynamics; Mr. Glazebrook, Higher Geometrical Optics; Mr. J. J. Thomson, Electrostatics; Mr. Macaulay, Thermodynamics; Dr. Besant, Theory of Equations, Differential and Integral Calculus; Mr. Lock, Fourier's Series, and Vibrations of Strings and Bars; Mr. Stearn, Hydrodynamics; Mr. Temperley, Laplace's Functions; Mr. Webb, Theory of Attractions and Elasticity, if a sufficient number apply.

THE formal inauguration of the University College of North Wales, Bangor, has been fixed for the 18th inst., and it is expected that the Duke of Westminster, the Earl of Powis, Lord Aberdare, Lord Penrhyn, Mr. Mundella, and other gentlemen, will take part in the proceedings. The fitting up of the new laboratories and lecture theatres for the chemical and physical departments is being rapidly pushed forward, and the buildings include a very complete suite of rooms for the use of each department. An excellent equipment of scientific apparatus has been secured for all branches of chemistry and physics. Mr. George Macgowan, F.R.S.E., formerly of Prof. Fresenius's Laboratory, Wiesbaden, and now of Prof. Kolbe's Laboratory, Leipzig, has been appointed Demonstrator in Chemistry under Prof. Dobbie, and Mr. D. M. Lewis, M.A., Trinity College, Cambridge, Demonstrator in Physics under Prof. Gray.

SOCIETIES AND ACADEMIES

SYDNEY

Linnean Society of New South Wales, July 30.—Dr. James C. Cox, F.L.S., Vice-President, in the chair.—The following papers were read:—Revision of the Lamellibranchiata of New Zealand, by Capt. F. W. Hutton, F.G.S. This is a carefully revised list of all the Lamellibranchiate mollusks of New Zealand, with the corrected synonyms and localities of each species. A list is also given of the names of each genus which had been wrongly included by previous authorities in the New Zealand fauna.—List of some New South Wales Zoophytes identified by Dr. Kirchenpauer, by Baron Sir F. von Mueller, K.C.M.G., F.R.S., &c. The list contains the exact localities of six species of Hydroida and fifteen of Bryozoa collected by Miss Bate on the south-east coast, and Miss Hodgkinson at the Richmond River. They were all detached from sea-weeds, and identified by Dr. Kirchenpauer, Burgomeister of Hamburg.—New Fishes in the Queensland Museum, part iii., by Charles W. De Vis, M.A. Mr. De Vis in this paper goes through the families *Berycidæ*, *Sciænidæ*, *Carangidæ*, *Scombridæ*, *Trachinidæ*, and *Triglidæ*, describing in all twenty-three new species, mostly from the coasts of Northern Queensland.—Census of Australian snakes, with descriptions of two new species, by William Macleay, F.L.S. The two new species are named *Dipsas boydii* and *Diemenia atra*, both from the Herbert River District, Queensland. The census gives the names, references, and localities of 108 species of snakes, thirty-five of these being innocuous, and seventy-three venomous. The paper concludes with some remarks on the immunity from snake-bite enjoyed by Australia, as compared with India.—On a new species of kangaroo (*Dorcopsis chalmersii*) from the south-east end of New Guinea, by N. de Miklouho-Maclay. A young kangaroo obtained by N. de Miklouho-Maclay in New Guinea, in 1880, has proved to be (on account of the great size of the præmolars, the general shape of the skull, and the direction of the hair on the neck) a new species of Dorcopsis, which he describes as *Dorcopsis chalmersii*, Mcl. The specific name, *Chalmersii*, is given in honour of the well-known and distinguished missionary of the south coast of New Guinea. The paper contains a full description of the animal and its dentition.—On a complete debouchement of the sulcus Rolando into the fissura Sylvii in some brains of Australian aboriginals, by N. de Miklouho-Maclay. A complete junction of the sulcus Rolando with the fissura Sylvii, which is very rare in brains of our race (a single case only having been described by Prof. Turner), has been found by the author in two out of four brains of Australian aboriginals. The junctions of the sulcus Rolando with other sulci are, according to Dr. Maclay, also not uncommon in brains of men of dark races, and occur more frequently than in the brains of men of the white race.—The Australian Hydromedusæ, part v. (conclusion), by R. von Lendenfeld, Ph.D. In this paper the monograph on the Australian Hydromedusæ is brought to a close. All known Australian species are enumerated, with the necessary references, and thirty new species discovered and described by the author are added. The total number of species

is 231. The most interesting of the new species are illustrated. The classificatory system established by the author is used.—Muscular tissue of Hydroid Polyps, by R. von Lendenfeld, Ph.D. A Hyroid Polyp discovered by the author in Port Phillip possesses a singular apparatus for escaping its enemies. This animal was investigated by Dr. R. von Lendenfeld, and a remarkable muscular structure was discovered. The histological structure of this is described, and some general conclusions drawn from the observations on muscular tissue, by O. and R. Hertwig, Claus, and the author.—Notes on the fibres of certain Australian Hircinidæ, by R. von Lendenfeld, Ph.D. The author discusses the origin of the "filaments," and describes some new and interesting peculiarities of the Australian Hircinidæ.—On the Myrtaceæ of Australia, by the Rev. W. Woolls, Ph.D., F.L.S. In this paper the author gives tabular statements of the distribution of this large order throughout the globe, but with special reference to its development in Australia. From an examination of these tables, as well as from other considerations, it is clear that West Australia must be regarded as the metropolis of the essentially Australian flora, the plants of the eastern portion of the continent bearing evident relation to Asiatic and Oceanic forms, while those of the west find their nearest, though still very distant, kindred in the yet more distant continent of South Africa.—On marine Annelids of the order Serpulea: observations on their anatomy, with descriptions of the Australian species, by William A. Haswell, M.A., B.Sc. The points treated of are the pseudohæmal system, the segmental organs, the tubiparous glands, budding and hermaphroditism, and the characteristics of the Australian representatives of the order. The arrangement of the vessels in several of the genera is described. Segmental organs of a simple type are shown to exist in addition to tubiparous glands which had been previously regarded as representing the segmental sacs of other *Polychæta*. Details are given of the structure of the tubiparous glands in a variety of genera.—On a new Crustacea found inhabiting the tubes of *Vermilia*, by William A. Haswell, M.A., B.Sc. In the tube of a Port Jackson *Serpulid* the author found several specimens of a remarkable Isopod, each with a brood of young. It proved to be a form differing in various points from any of the known families, but most nearly related to the Anthuridæ. The young were free in the cavity of the tube, sheltered, however, by fasciculi of hairs fringing the pereion of the parent. Like the "normal" Isopoda, and unlike the Anthuridæ, the embryos are flexed in the egg towards the dorsal side; there is a pair of jointed larval appendages connected with the second larval cuticle.—Note on *Pristiophorus cirratus*, by William A. Haswell, M.A., B.Sc. This remarkable genus of sharks was shown to be viviparous, and to possess a rudimentary shell thrown off in the uterus as in *Mustelus*, *Carcharias*, *Galeus*, and *Sphyrna*.

PARIS

Academy of Sciences, October 29.—M. Rolland, President, in the chair.—Note on the total eclipse of the moon on October 4, by M. Mouchez. Owing to its long duration, this eclipse offered a favourable opportunity for more exactly determining the diameter of the moon through the occultation of numerous small stars near the lunar disk. Although the weather was far from favourable, a sufficient number of observations were taken by MM. Périgaud and Bigourdan to advance the solution of this problem considerably. A large number of photographs were also taken by MM. Paul and Prosper Henry. The duration of the eclipse appeared to be rather less than the period theoretically determined.—Note on the experiments recently made at Turin and Lanzo to distribute the electric light to great distances, by M. Tresca. These experiments, carried out by Messrs. Gaulard and Gibbs in connection with the International Electrical Exhibition now being held at Turin, are stated to have been attended by a large degree of success. A Siemens' dynamo-electric machine of 30 horse-power generated an alternate current, which was simultaneously utilised by the Swan, Siemens, and Bernstein systems distributed over a circuit of twenty-four miles between the Exhibition, Lanzo, and intermediate stations.—Note on the nitrates present in plants at the various periods of their vegetable development, by MM. Berthelot and André.—On the explicit solution of Hamilton's quadratic equation in quaternions or in matrices of the second order, by Prof. Sylvester.—A fresh communication on a method of extracting the colouring matter from straw, by M. E. Cadoret, was referred to the previously appointed Commission; and a memoir by M. Goyet, on a project for the construction of a marine canal between the Atlantic and the Mediterranean was referred to M. de Lesseps for examination.—Results of the observation of the recent lunar eclipse made at the Paris Observatory (equatorial *coudé*), by M. Périgaud.—Note on the same eclipse as observed at the Paris Observatory (equatorial of the West Tower), by M. G. Bigourdan.—Observation of the same eclipse, by M. Trépied.—Observations of Wolf's comet made at the Observatory of Algiers (0·50 m. telescope), by M. Rambaud.—Observations of the new comet, made on September 24, 25, and 26, by M. Perrotin. Under the spectroscope the nucleus yielded a continuous brilliant spectrum crossed by the three usual bands of comets, and by a fourth in the violet, like that observed some months ago in the spectrum of the Pons-Brooks comet.—Observations of the solar spots and faculæ during the third quarter of the present year, by M. Tacchini.—Remarks on the solar halos observed at Rome during the last four months (four illustrations), by M. P. Tacchini. This phenomenon, which has been constantly visible at Rome shortly before sunset since the first appearance of the after-glows in November 1883, is stated to resemble in every respect that already described elsewhere by M. Cornu.—Note on the action of water and of nitric acid on the basic acid of the bioxide of tellurium, by MM. Klein and J. Morel.—Note on the experimental study of infectious osteomyelitis, by M. A. Rodet.—On the elimination of phosphoric acid by the urine in cases of mental disorders and epilepsy, by M. A. Lailler.—Geological observations on the section of the Cordilleras traversing the Isthmus of Panama, by M. Ch. Mano. A careful survey of this region in connection with the works now in progress on the Interoceanic Canal has satisfied the author that the northern continuation of the Andes system following the double curve of the isthmus throughout its entire length, belongs to a far more recent geological epoch than that of the syenites and serpentines of Choco and Antioquia, whence they appear to branch off. They are also later than the diorites, volcanic and other porphyries of the Costa Rica coast range, which belong to the system of the Rocky Mountains, stretching thence northwards to the Polar Sea. The eruptive rocks of the isthmus seem to be contemporary with the volcanic formations of Auvergne, dating from the Quaternary or the dawn of the present epoch, and containing fossil human remains.

CONTENTS

	PAGE
Handbook of Botany	581
Our Book Shelf:—	
Hobkirk's "Synopsis of the British Mosses."—J. G. Baker	582
Wood's "Our Insect Allies"	582
Letters to the Editor:—	
Shifting of the Earth's Axis.—Prof. C. Piazzi-Smyth	582
The Sky-Glows.—Robert Leslie; Joseph John Murphy	583
Circular Rainbow.—William P. Marshall	584
To Find the Cube of any Number by Construction.—R. Tucker	584
Explorations in Iceland. By Th. Thoroddsen	584
Storage Batteries	585
Meteorology of the Lower Congo	589
The Recent Eclipse of the Moon. By Otto Boeddicker; E. J. Lowe; George F. Burder. (*Illustrated*)	589
Notes	591
Our Astronomical Column:—	
The Approaching Appearance of Encke's Comet	594
Variable Stars	594
Southern Binaries	594
On the Seat of the Electromotive Forces in the Voltaic Cell	594
The American Association	596
The Prime Meridian Conference	602
University and Educational Intelligence	602
Societies and Academies	603

THURSDAY, OCTOBER 23, 1884

FIELD AND GARDEN CROPS

Diseases of Field and Garden Crops. By Worthington G. Smith, F.L.S. (London: Macmillan and Co., 1884.)

THE fact that a handbook of the diseases of crops has been written would not seem to other than botanists and agriculturists to be anything specially noteworthy. But in the British Empire, where plant economics is certainly better understood and its lessons more eagerly and thoroughly applied than in any other community, it is both true and surprising that no guide to the study of plant diseases and their prevention—at least none worthy of the name—has until now appeared. Nothing more admirable than the papers on vegetable pathology contributed by the Rev. Mr. Berkeley to the pages of the *Gardeners' Chronicle*, and the many writings of this and other authors scattered throughout our serial scientific literature, can, within their range and for their time, be shown elsewhere. But of recent years remarkable advances have been made, especially in Germany, in the study of the ætiology of plant diseases, and an excellent and comprehensive handbook was prepared a few years ago by Prof. Frank. Without doubt this author has gone as far as the state of science permitted him, but nevertheless a serious attempt to deal with vegetable pathology has yet to be made, and the attempt must be preceded by a great amount of laborious research. The activity shown in the investigation of parasitic diseases leaves little to be desired, but the many other ailments that the plant is subject to are but little regarded. That injuries are done by defective nutrition, by frost, and such like causes, is doubtless well recognised, but beyond this recognition there has not been very much inquiry into the matter. It is as if we were to be content with classifying the diseases of man into those due to the prevalence of east winds and the like.

While pathology is in this condition our therapeutical resources must continue scanty. Much may be hoped however from such researches in plant nutrition as those of Dr. Gilbert and Sir John Lawes. The means in our power of coping with the attacks of insects and of fungi are, it must be confessed, not very effective. There is doubtless something exhilarating in the wholesale destruction of insect pests by means of a judicious mixture of soapsuds and petroleum (applied on occasion by a fire-engine), and the heroic slaughter of the enemy may spur on the administrator to further and greater deeds, but except for very "local application" even this method will hardly lead to generally useful results. More—much more—is to be hoped from the encouragement of insectivorous birds, as recommended by entomologists. In fungal diseases our chief hope lies in "stamping out" either by means of the interception of a generation (where possible) on a comparatively worthless host, or by rigorous destruction of infected crops. It is true cases occur where timely amputation may save the remainder, and a method of cultivation (of potatoes) is under trial, the aim of which is to check the disease in each case at a certain stage of its progress—but the result will be seen. The introduction of new and "disease-resisting" races opens up also a means of evading fungal diseases.

Mr. Worthington Smith in the introductory chapter of his book laments that "there are no special teachers of vegetable pathology in this country, and the few men who have made the subject more or less a specialty, have not the time or opportunity for extensive or continued experiment and research." As one of those who have given much time and attention to this subject, Mr. Smith has here endeavoured to make up in some measure for this want by supplying us with a treatise on the diseases of crops, selecting such as are of the first economic importance, describing their phenomena in simple language, and considering the best means of preventing attack. With the exception of the attacks of Nematodes, he has confined himself to vegetable parasites, and of these he has supplied copious illustrations faithfully recording his views of the structure and the phases passed through by such organisms. The advice given throughout is cautious and to the point; the book is in very handy form, and within the reach of all in point of price. As such, then, it must be considered a decided gain to the farmer, the gardener, and the author's fellow-workers. Many of the last-named will regard with regret the fact that the author has not seen his way to accepting the proofs of so well-established a fact as the heteroecism of the *Uredineæ*. Mr. Smith devotes a chapter to the consideration of the subject, in which he attempts to combat the irrefragable evidence of the truth of this fact furnished us by experiment. Such objections, to give but one example, as that to the different periods occupied by the cultivation-experiments of different observers are not only of no account, but Mr. Smith must surely know from his own experience that the germination and further growth of spores as well as seeds vary exceedingly in different circumstances even under the same observer's hands. But it would be beyond the scope of this review were I to enter upon any defence of the existence of heteroecism in the Uredineæ. What is more particularly to be noticed in this section of the book is a theory of the hereditary nature of parasitic diseases. At p. 197 the author says:—

"We have shown that plants invaded by *Puccinia* and *Æcidium* carry an hereditary disease by which they are saturated, and that the disease is capable of reaching the seeds and reappearing in the youngest seedlings. Now, if plants thus suffering from hereditary disease, and having the latent germs of disease in every part of their organisation, are experimented upon in an unnatural way, have spores of fungi placed near their organs of transpiration, whose germ-threads can pierce the epidermis or enter and choke the stomata and so reach their intercellular spaces, is it not likely that this inoculating process may start into activity the latent germs of disease?"

This is illustrated by the "instance of a person constitutionally subject to phthisis (consumption): give that person a cold and phthisis appears; but the same cold will give rise to rheumatic fever with a second constitution, and scrofula with a third, according to the tendency of the individuals to these disorders." Since Mr. Smith considers the heteroecism of the *Uredineæ* as not proven in spite of the nature and the amount of the evidence, one cannot help being profoundly astonished at the ease

with which he, even their own author, accepts such startling speculations concerning the hereditary nature of the parasitic diseases of plants.

In the matter of the potato disease, Mr. Smith gives a history of the whole subject, and a full description of the oospores, which he claims to be those of the *Phytophthora*. At p. 340 there is a sentence of some interest in view of the above-mentioned theory.

"It is quite possible, then, that just as every atom of a mycelial thread of this fungus (potato fungus) will continue its growth to a perfect form, so every atom of a broken-up flagellum—perfectly invisible to the eyes even when the highest powers of the microscope are used—may be capable of carrying the poison and at length reproducing the perfect form of the fungus in the potato plant."

Everything is possible, but some things are undoubtedly highly improbable, and chief among these are those which we have not the slightest grounds for supposing probable. Such is the case with this speculation since (to take the flagellum only) in the first place it is not by any means certain, as the author indeed points out in the same paragraph, that a flagellum breaks up at all, and in the second it is quite unwarrantable on any known basis of fact to suppose that its fragments are endowed with any reproductive function.

Apart from such speculations, I venture to think that Mr. Smith has rendered the study of vegetable parasites a signal service in the publication of this book. Its practical uses to the farmer and the gardener are apparent, and to the student of the subject the advantage is no less, even in those cases where the author differs from the great majority of his fellow-workers, since "the case for the opposition" is as well and as strongly stated as the materials permit. The book is of practical value in this country, and it is, moreover, one which no intelligent agriculturist can afford to dispense with in these times, when farming is engaged in a struggle of such severity at so many points.

GEORGE MURRAY

OUR BOOK SHELF

How to Foretell the Weather with the Pocket Spectroscope. By F. W. Cory. (London: Chatto and Windus. 1884.)

IT is of little use putting any instrument, however simple it may look, into a student's hands, if he is not previously taught how to use it. This needful information is supplied by the handy little book now before us, showing what can be done with a direct-vision spectroscope only some $3\frac{3}{4}$ inches long.

The book commences by describing two pocket spectroscopes now in use: the "rainband spectroscope," and a newer and somewhat larger instrument, "Grace's spectroscope," which, however, is still small enough for the pocket, being only $5\frac{3}{8}$ inches long when closed, and which has the advantage of giving a larger spectrum. Here, however, there is a most important omission, for the adaptation of a lens to focus the image of a cloud or a part of the horizon on the slit is not referred to. Instruments thus armed are far better than those of the ordinary construction for meteorological purposes, and, as made by Hilger, they are not appreciably larger. We are next told how to use the spectroscope, and a map is given (Plate 1), showing the positions of some of the lines which the student should learn to recognise in the spectrum of the sun, in order to see at once if the rainband is present or not.

On another page we find the principal rainband itself (Plate 2), which is instructive as showing the student what to look for; but in the construction of this map a larger spectroscope, of two prisms, has been employed, so that if the student in looking for the rainband uses his pocket spectroscope, he will be somewhat disappointed. It would have been more complete if a drawing of the rainband, as seen with Grace's spectroscope, could have been given side by side with Plate 2, which shows so much of the detail.

The book concludes with letters, reprinted from the *Times*, from the Astronomer-Royal for Scotland and others, showing the value of the spectroscope for meteorological purposes.

We think no one can lay down this little volume without feeling this opinion confirmed, and that in the pocket spectroscope we possess an invaluable instrument with which to forecast the state of the weather. B.

Celestial Motion: A Handy Book of Astronomy. By W. T. Lynn. (London: Stanford, 1884.)

MR. LYNN'S long training at the Royal Observatory has eminently qualified him to write this little book. It is in no sense a school-book, but all the same it contains a most useful introduction to those parts of the science of astronomy of which it treats. These are the earth, sun, and moon; the planets arranged in three groups; comets, meteoroids, and the fixed stars. There is added a very painstaking and concise history of astronomical discovery, the only blot in which is an ineffective reference to spectrum analysis at the end.

The First Six Books of the Elements of Euclid, and Props. i.—xxi. of Book xi., and an Appendix on the Cylinder, Sphere, Cone, &c. With copious Annotations and numerous Exercises. By John Casey, LL.D., F.R.S. (Dublin: Hodges, Figgis, and Co., 1884.)

THIS is the second edition of a work which so accomplished a geometer as Prof. Henrici (vol. xxix. p. 453) has pronounced in these columns to be in many respects an "excellent" book. As the first edition contained 254 pages, and this one reaches 312 pages, it is manifest that the work has grown—and with its growth we find that it has acquired an accession of strength. We will indicate in what directions it has increased. First and foremost is the addition of the propositions of Euclid's Eleventh Book, which are generally read by junior students, and an appendix (well suited for candidates for the London Intermediate Examination) on the properties of the prism, pyramids, cylinder, sphere, and cone. There is also now given an explanation of the ratio of incommensurable quantities, and a still greater number, than in the first edition, of alternative proofs. Further, we can testify, by a careful perusal of the text, that the work has been "thoroughly revised as well as greatly enlarged." One feature we note, that whereas in the first edition the *syllabus* of the Association for the Improvement of Geometrical Teaching was often referred to by quotation, in this edition the name occurs but once or twice. There are reasons for most actions—we presume there are for this course of action.

We are glad to note that Dr. Casey makes frequent use of the term *right* line; the absence of the word "right" is liable to lead young boys astray: we should also prefer in one or two instances the term "circumference" (the line) to the term "circle."

Numerous easily rectified clerical mistakes occur, and we could wish that the author had uniformly written *A B* for a line drawn from *A* to *B* instead of apparently writing the letters haphazard. The terms *area* and *perimeter* are employed without definition; a work by Prof. Townsend (p. 142) is referred to without giving exact reference; and an examination question (p. 173) in-

volves an acquaintance with Gauss's discoveries in regular polygons without the information having been given to the student. The proofs of i. 9 and iii. 35 appear to us to admit of improvement, the first by the familiar addition of "on side remote," &c., and the latter might advantageously be curtailed. These are small faults in a work of such extent, and we instance them to show how little we find not to our liking in an admirable text-book. We notice that Dr. Casey has adopted the convenient terms "circum-circle," "circum-centre," &c., first introduced, we believe, by W. H. H. H. in these columns. He also calls a certain well-known locus by the name of "Simson's line," following the practice now usually adopted by geometers in this country, we do not know on what authority; that well-informed writer in the *history* of the subject, Mr. J. S. Mackay, states in his edition of Euclid, recently reviewed in these columns, that he had not met with the property in Simson's writings.

Prof. Henrici in his article on "The Axioms of Geometry" (NATURE, *l.c.*) does not approve of Dr. Casey's treatment of the Fifth Book (the Algebraic), and criticises adversely Hamilton's quaternion proof of Euclid i. 32, given by our author in an appendix (cf. also NATURE, vol. xxix. p. 573). Dr. Casey prints the article as in the first edition, and takes no notice of the criticisms we refer to. A very large and well-selected collection of exercises (upwards of 800 we think), with the addition (now) of numerous examination questions, complete a work every way worthy of the reputation of the great Irish geometer.

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 Sky-Glows

ON reading Prof. Herschel's letter in NATURE for October 2 (p. 536), in which he so vividly describes the sunset of Sept. 20, I was so forcibly reminded by its similarity, especially with regard to the "diverging beams," to one which I lately witnessed during an excursion to the White Mountains (New Hampshire), that I send you a short account of it. It occurred on the evening of September 9 while we were staying at Twin Mount House, at a short distance from which is an elevated wooden erection, commanding splendid views of the neighbourhood. We had been watching the shadows creeping over the hills, the evening light reflected on a bend in the river below, had seen the sun go down behind the soft gray outlines of Mount Agassiz, and revelled in the glorious tints, such as Prof. Herschel describes, when, on returning to the hotel and stepping out on the balcony to take a last look, we saw, from the point where the sun had lately disappeared and where the fiery glow still lingered, these remarkable "diverging rays," so distinct in their character and so sombre in their dark (though slightly greenish) shadow-like hue—there were not many of them—that I involuntarily exclaimed that I had never seen anything like them before, and that surely the climate must have something to do with their striking appearance and unusual definition. I may mention that the day-glow was also conspicuous at times on that continent, notably at Quebec on August 25 last.

Since writing the above, I find that your correspondent, Mr. J. E. Clarke (September 18, p. 488), also refers to dark bars at sunrise and sunset, and the radiating character of the latter.

Further Barton, Cirencester, October 17 E. BROWN

THAT Mr. Backhouse is right in thinking the day-glows were entirely fresh in November of last year, the following extract from my diary confirms. As ordinary meteorological phenomena are entered upon a daily chart, my note-book only refers to what is unusual. Those whom I called to notice the sky thought it quite strange. "1883, xi. 25.—SKY COLOURING at 2.45 to 3 p.m. of a pale rosy-pink tint to the blue, giving a greenish-gray cast to cirro-cumuli where it shone through. Formed circle round sun extending from about 10° to 25° or 30° away. Inside the 10° sky yellowish. Can this have anything to do with the green sun seen in India, and therefore with the Java eruptions? Have noticed once or twice of late unusual sunset-colouring very late. At 4.30 strange ruddy or bright red tint on brick houses in Bootham. At 5.30 the west ruddy, as from glare of fire; still signs visible of this up to six. Sunset at Greenwich at 3.58; therefore here at 3.38. Notice also various newspaper reports and also in NATURE of striking appearances after sunset, ascribed to auroras, &c." J. EDMUND CLARK

Bootham, York, October 19

Cole's Pits

IN reference to the subject of the "Cole's Pits," respecting which a notice from Mr. A. Irving appeared in NATURE for Oct. 9 (p. 560), I find that as early as 1784 these pits, or rather perhaps some of them, were investigated by the Hon. Danes Barrington. And a paper appears on the views entertained by him regarding them in *Archæologia*, vol. vii. p. 236, under the head of "An Account of Certain Remarkable Pits, or Caverns, in Berkshire." Although Mr. Barrington expresses some doubts as to his conclusions, he nevertheless leans to the opinion that they are the winter dwellings of a pre-Roman people, the entire series constituting perhaps an ancient British town. He estimates them at about 273 in number, and covering a space of about 14 acres. In depth they vary from 7 to 22 feet, and are 40 feet and upwards in diameter, the largest being not in all instances the deepest. They extend in regular series, and are placed rather closely to each other. They are referred to a period anterior to that of Stonehenge; and it is conjectured that if each pit contained five occupants the entire community would have numbered something like a population of 1400 souls. As suitable for the residence of uncivilised people stress is laid on the fact that the place is entirely of the dried sand on the rich vale of the White Horse. The dwellings are supposed to have been entered by climbing down a rude ladder or notched pole after the manner adopted by the natives of Kamchatka in reaching their underground habitations. It is remarkable as bearing on the theory that these pits are abandoned quarries, that no objects, such as pottery, indicative that they (the pits) were used as dwellings, were found by Mr. Barrington. There can be no doubt that the pits are simply the sites of shafts dug for the purpose of obtaining the underlying ironstone. Indeed, Mr. Godwin-Austen appears to have set the matter at rest many years ago; and although I am not able at the moment to state in what paper on the subject the opinion occurs, I am in possession of a note in which Mr. Godwin-Austen, with the keen perception of the skilled geologist, observes that although "the Faringdon tradition points this spot out as the site of the castle of King Cole, whose memory is preserved in a well-known fragment of popular poetry, geology can countenance no fictions except its own, and Cole's Pits are evidently the remains of the open workings for the ironstone underlying the mass of sand."

Reading, October 10 JOSEPH STEVENS

Circular Rainbow

THE circular rainbow mentioned by Mr. Marshall seems to be similar to what may be seen at the Niagara American Falls by persons who are fortunate enough to have taken the trip under a portion of that Fall at the right time. When coming out into the front of the Fall, if the sun be shining and in a favourable position, each observer is surrounded by a rainbow of which his eye is the centre, and which accompanies him while in front of the Fall like the halo of a saint of old, but larger.

Before railroad days, when travelling by coach from Bristol to Bridgwater, I once saw a complete circular rainbow resting on the vale below the Leigh Woods, just out of Bristol.

Barnstaple, October 20 W. SYMONS

P.S.—One morning, as the sun was rising over the Southern Atlantic, the sea being moderately rough, I saw each white crested wave drowned with the prismatic colours, causing a dancing play of glorious colour never to be forgotten.

THE NEW GEOLOGICAL MAP OF RUSSIA[1]

GEOLOGISTS will be glad to hear of the appearance of the first sheet of the "Geological Survey of Russia," published by the Geological Committee on the scale of 10 versts to an inch. It comprises nearly the whole of the Government of Yaroslav and the eastern parts of Tver, between 57° 0′ and 57° 42′ N. lat., and 43° 10′ to 47° 40′ E. long., corresponding thus to Sheet 56 of the General Staff Map of Russia. This region, which is watered by the Upper Volga, the Mologa, and the Sheksna, is an undulating plain, the highest points of which, close to Bejetsk, reach 700 feet above the sea-level, gently sloping east and west to a level of from 350 to 420 feet. It has been dealt with first on account of a series of geological explorations which have already been made within its limits. It was visited by Blasius, Murchison, Keyserling, and Barbot-de-Marny, and careful explorations have been undertaken during the last few years within the limits of the province of Yaroslav, under the direction of its Provincial Assembly and Statistical Committee, by MM. Schurovsky, Piktorsky, Eremeyeff, Dittmar, Kryloff, and Nikitin.

The map, which has been prepared by M. Nikitin, is very carefully printed, and will be the more welcome to European geologists as all important names and explanations are given in French, side by side with the Russian text. The colours and the explanatory letterpress are in conformity with the recommendations of the International Geological Congress. A quarto volume, in Russian, by M. Nikitin, with plates and drawings, accompanies the map, the whole being summed up in German at the end of the volume.

The first thing which strikes one on looking at the map is the very great space covered with the gray colour of the Quaternary deposits. A greenish patch of Jurassic rocks in the middle of the map, several patches of Trias on its borders, and a very small Carboniferous patch, altogether hardly cover one-third of the surface; the remainder representing the "Boulder Clay, which conceals deposits of unknown age." The thick sheet of Boulder Clay will be for a long time the stumbling-block of Russian geologists. Natural sections are found only on the banks of the greater rivers, while the valleys of the smaller ones, to their very bottom, are cut through Quaternary deposits. Even the two railways that cross the space covered by the map have been laid without excavations of any importance to the geologist; and no artificial excavations worthy of notice are to be found in the whole area.

As to the geological description which accompanies the map, it is full of interest. The Carboniferous deposits which are denuded over a very limited space in the north-west, belong to the Upper series, characterised by *Spirifer mosquensis*. They probably extend throughout the region in nearly horizontal strata gradually inclined towards the east; but they are concealed by the Variegated Marls which are the subject of so lively a controversy among Russian geologists, and which are considered by the author as belonging to the Trias, contrary to the opinion of the Kazan geologists, who consider them Permian. Although appearing on the surface only in isolated islands, these Marls probably also extend throughout the Yaroslav region; the salt-springs at least, which appear at many places, and which usually take their origin, in Russia, either in the Devonian or in the Variegated Marls, seeming to indicate a great extension of these deposits. The Jurassic formations appear now (as throughout Middle Russia) only as sporadic islands, which are remains of a widely-extended strata destroyed by denudation; the Jurassic sea, according to the author, extending at least as far north as the latitude of Tver. The Jurassic deposits, which have been, like the Variegated Marls, the subject of special monographs by M. Nikitin, are represented in the Yaroslav region; the lower ones by the Callovian and the Oxford Clay, the two chief subdivisions of the former being characterised respectively by *Cadoceras Milaschevici* and *Quenstedioceras Leachi*, and those of the latter by *Cardioceras cordatum* and *C. alternans*. The Upper Jurassic is represented by the "Volga Series," Lower and Upper, respectively characterised by *Perisphinctes virgatus*, *Oxynoticeras fulgens*, and *Olcostephanus subditus*. They are invariably covered with a sheet of sands (like the Jurassic of Central Russia), which seems to have been a littoral deposit accumulated during the retreat of the Jurassic sea.

A very interesting chapter is devoted to the Quaternary deposits of Yaroslav and Central Russia. The thick sheet of Boulder Clay which covers Central and North-West Russia, and contains erratics from Finland and Olonetz, as also from those regions which the erratics had to cross on their way from the north, has long been a puzzle to Russian geologists. Within the limits of the map, it appears with its usual characters, that is, those of a layer 8 to 10 m. thick, spread without interruption over the country—over the watersheds as well as the valleys—without any traces of stratification or even of striation by water: the thickest boulders and the finest particles appearing closely mixed together without bearing any traces of sorting by water-currents. As to the boulders, they are of all possible sizes, from a grain of quartz to masses 2 and 3 m. in diameter. While crystalline rocks and schists from Finland and Olonetz are prevalent, local boulders—Carboniferous and sometimes Jurassic—are also not absent, especially in the lower strata. The boulders have a tendency towards a disposition in ridges which run from north-west to south-east, crossing the rivers, or rising sometimes in the shape of moraines, or eskers of great size. A sheet of boulder-bearing sand, with traces of stratification, appears at many places beneath the Boulder Clay, which passes also in its upper parts into an unstratified sand with boulders.

Such being the character of these deposits, it is obvious that the theory fails which tries to explain them by floating ice, as does also Prof. Trautschold's theory of "Eluvium." The author accepts, therefore, the theory now generally adopted by geologists, and specially advocated for Germany by Berendt, Penck, and Bernhardi, and for Russia by P. Krapotkin, and considers the Russian Boulder Clay as an equivalent of the *Krosstenslera* of Sweden. Like the British Till, it is no doubt the bottom-moraine of the great ice-sheet which covered Northern Germany and Russia, without reaching the Ural Mountains, during the ice-period. This period succeeded to a relatively mild climate, when the plains of Moscow were covered with thick oak and maple forests, inhabited by the mammoth and the rhinoceros, which were compelled by the ice-sheet slowly advancing from the north-west to emigrate east and south. The Loess of Southern Russia, and the Loess-like deposits of the intermediate region, were probably contemporary with the glaciation of the north.

Another chapter is devoted to the formation of rivers in European Russia, and to the great processes of denudation in the later parts of the Quaternary period. This subject has been keenly discussed of late by Russian geologists. The author is to be congratulated on the scientific manner in which he has laid the basis for a discussion of the three important questions—as to the Variegated Marls, the Boulder Clay, and the more recent alluvial deposits—with which he has had to deal in this first fascicule of the Geological Survey of Russia.

[1] "General Geological Map of Russia." Sheet 56, Yaroslav, &c. By S. Nikitin. (*Memoirs* of the Geological Committee, vol. i. No. 2.) St. Petersburg, 1884.)

EARTHQUAKES

THOSE observers who have undertaken the detailed study of a region severely injured by an earthquake are well acquainted with the difficulties that attend on

such a perilous and unthankful work as examining the ruins. The necessity is soon felt for some means of accurately registering the various characters of the earth's movement. The imperfect record of the features of an earthquake afforded by broken walls, fissured roofs, and overturned objects is dependent upon a variety of causes.

1. The earthquake consists of a series of movements that do not radiate from a mathematical point, or even from the focal cavity, with perfect uniformity.

2. The group of disturbances which constitute a shock (of variable duration) may not arise from the same point, as, for instance, in the rending of a fissure in an upward direction, the first impulses would be derived from a much lower point than the last.

3. The great variation in the physical qualities of the rocks traversed, dependent upon their composition, intimate structure, and mode of arrangement. Also we may here include the irregular conformation of the surface.

4. The want of homogeneity and of regularity in the structure of houses and walls, and also the presence of door and window openings.

5. The presence of old fissures in buildings, either the result of displacement, shrinkage, or former earthquakes.

Were it possible to construct absolutely perfect instruments for registering the complex movements of an earthquake, we should be able to exclude the two important causes of error coming under the heads (4) and (5), but the others can never be removed, unless that under head (3) might be so by a complete knowledge of the subterranean geology of a district in question—a far from easy matter.

After perusing the recent paper by Prof. J. A. Ewing on "Measuring Earthquakes" (NATURE, vol. xxx. pp. 149 and 174), one might despair of ever understanding the complex tracings the author obtained. A more careful consideration of the subject would seem to help us out of the difficulty to a considerable extent in so far as theoretical reasons will permit us, and it is not till suitable seismographs have been fairly tried in other districts than the unsuitable alluvial plain of Yeddo that we shall learn whether there is any practical use in instrumental observation of earthquake movements.

In an alluvial plain like that of Yeddo, reposing as it probably does on the irregular surface of different but more elastic rocks, from which are transmitted to it the vibrations, the condition is such that a number of waves would be reflected and refracted so as to meet each other at various angles interfering with each other and producing very complex results on any pendulum instrument.

I am personally neither acquainted with the geology of the region in question nor with the type of disturbances constituting its earthquakes, yet from descriptions of the latter one would feel inclined to regard them as the tail-end movements of powerful shocks far below the surface, conditions highly favourable to complexity from reflection and refraction. Besides, the incoherent alluvium, often water-logged, is subject to a remarkable disturbance when vibrations are communicated to it from without, as may experimentally be illustrated by spreading jelly, or, better, mud, over the irregular surface of a piece of wood and tapping with a hammer.

These remarks may at first sight appear beyond the question, but we must not leave the subject without further trial. Any one who has studied the injuries resulting from destructive earthquakes such as that of 1857, described in Mallet's classical memoir, or of those of 1881 and 1883 in Ischia, cannot but be struck with the regularity of the injuries when the observer carefully excludes the large number of modifying influences, as heterogeneity in structure of buildings or the surface configuration of the point in question.

The following instruments were suggested by the study of the two great Ischian earthquakes, and with suitable modifications might be made appropriate to study small or great shocks as the case might require. The use of a pendulum as the main part of the mechanism has many objections, which have often been pointed out, and I think that future investigations will strongly confirm such opinions. Nevertheless I have given examples where the pendulum may be used, or replaced by other methods employing the same type of registering apparatus (Fig. 1). *a* is a pendulum with preferably a pear-shaped bob of great weight, which has attached to its lowest point a strong plaited thread of dentist's silk, *c*, which passes through a perforated glass plate, *d*. The hole in the glass plate is smoothly drilled of the exact size of the silk thread, so as to allow it to run easily but no more; it has its lip smoothly rounded off so that a section of the edge (see *d'*) is semicircular. The glass plate is firmly gripped by the horizontal metal plate *e*, which is rigidly fixed to the supports *b*, which in their turn are embedded in a solid masonry or rock basement. The silk thread is connected by a light wire cage, *f*, to the cylinder *g*, which slides easily up and down the fixed triangular column *h*. The cylinder *g* is connected to the writing arm lever *i*, which

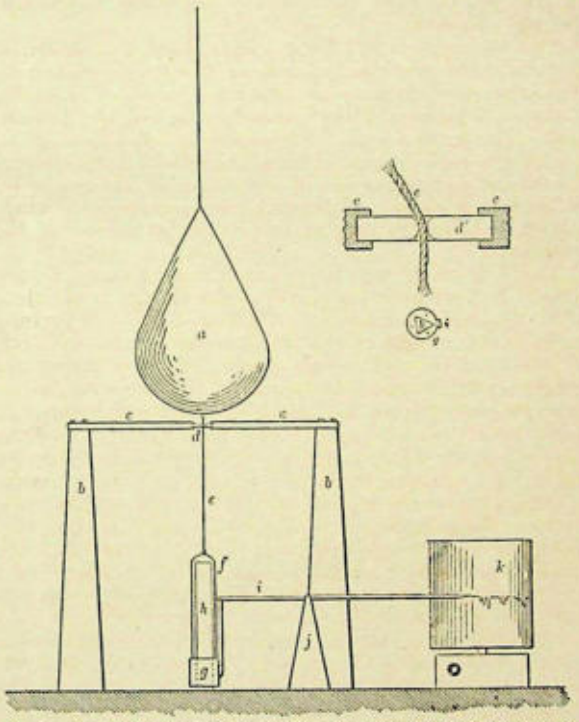


FIG. 1.—Pendulum apparatus to register amplitude of wave continuously.

may be short, and write directly on the recording drum *k*, being then a simple stylus, or, as in the figure, arranged to magnify the amplitude two or more times at choice.

When any earth-movements take place, the *relative* horizontal swings of the pendulum are converted into vertical movements of the silk thread, cylinder, and stylus, which on a time-ruled recording sheet will give accurate amplitude tracing minus the friction of the apparatus, which, if well constructed and the pendulum proportionally very heavy, may be excluded. By using a heavy pendulum with short suspension we may measure oscillations of short period, or, by using a long suspension and a delicate apparatus with greatly magnifying lever, this apparatus might be a useful tromometer, or measure of slow earth oscillations or tiltings (Fig. 2).

Three solidly-fixed cast-iron uprights, *a*, support a circular massive cast-iron plate, *b*, which has a conical aperture at its centre. Resting upon this is a circular sheet of plate-glass drilled at its centre in the same manner as the silk thread perforation in Fig. 1, as it serves a similar

purpose. This glass plane must be perfectly horizontal. A circular disk of lead, *g*, is inclosed between glass planes, *d*, and rests on three perfect spheres, *f*, which should be preferably of glass or ivory. Rigidly attached at its centre on the lower side is a conical spire, *m*, whose point reaches just the level of the glass plane *c*, and has fixed to it the silk thread *n*. From the centre of the upper side

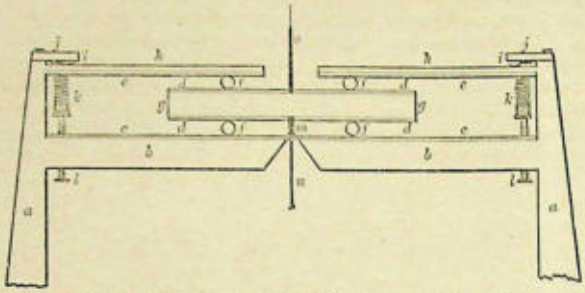


FIG. 2.—Ball and plane seismograph for indicating amplitude and azimuth in all phases of a shock.

projects the steel stylus *o*, bearing a fine platinum wire at its extremity, which may be used with the double azimuth circle of Fig. 3 in a direct manner in case of large earthquakes, or by a lever supported in gimbals, as also in Fig. 3. Another glass plane, *c*, with a large circular aperture at its centre for the free movement of the azimuth stylus *o*, has a wrought-iron trellis work backing *h*. This reposes on the springs *k*, which are regulated by the

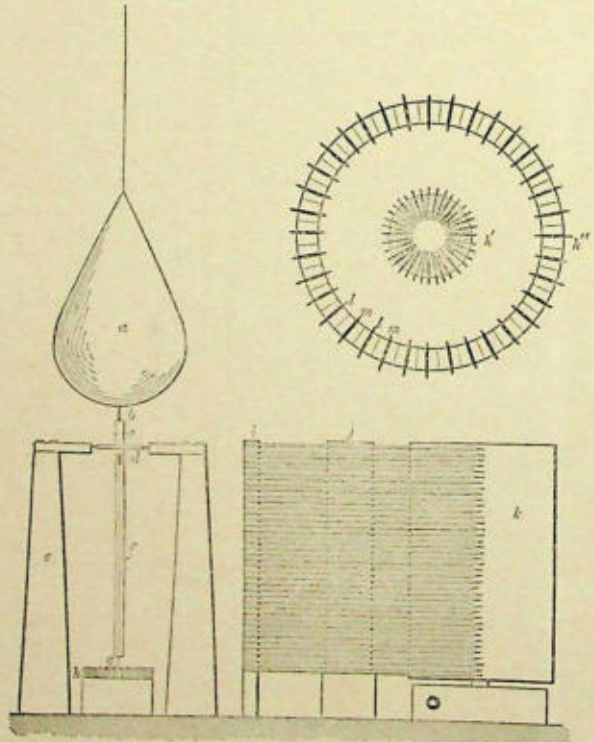


FIG. 3.—Azimuth register of wave path in all phases of an earthquake.

milled-head screws *l*, so that it is only pressing sufficiently on the upper balls *f* to keep them in place. The upper springs *i* are introduced to allow slight freedom of motion to prevent breakage of the plates in almost vertical shocks or from the expansion of the lead disk, balls, &c. The silk thread is connected to the registering apparatus in the same manner as in Fig. 1, the slight weight of which will tend to draw back the rolling lead disk to its central position, and so prevent it shuffling out of its place, and yet have almost no effect in modifying the register of the absolute wave amplitude.

In working over an earth-shaken district of small area, such as that of Ischia, an error of observation of azimuth of even a few degrees matters little in determining the exact position of the epicentre. But on the contrary, in large areas such as the Neapolitan earthquake of 1857, and to a far greater extent in widespread disturbances such as the great Lisbon catastrophe, an error of a few minutes of a degree is sufficient to produce great divergence in the orientation of the azimuth and a consequent incorrectness in the location of the epicentre. In most seismographs so far employed, especially those of Italy, no attempt has been made to divide the circle into eight divisions, so that an error of nearly 45° could occur.

Fig. 3 represents a separate apparatus, although it would probably in practice be found preferable to replace the pendulum by the rolling disk and balls as already mentioned when describing Fig. 2, except that the contact rings *h* would then be inverted. A pendulum, *a*, with a

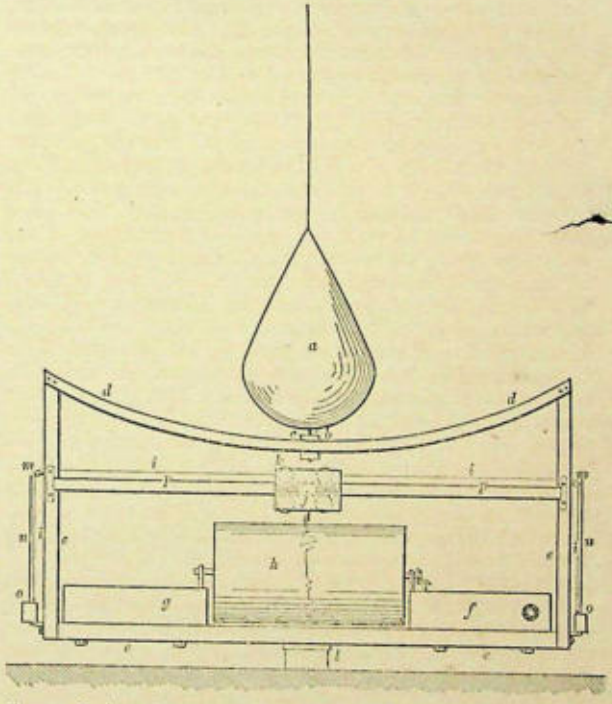


FIG. 4.—Horizontal component of wave-path register for strong and destructive earthquakes.

length of suspension suitable to circumstances of observation, carries a steel spring wire, *b*, which slides in the cylinder *c*, which, together with the light wire arm *f*, forms a universal lever moving about the fulcrum at *d*, which are gimbals. This lever should be so balanced that, if placed in a horizontal position, the part above *d* should counterpoise the part *f*. The lever carries a fine platinum wire, *g*, which, when at rest, is the centre of the two contact circles *h*, *h'*, *h''*. This part of the mechanism is in connection with one pole of a battery.

The contact circles *h* seen in detail, *h*, *h*, consist of a suitable number of brass segments, *l*, which have a V-shaped groove on their upper surface, and the edges, both inner and outer, are bevelled off. Each one is insulated from its fellow by the vulcanite plates *m*, which project a little on the inner, upper, and outer sides, and are sharpened to a knife edge.

The registering apparatus consist of a number of long soft-iron spring styles bolted to the column *i*, with their

points near the revolving register cylinder *k*. A pile of electro-magnets, *j*, each of which is in connection with the two corresponding segments of the two contact circles and the battery, when the current passes, draws one soft-iron spring style towards its poles, and brings the point in contact with the cylinder *k*. The pendulum might be made to act directly on the contact circles without the magnifying lever *e f*, if thought necessary, and the breadth of the outer circle might be greater and give a correspondingly longer dash so as to distinguish those derived from the two circles.

It will be seen that the most complex movements of the pendulum or rolling disk can be accurately registered, since four contacts will be marked in each semiphase of the oscillation of the pendulum, and a fifth point can be obtained by calculation from the instrument for registering amplitude, which, together with the position of rest, will give sufficient data to obtain the loops for each semiphase throughout the disturbance.

In large earthquakes where the wave-amplitude is very great, the rolling disk and balls would require to be of very great size, which in many cases it might be impracticable to carry into execution, although the results might be of great perfection in so doing. The present instrument (Fig. 4) is intended to replace the rolling disk where that cannot be used of sufficient size.

A strong rectangular frame, *e*, carrying two strong uprights at its two extremities, is made so as to rotate with great facility around the vertical axis *l*. It supports the registering drum *h* with the clockwork arrangement *f* and a counterpoise, *g*. In practice it might be found advisable to attach these beneath the frame and so lower the centre of gravity of the whole apparatus. At a suitable distance above the drum a crossbar, *p*, is attached, which should be highly polished and square in section. The weight *j* should be made very heavy, and be allowed a very easy motion by means of four pairs of wheels, *k*, which are in contact with the crossbar *p*; these might be mounted on friction wheels (not shown in diagram). Attached on both sides of the weight are the silk threads *i i*, which traverse the upright, run over the pulley *m*, and are attached to the weights *o o*, which are only heavy enough to draw the weight *j* back to its place when it has been disturbed, that is to say, only just sufficient to overcome the friction of the wheels *k*. These weights, *o o*, are traversed by the guide wire *n* to prevent them dangling about during the swinging round of the frame.

The upper part of the frame carries two parallel bars, *d*, between which is a narrow groove to allow of the sliding of the plate *c*. They form the segment of a circle whose radius is equal to the length of the entire pendulum and its suspension. The pendulum *a* has fixed rigidly to its inferior extremity the steel axle *b*, which passes through the rectangular flat block *c*, which is prevented from slipping off by a bolt-head below, so that the flat block can rotate around the axle without falling off.

The action of the apparatus is as follows:—When an earth movement takes place the whole apparatus is brought into the azimuth of the wave-path by the oscillations of the pendulum *a* in that direction, which is affected by the block *c* sliding in the groove between the bars *d*. The pendulum should, in preference, have a short suspension, so that the period of its oscillations should be less than the wave intended to be registered by the apparatus, and should possess sufficient weight to have complete command over the frame, keeping it always in the wave-path azimuth. The weight will now appear to slide backwards and forwards on the bar *p*, registering its movements by the writing stylus, attached beneath it, on the drum *h*. The moment that *j* is moved from its central position one of the weights *o* is raised from its position of rest (these weights should preferably be hollow brass boxes into which only sufficient fine shot could be poured to overcome the friction of *j*), and rises as long as *j* continues to roll along the bar; if then the second half of the semiphase is not sufficient to bring it back to its normal position this will be done by *o*. When *j* has reached its central position, *o* will have come to rest at the base of the guide wire, and so no longer has any action, but is replaced in the second semiphase by its fellow of the opposite side. Of course the influence of the counterweights in retarding the rolling mass must be experimentally tried and taken into consideration in the calculations made from the tracings.

The principle of this instrument is the acceleration and retardation of a falling body during each semiphase of an earth-wave. Fig. 5 illustrates a means of registering such changes in the rate of a falling body so acted on, although some other person better acquainted with mechanical movements might possibly suggest some improvement. A rigid vertical support of considerable length, *a*, is attached to the side of a well and is connected at its upper end to the table *c*; and by a small bracket *b* two vertical guide wires, *n*, pass through rings in the sides of the weight *g*, so far resembling Morin's apparatus illustrating the falling of bodies. Attached to the weight *g* is the silk thread *f*, which turns once or twice around the wheel *d*, and is supplied from the drum *k*. The wheel *d* is connected by the axle *e* and the continuous screw *h* to the apparatus *i*, which is a skeleton of flat steel springs, generally used to illustrate the distortion of a sphere by centrifugal motion. (I have proposed this in preference to the *ball governors* as retaining less impressed energy, which would unnecessarily complicate and even modify the results.) Sliding on the central axis of the spring sphere is a small cylinder, *j*, which is prevented from

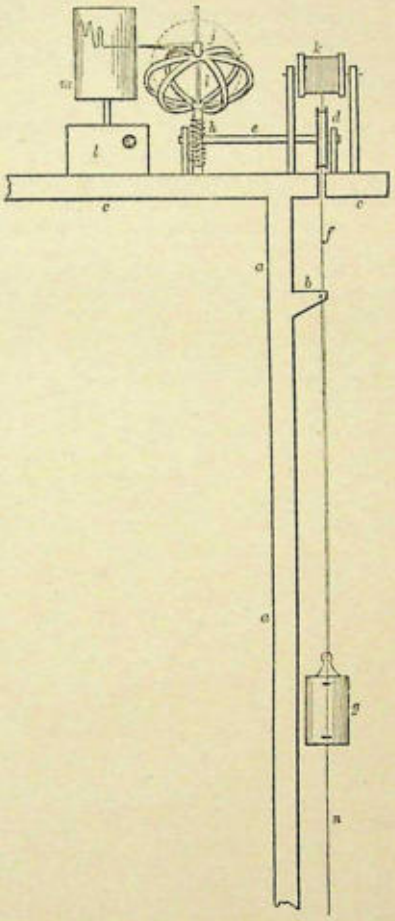


FIG. 5.—Apparatus for registering the vertical component of earth-waves during the whole of the disturbance.

rotating by means of a ridge on its inner surface and a corresponding groove on the upright bar. This cylinder carries the writing arm and stylus, which registers on the cylinder the rising and falling of the former; *l* is the motive power of the cylinder *m*. The apparatus for detaching the falling weight *g* is not shown in the diagram, but might be of the following arrangement:—A bob suspended by a spiral spring is made to make contact with a cup of mercury, as in the old form of vertical seismometers, besides a small lever of the first order attached at one end to the bob, the other extremity being above another cup of mercury. In this way, whether the movement of the bob be either up or down, in relation to the mercury cups, contact will be either made in the first case through the lever, or in the second directly by the bob. The current thus established could be used by an electromagnetic apparatus for removing a catch which holds the weight *g*. It could also start the cylinder *m* and stop a clock. The diagram will sufficiently explain the action of the apparatus.

If we review the advantages and disadvantages of the different instruments, I venture to say that, though far from perfection, they have much to be said in their favour. Their principal feature is the capability of registering continuously all the variations of the earth's movement during the complex disturbance known as an earthquake; that by employing large tracing drums with a spiral arrangement and time-ruled paper, accurate time-records can be obtained for a considerable period and without interruption, so that a single observer could have under his command a large number of instruments, even at stations some considerable distance apart, thus resulting in much economy of trained observers. Then again the records are all permanent, being graphically inscribed. The instruments for registering azimuth and amplitude, and capable of doing so with the greatest delicacy and friction, in all cases can be reduced to a minimum, or easily calculated. With regard to the registration of the vertical component of an earth-wave, the old form of spiral spring and bob principle may be excluded from consideration as perfectly unreliable; and even the improvements by Messrs. Milne and Ewing, and the ingenious idea of Mr. T. Gray, with its mercury trough compensator, cannot give accurate indication of the characters of a group of earth-waves. Another instrument worthy of trial is the hydrometer vertical-motion seismograph of Mr. T. Gray (*Phil. Mag.*, September 1881, p. 209). I think, however, that this instrument might be improved by using a long thin glass tube filled with air and floating in ether or some other fluid of very low viscosity. I would, however, venture to predict that a seismometer based on the principle of a falling weight, being accelerated or retarded according as the earth moves up or down, will supersede other methods, although no doubt such means of registering as described in this paper may be greatly improved upon.

The instruments described in this paper are all of considerable size, but it seems impossible to get good results unless heavy weights and their attendant mechanisms are used so as to reduce friction to a minimum in the consideration of results; for it is certainly a pity to have imperfect results in consequence of limiting the size of the apparatus. One great objection to the falling weight seismometer is the necessity for a deep well, to give sufficient time to register an earthquake of ten or twenty or even more seconds' duration; yet, by giving the weight more work to do by the introduction of multiplying wheels, this might be reduced as the circumstances might demand.

These instruments and the remarks on them are the outcome of long meditation while wandering over the ruins of two great earthquakes, and although expressed without a technical knowledge of mechanical construction, I hope I have made my ideas sufficiently clear.

H. J. JOHNSTON-LAVIS

INTERNATIONAL WEIGHTS AND MEASURES

IN inviting attention to the work done at Sèvres during the past year by the Comité International des Poids et Mesures,[1] we are glad to have the opportunity of congratulating those interested in accurate measurement on the fact that this country is now to be represented on the Committee, and will thus have a voice in their discussions. This, as we have pointed out on previous occasions, appears to be required of a country so largely interested in scientific research as ours.

METRES

Description of Standard	Error in terms of the true standard metre ($I_{\pi(t)} - \epsilon_\mu$)	Mean coefficient of dilatation, o° to t° C.
	μ	
Standard I_2, which serves as the provisional standard of the Comité until the final prototype is verified ...	+ 6·00	$10^{-9}(8594·6 + 1·26t)$
Standard I. for the use of the Bureau	+ 76·04	$10^{-9}(8602·9 + 2·09t)$
Standard II. for the use of the Bureau	+ 80·61	$10^{-9}(8569·1 + 2·79t)$
Standard III. for the use of the Bureau	+ 14·53	$10^{-9}(8560·0 + 1·63t)$
Standard XIII., belonging to French section of the Comité	+ 3·05	$10^{-9}(8540·6 + 2·62t)$
Bronze subdivided Standard N belonging to the Comité	+ 48·58	$10^{-9}(17483 + 7·07t)$
Brass Barometer-Standard T_1 belonging to Comité, constructed by Société genevoise pour la Construction d'Instruments de Physique	− 7·2	$10^{-9}(18178 + 7·9t)$
Brass Barometer-Standard T_2	− 31·6	$10^{-9}(18213 + 7·2t)$
" " T_3	− 0·5	$10^{-9}(18037 + 4·7t)$
Brass Barometer-Standard constructed by Messrs. Hermann and Pfister, P...	− 149·3	$10^{-9}(18821 + 8·4t)$
Platinum Standard for Spain originally constructed by Froment with lines traced by J. Alfonso, Secretary to Standards Commission at Madrid, E	+ 4·95	$10^{-9}(8898)$
Iron Standard of the United States Government made by Repsold, US	+ 97·8	$10^{-9}(10563)$
Standard for Office of Weights and Measures at Vienna, H_A	+ 14·1	$10^{-9}(18708 + 3·00t)$
Standard for Office of Weights and Measures at Vienna, A_A	− 8·9	$10^{-9}(17971 + 3·15t)$
Iron Standard of Société genevoise, F	− 31·4	$10^{-9}(11063)$
Brass Standard of Société genevoise, L	− 62·6	$10^{-9}(19155)$
Bimetallic Standard for French War Department, constructed by Porro—		
Brass, C	− 111·8	$10^{-9}(18699)$
Steel, A	+ 31·1	$10^{-9}(10420)$
Copper Standard for M. Tresca, Cu	+ 10·7	$10^{-9}(16334 + 5·82t)$
Green Glass Standard made by M. Baudin for thermometric purposes, V	+ 128·2	$10^{-9}(8392 + 4·8t)$

[1] "Travaux et Mémoires," tome iii. 400 pages. (Paris: Gauthier-Villars, 1884.

KILOGRAMMES

		mgr.	mgr.
International kilogramme Ki belonging to the Bureau ...		—	—
International kilogramme Kiii belonging to the Bureau ...	Ki—Kiii =	−0·1232	±0·0026
Kilogramme-type C belonging to the Bureau	C—Kiii =	+0·3217	±0·0034
Kilogramme-type S belonging to the Bureau	S—Kiii =	+0·4632	±0·0034
Standard kilogramme H for Spain	H—Kiii =	−1·8762	±0·0034
Standard kilogramme Z for Austria	Z—Kiii =	−1·3501	±0·0034

The present volume, like its two predecessors, is published by the Director of the Bureau under the authority of the Comité, and contains some account of the modes of comparison of the standards, with descriptions of the apparatus used, and a complete statement of the observations and of the methods of their reduction. The work of the Bureau has mainly included determinations of the lengths of certain standard metres and of the weights of certain standard kilogrammes for different Governments and authorities, as shown in the above tables.

These tables do not include the important comparisons of the British Standards with those of the Bureau, an account of which is given in a Report presented to Parliament by the Board of Trade last year, and in the Report of the Proceedings of the Committee for 1883.

The comparisons of the metres by Dr. René-Benoit, and those of the kilogrammes by M. Marek, were made in the same manner and after the same methods as those described in vols. i. and ii., to which we have previously referred.

M. Marek gives a thoughtful description of the excellent normal barometer and cathetometer in use at the Bureau, as well as of the methods of calibrating the thermometers used during the weighings. There are also illustrations of the apparatus used in ascertaining specific gravities, and of M. Stas's method for clearing the surfaces of metals by a jet of alcohol vapour, of which we regret that the demands on our space do not allow an account.

The many pages of observations and calculations which are given in this volume are clearly arranged and carefully printed. We doubt, however, whether it may be desirable to publish so much detail, particularly all the observations of the balances. Each Report of verification should evidently include all the observations, &c., from which the results have been obtained, but it would appear to be necessary only that the Government or authority directly interested should be furnished with a full detailed Report. Economy of time and money might be effected to readers and purchasers, and perhaps the objects of the Comité further advanced, by the omission in such publications of any unnecessary detail.

NOTES

THE Washington Prime Meridian Conference has adopted a resolution declaring the universal day to be the mean solar day, beginning, for all the world, at the moment of mean midnight of the initial meridian, coinciding with the beginning of the civil day, and that meridian to be counted from zero up to twenty-four hours. The resolution further declares that the Conference expresses the hope that, as soon as practicable, astronomical and nautical days may be arranged everywhere to begin at mean midnight. Prof. Janssen, of France, moved that the Conference should express the hope that technical investigations to regulate and extend the application of the decimal system to the divisions of the circle and of time would be resumed, in order to permit of the extending of that application to all cases where it might present real advantages. The motion was adopted, and the Conference adjourned until Wednesday.

M. BERTRAND, the Perpetual Secretary of the Paris Academy of Sciences in the Mathematical Section has been proposed as a candidate to fill the place vacated by the death of M. Dumas in the Académie Française. His nomination is certain, and will take place without opposition. It is almost customary for the Académie Française to offer a seat to one of the secretaries of the Academy of Sciences; Delambre, Fourier, Flourens, Cuvier, and Dumas enjoyed this honour in succession. Arago was offered it several times, but obstinately refused it. He strictly adhered to the old constitution of the Institut National as created by the Directory of the First Republic, which states that the five sections constitute the several parts of a living encyclopædia established to deliberate *in common* on many different questions, and that consequently no member of one section should be eligible to another. When the Restoration took place, the Institut was divided into independent academies, and the old practice of electing a person to several of them was revived. It has not been altered since 1848, although several attempts have been made in order to recall into existence the former republican organisation.

ON the night of Saturday, October 4, some interesting observations of lunar coronas and fog-bows were made at Ben Nevis Observatory. The mountain-top had been enveloped in mist for several days previously, but about 9 p.m. it began to clear, and by 11 o'clock the moon, partially eclipsed, was visible, surrounded by a strong double corona; all the colours from red to blue being seen in both rings. Measurements of these were taken by Mr. Dickson, Interim-Superintendent, with an instrument designed for the purpose by Prof. Tait. These gave:—Outer diameter of red—outer ring, 7° 46′; inner ring, 4° 52′. After midnight the sky became quite clear and the moon shone brightly, no corona being visible. At times, however, detached portions of very thin mist came up the north-west side of the mountain and brushed over the top. Whenever this occurred a strong corona again surrounded the moon, with a *third* set of rings, outside the other two, and much fainter, but sufficiently bright to allow of all the colours being distinguished. At 1.30 a.m. on October 5 the outer set of rings was more distinctly marked than before, and measurements were again taken. These gave:—Outer diameter of red—inner ring, 4° 6′; middle ring, 6° 2′; outer ring, 8° 10′. All these measurements are subject to an error of not more than ± 6′. At 1.15 a.m. a lunar fog-bow was visible on a fog bank to the northwards. From the edge of the precipice to north-north-east of the Observatory this appeared to consist of an outer ring, having a diameter of 75°, and an inner and fainter ring, diameter 65°, the space between the rings appearing almost quite dark, as if caused by a sharply-defined break in the fog. No colours could be distinguished.

FROM the *Alta California* we learn that the Lick Trustees have just received, through the kindness of Capt. Goodall, of the firm of Goodall, Perkins, and Co., important advices from Paris in regard to the glass disk which is needed to complete the 36-inch equatorial for the Lick Observatory. It will be remembered that the contract for two disks—one of flint and the other of crown glass—which are needed for the construction of an achromatic objective, was let to the celebrated firm of Alvan Clark and Sons in 1861. There were only two firms in the world who were capable of making glass disks of such size, nearly 40 inches in diameter. The Clarks employed one of these, Messrs. E. Feil and Co. of Paris, to cast the rough disks for them. The flint disk was cast in an unexpectedly short time, but the making of the crown glass disk has proved to be a matter of great difficulty, and this alone will have delayed the making of the large objective, and thus the completion of the Lick Obser-

vatory, by several years. The Lick Trustees will have all the Observatory, excepting the large telescope and the dome to contain it, finished and ready for work during 1885. As soon as two perfect disks of crown and flint glass are on hand, the focal length of the telescope can be calculated, and the size of the great dome determined upon; and nothing can be done until this focal length is known. Nineteen trials have been made by the Messrs. Feil to cast a perfect crown disk, and a delay of more than two years has been incurred through the difficulties and risks of the operation. It appears from the letter of Capt. Goodall to Capt. Floyd, which has been referred to, that Messrs. Feil have cast two disks, which they expect to be suitable for the purpose. The Captain visited their works early in September, and they were expected to ship one of the disks to Clark and Sons early in October. There is then reason to believe that the rough disks for the large telescope will soon be in the hands of the optician. The successful working of these disks into the proper curve for a perfect object-glass is a matter of the greatest difficulty, but the extraordinary skill which the Clarks have acquired leave no doubt that within two or three years after the receipt of a perfect disk the whole 36-inch objective (the largest possible) will be finished. While the objective is making, the dome and the mounting can be constructed, so that the whole delay is and has been due to the difficulties incident to the opticians' work. The work on Mount Hamilton has progressed as far as possible under the present conditions, and it will not be long before California possesses the most perfect observatory in the world, placed in the most favourable situation which can be found.

THE recent works of the United States Geological Survey, and especially the remarkable report of Capt. Dutton, have given an opportunity to Prof. Trautschold of Moscow, to draw a parallel between the geological structure of Colorado and that of European Russia, which appears in the *Bulletin* of the Moscow Society of Naturalists. In Russia, the Silurian, Devonian, Carboniferous Limestone, and Lower Permian series are marine deposits, while the Upper Permian is of fresh-water or terrestrial origin. The Trias and Lower Jurassic rocks are also continental deposits,—or seem to be so to a great extent,—while the Upper Jurassic groups are again of marine origin, as is also the Chalk, which contains only islands with land-vegetation. Three parts of the Tertiary series consist of terrestrial and fresh-water deposits, marine deposits appearing only in the south; and the Quaternary is also a continental formation. Such being, according to Prof. Trautschold, the structure of Russia, he had already concluded that in the Northern Hemisphere there was a general retreat of the sea during Palæozoic times, and a growth of continents, upon which the Carboniferous and then the Permian floras largely increased, European Russia being, during the Triassic and the first half of the Jurassic periods, a continent with nearly the same outlines as now. During the second half of the Jurassic period, another subsidence of the continent, and an advance by it into the Northern Hemisphere, again took place, without reaching, however, the same level that it had had during the Palæozoic period; the sea remaining shallow. A second retreat of the water took place during the Tertiary and Quaternary periods. Similar oscillations might well explain, in Prof. Trautschold's opinion, the structure of the Grand Cañon district, where the connection between the Jurassic and Triassic is as close as in Russia.

THE next ordinary general meeting of the Institution of Mechanical Engineers will be held in the large Lecture Theatre, University College, Shakespere Street, Nottingham, on November 5. The chair will be taken at 4 p.m., by the President, I. Lowthian Bell, F.R.S. The following papers will be read and discussed, as far as time will admit:—On the Mineral Wagons of South Wales, by Mr. Alfred Slater, of Gloucester; on the Application of Electro-Magnets to the working of Railway Signals and Points, by Mr. Illius A. Timmis, of London; Second Report on Friction Experiments, by Mr. Beauchamp Tower, of London.

THE International Congress convened to deliberate upon the best means of preventing the spread of *Phylloxera vastatrix* was opened on Monday at Turin. Among the personages present were the Duke d'Aosta, Signor Grimaldi, Minister of Commerce, the Syndic of Turin, and the French, Greek, Spanish, Portuguese, Servian, and Roumanian Delegates to the Congress. After a short address of welcome from the Syndic of Turin, Signor Grimaldi explained the object of the Congress, and dwelt particularly upon the necessity of common legislative measures being adopted in all infected countries in such a form as not to interfere with the liberty of trade. It was, however, most requisite to raise barriers to the spread of the Phylloxera.

THE last issue of the *Transactions* of the Seismological Society of Japan (vol. vii. part 1) contains a paper by Prof. Milne on Earth Tremors, dealing successively with artificially produced tremors, natural tremors, and at some length with various instruments constructed to record these minute movements. Microseismology, by the way, appears to be the name of this new branch of science. The results which have been obtained so far do not appear to be of great importance. The motions are more law-abiding than earthquakes; but it is impossible to say yet whether their systematic study will enable us to foretell an earthquake, although from examples quoted it appears that earthquakes are frequently preceded by great microseismic activity. Nor is the cause of these constant movements understood. Among the theories on this subject mentioned by Prof. Milne is one that they may be due to slight vibratory motions produced in the soil by the bending and crackling of rocks caused by their rise upon the relief of atmospheric pressure. Rossi thinks they may be the result of an increased escape of vapour from the molten material beneath the crust of the earth consequent upon a relief of external pressure. In the same number Dr. Du Bois writes on the great earthquake of Ischia; and a catalogue of earthquakes in Tokio between July 1883 and May 1884, as observed by a Palmieri's seismograph, is also given. From the annual report of the Society we observe that the committee appointed to report on a system of earthquake observations give as their conclusion that the most important observation is that of time, and experiments are now being carried out to obtain a suitable clock for this purpose. The next number is to contain an important paper by Prof. Milne giving a detailed account, with a series of maps, of 387 earthquakes recently felt in Northern Japan.

MR. SPENCE PATERSON, H.B.M. Consul at Reykjavik, writes to the *Standard* that on September 9 he visited Cape Reykjanes, the south-west point of Iceland, in order to observe the volcanic island which recently appeared off that Cape. It was first seen by the light-keeper at Reykjanes on July 29, and had then the shape of an irregular truncated cone, with a slight hollow on the top and a projecting shoulder on the north side. No earthquakes or other volcanic manifestations accompanied its appearance, but on August 5 a series of severe shocks occurred, which split the walls of the lighthouse and damaged the lamps. For several days rain and fog obscured the island; when next seen, its shape had altered; part of the south side had fallen down into the sea, forming two little mounds, and leaving a steep, almost perpendicular face on the south. The height of the island is about two-thirds of its length. It lies about west-south-west of Reykjanes. Two officers of a French war-vessel, who recently visited Reykjanes, estimate its distance from the coast at nine or

ten miles, but Mr. Paterson believes it to be considerably greater. When first seen, the upper part of the island was perfectly black, but it has now begun to whiten, owing to the droppings of the myriads of sea-fowl which frequent the adjacent coast and neighbouring islands, and seem already to have taken possession of the new land. The neighbourhood of Reykjanes is noted for volcanic manifestations—islands have from time to time risen and sunk there, and only a couple of years ago a violent eruption occurred near the spot where the new island lies; columns of smoke and steam rose out of the sea, and large quantities of pumice were thrown up and floated ashore on the neighbouring coast.

IT is stated that in consequence of the immense success obtained by the opening of the Arlberg Tunnel, France has confidentially sounded the Swiss Federal Council as to piercing the Alps at the Simplon.

A FATAL gas explosion took place in Paris four months ago near the Porte St. Denis, under circumstances quite similar to the accident which took place in Bermondsey last week. Since that time the Prefet de la Seine has appointed a Commission to determine the best manner of searching for gas escapes. An electric lamp fed with a portable accumulator has been selected and rendered obligatory for such operations. This apparatus has been described at length in the French illustrated papers. It might perhaps be improved, but the principle is quite sound, and it is to be regretted that the results of the French experiments have not become known in England.

WE have received a communication from Prof. M. Nyrén, Director of the Imperial Observatory at Pulkowa, near St. Petersburg, informing us that the weather there was so cloudy that not a vestige of the moon could be seen on the occasion of the recent total eclipse. In Helsingfors, where Prof. Nyrén happened to be that night on his return journey from abroad, he could distinguish the darkening of the moon's disk through the clouds, but it was too thick to observe the eclipse of the stars. At Dorpat, the second great Russian Observatory, the weather was also entirely unfavourable for observations. This is greatly to be regretted, in view of the elaborate preparations made by the Russian astronomers, to which we referred last week.

THE Royal Bohemian Society of Sciences will celebrate its hundredth anniversary at Prague on December 6 next.

THE new University building at Vienna was completed on the 11th inst. The new building at Strasburg will be inaugurated on the 26th inst.

THE death is announced of Dr. Robert Ave-Lallemant, well known as a traveller in Brazil, who was born at Lübeck in 1812. He died there on October 10. Also of Dr. Wilhelm Gonnermann, a naturalist who, together with Dr. Rabenhorst edited the celebrated "Mycologia Europæa." He died at Coburg, aged seventy-eight years.

THE French Minister of Public Instruction has commissioned M. Brau de St. Paul Lias to proceed to Malacca and Sumatra for the purpose of making natural history collections. M. Étienne Gautier is to do the same in Persia and Asiatic Turkey; and Dr. Guardia goes to the Balearic Isles to study the dialect there.

THE life of a Ceylon planter appears to be a constant contest with insect pests of one kind and another. A short time since we noticed a correspondence on a "blight" which attacked the tea-plant, and now the Ceylon papers which arrived by the last mail contain a report, by Dr. Trimen, the head of the Botanic Gardens in the colony, on an insect which has caused much alarm by its depredations on cacao and cinchona plantations. He thinks the only serious damage to cacao comes from the *Helopeltis antonii*, which appears to be a recent importation to Ceylon, although well known in Java. It is believed to be still in small numbers, and to be confined to certain localities, and the only remedy suggested by Dr. Trimen is that the planters should have it carefully sought for and destroyed.

WE are requested to announce that in future the ordinary meetings of the Essex Field Club will be held in the large hall of the Public Hall, Loughton, Essex. The first meeting of the winter session will be on Saturday next, the 25th inst., at seven o'clock.

A SOCIETY has been established at Vladivostok in Eastern Siberia for the purpose of exploring the Amour district, with a view of founding in Vladivostok a museum illustrative of the natural history of the region.

THE additions to the Zoological Society's Gardens during the past week include a Meadow Pipit (*Anthus pratensis*), six Twites (*Linota flavirostris*), a Linnet (*Linota cannabina*), eight Lesser Redpolles (*Linota rufescens*), British, presented by Mr. T. E. Gunn; two Robben Island Snakes (*Coronella phocarum*) from South Africa, presented by the Rev. G. H. R. Fisk, C.M.Z.S.; a Hardwick's Mastigure (*Uromastix hardwickii*) from India, presented by Mr. Cuthbert Johnson; a Moustache Monkey (*Cercopithecus cephus*) from West Africa, a Greater Sulphur-crested Cockatoo (*Cacatua sulphurea*) from Australia, a Blue and Yellow Macaw (*Ara ararauna*) from South America, deposited; six Coypus (*Myopotamus coypus*), three Cockateels (*Calopsitta novæ-hollandiæ*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN

WOLF'S COMET.—The observations of this comet to the end of September having been found irreconcilable with parabolic motion, Prof. Krueger, the editor of the *Astronomische Nachrichten*, and Mr. S. C. Chandler, jun., of Harvard College, have investigated the elements by a general method, and find an elliptic orbit of very limited dimensions, the period of revolution being 6·55 years by Prof. Krueger's calculation, and 6·65 years by Mr. S. C. Chandler's. Other elements by the former calculation are as follows:—

Perihelion passage 1884 November 17·8999 G.M.T.

Longitude of perihelion	19° 20′ 56″	M.Eq. 1884·0
,, ascending node	206 35 35	
Inclination	25 3 54	
Angle of eccentricity	33 32 29·7	
Log. semi-axis major	0·544040	
Log. perihelion distance ...	0·194792	

In such an orbit there would be a very close approach to the orbit of Jupiter in about 209° heliocentric longitude, where the distance between the two would be less than 0·12, and with Prof. Krueger's period of revolution there would be great perturbation early in the year 1875, so that it is possible the comet may not have been moving long in its present track. It will be interesting to examine this point further, when the major axis of the comet's orbit has been more accurately determined by a wider extent of observation.

We have thus two comets of short period brought to light in the same year. As regards Barnard's comet the length of revolution appears to be yet somewhat doubtful, Prof. Morrison of Washington assigning 6·43 years, and Dr. Berberich of Strasburg 5·50 years only.

THE NOVEMBER METEORS.—Assuming that these bodies are moving strictly in the orbit of the first comet of 1866, we find by Prof. Oppolzer's definitive elements that the nearest approach to the orbit of Mars is in about heliocentric longitude 0°·5, distance 0·30; the nearest approach to the orbit of Jupiter is in 198°·7, distance 0·79; in the case of Saturn the least distance of orbits is 0·46 at 214°·9; and in that of Uranus 0·37 at 234°·2. In 1866 the comet traversed the plane of the earth's orbit in 51°·4, distant therefrom only 0·0066.

NEW SOUTHERN DOUBLE-STARS.—Mr. H. C. Russell, Government Astronomer at Sydney, has circulated a list of newly-detected double-stars, some found by himself with the large instrument, and others by Mr. Hargrave with the 7½-inch equatorial. In most cases the components belong to the tenth and eleventh magnitudes.

THE TOTAL SOLAR ECLIPSE OF 1816, NOVEMBER 19.—The first total eclipse of the sun in the present century in which the central line passed over Europe took place on the morning of November 19, 1816. Maps of its track appeared in the *Berliner Jahrbuch* for 1816, and in the first part of Hallaschka's *Elementa Eclipsium*, where the full computation of this eclipse is given as an example. In Lindenau and Bohnenberger's *Zeitschrift für Astronomie*, vol. v., Hagen gives the moon's place deduced from Burckhardt's Tables, with the horizontal parallax and semi-diameter: if we combine these with similar quantities for the sun, taken from Carlini's Tables of 1833, we find the following elements of the eclipse:—

G.M.T. of Conjunction in R.A. 1816 Nov. 18 at 21h. 46m. 57s.

R.A.	234	42	20
Moon's declination	18	37	9 S
Sun's ,,	19	30	29 S
Moon's hourly motion in R.A.		36	58
Sun's ,, ,,		2	37
Moon's ,, ,, Decl.		11	37 S
Sun's ,, ,, ,,		0	38 S
Moon's parallax		60	15
Sun's ,,		0	9
Moon's semi-diameter		16	25
Sun's ,, ,,		16	12

In the *Berliner Jahrbuch* Bode makes the eclipse total at both Dantzic and Warsaw: the above elements do not show totality at either place, but give the magnitudes 0·990 and 0·992 respectively. They indicate, however, a total eclipse at Bromberg, duration 1m. 22s. Possibly there may be other observations of the totality on record, but the only one we have found was made by Hagen at Culm in Bohemia, where he observed its commencement but not the ending. It would appear that the weather at this season was an impediment to observation, or more details of the total phase in its passage over Germany might have been expected. Before the eclipse of July 1842 there was only one in which the line of totality approached near the European continent, viz. that of July 17, 1833, which was total in Iceland; on Mount Hecla the total eclipse commenced at 4h. 56m. 37s. a.m., and continued two minutes, the sun at an altitude of 13°; but the days of physical observations had not then arrived, and we do not find it recorded that a midsummer expedition to Iceland was organised.

CHEMICAL NOTES

THERE has of late been a considerable amount of work done on the relations between the composition and structure of chemical compounds and various physical constants of these compounds; and also on the relations between the conditions of chemical change and some of the physical properties of the constituents of the changing systems. Among the more important work on the former class of relations are to be mentioned Perkin's researches on the *magnetic rotatory polarisation* of compounds (*C. S. Journal, Trans.* for 1884, p. 421 *et seq.*); and Schiff's researches on the *coefficients of capillarity* of liquid carbon compounds (*Annalen*, ccxxiii. 47). The investigations of Raoult on the connections between the freezing-points of solutions and the distribution of the salts therein form an important contribution to the study of the second group of relations (see especially *Ann. Chim. Phys.* (6), ii. p. 66, *et seq.*). Perkin has measured the rotations of the plane of polarisation of a ray of monochromatic (sodium) light, produced by passing the ray through columns of various liquid carbon compounds placed between the poles of a large electro-magnet. Then, by the use of the formula $\frac{r \times M}{d}$, where r = observed rotation, d = density, and M = molecular weight (as gas), of the given compound, he has calculated the magnetic rotatory effect of unit-length of the liquid obtained by condensing unit-length of the vapour of the same liquid. The observed results are thus referred to lengths of liquid related to each other in the ratio of the molecular weights of the various compounds examined. Each result is divided by the number obtained, by the same method, for water, and the quotient represents the *molecular rotatory power* of the given compound. The molecular rotatory powers of a great many compounds belonging to twenty-six series have been determined, and the results show that the constant in question is closely connected with the valencies of the atoms, and with the distribution of the interatomic actions, in the molecules of the compounds examined. Schiff has made an extended series of determinations of the *coefficients of capillarity*, that is the capillary elevations in tubes 1 mm. radius, of many liquid carbon compounds. By multiplying this constant by the density of the compound, and dividing by 2, another constant is obtained which represents the weight of liquid raised by capillary action through unit-length of the line of contact between the liquid and the containing vessel. Lastly, by dividing the coefficient of capillarity by twice the "molecular volume" $\left(i.e.\ \frac{\text{molecular weight of gas}}{\text{density of liquid}}\right)$, a quotient is obtained which represents the relative number of molecules raised along the line of contact between the liquid and solid surfaces. Schiff's results, although very numerous, do not yet allow very definite conclusions to be drawn regarding the connection between the three constants and the molecular structure of the compounds examined; but that a definite connection exists is rendered very probable by these investigations. Raoult has made many determinations of the *molecular lowering of the freezing-point*—that is, the lowering of the freezing-point produced by the solution of 1 gramme-molecule of substance dissolved—of various solvents by acids, bases, and salts. The solvents employed were water, benzene, nitro-benzene, ethylene dibromide, acetic and formic acids. In each case the molecular lowering of the freezing-point is approximately equal to one of two values, of which one is double the other. The acids examined may be divided into two groups as regards their effect on lowering the freezing-point of water. The value of the constant measured by Raoult is approximately 40 for one of the groups, and 20 for the other group. The bases examined likewise fall into two groups; the mean values of the constants being 39 and 19 respectively. Raoult states that the acids with the higher value (40) almost completely displace the acids with the lower value (20) from their combinations with bases, when the acids and salts react in equivalent quantities. The bases of the first group almost completely displace those of the second from their combinations with acids. Measurements of the molecular lowering of the freezing-point of water by the action of acids, bases, and salts, present us with data from which, according to Raoult, the distribution of the various acids, &c., in a changing chemical system may be deduced.

AMERICAN ORNITHOLOGISTS' UNION

THE second annual meeting of the American Ornithologists' Union was held in the American Museum of Natural History, New York City, September 30 to October 2, 1884, the President, Mr. J. A. Allen, in the chair.

The Active Members present were: J. A. Allen, H. B. Bailey, Chas. F. Batchelder, Eugene P. Bicknell, William Brewster, Montague Chamberlain, Dr. Elliott Coues, D. G. Elliot, Dr. A. K. Fisher, Col. N. S. Goss, Dr. J. B. Holder, Dr. C. Hart Merriam, Robert Ridgway, Thomas S. Roberts, John H. Sage, George B. Sennett, Dr. Leonhard Stejneger.

Dr. Philip Lutley Sclater, Mr. Howard Saunders, and the Rev. E. P. Knubley, of the British Ornithologists' Union, were also present, and were cordially invited to take part in the proceedings of the Union.

The Associate Members in attendance were William Dutcher, Fred T. Jencks, and Dr. Howard Jones.

On the recommendation of the Council the following persons were elected to Foreign Membership:—Heinrich Gätke, Heligoland; Dr. W. Taczanowski, Russia; Henry Seebohm, England; Howard Saunders, England; Dr. H. Burmeister, Brazil.

The following among others were elected Corresponding Members:—Dr. John Anderson, F.R.S., India; W. T. Blanford, F.R.S., London; Major H. W. Feilden, London; Dr. Hans Gadow, England; Col. H. H. Godwin-Austen, London; Dr. Julius von Haast, New Zealand; Dr. E. Holub, Austria; Dr. C. F. Homeyer, Germany; E. L. Layard, New Caledonia; Dr. A. B. Meyer, Germany; Dr. A. von Mojsisovics, Gratz; Dr. A. J. Malmgren, Finland, Dr. A. von Middendorff,

Russia; Col. N. Przevalsky, Russia; Dr. Gustav Radde, Russia; Dr. Leopold von Schrenck, Russia; Dr. W. Severtzow, Russia; Rev. Canon H. B. Tristram, England; Dr. Hjalmar Theel, Sweden.

The report of the Committee on Revision of Nomenclature and Classification of North American Birds was presented by the Chairman, Dr. Elliott Coues, who said that the work of the Committee had been divided by the creation of two Sub-Committees: one (consisting of Messrs. Ridgway, Brewster, and Henshaw) to determine the status of species and sub-species; the other (consisting of Mr. Allen and Dr. Coues) to formulate the canons of nomenclature and classification adopted by the Committee. He also expressed the indebtedness of the Committee to Dr. Leonhard Stejneger for determining many points in synonymy, and for other aid. Dr. Coues then read at length the report of the Sub-Committee on Codification of Canons of Nomenclature and Classification, as adopted by the full Committee. The reading occupied about an hour and a half. Mr. Ridgway continued the report by reading the list of species prepared by the Sub-Committee on the Status of Species and Sub-Species as adopted by the full Committee. The Committee unanimously adopted the tenth edition of Linnæus's "Systema Naturæ" as the starting-point in zoological nomenclature; it unflinchingly avowed its adherence to the rule of priority; and emphatically and unequivocally indorsed the employment of trinomials in the designation of sub-species.

The report of the Committee on Bird Migration was presented by the Chairman, Dr. C. Hart Merriam. Dr. Merriam stated that a circular had been issued setting forth the objects and methods of the Committee, specifying the division of the territory of the United States and British North America into thirteen districts (each of which had been placed in charge of a competent superintendent), and supplying instructions to observers concerning the data desired—which were classed under the heads of Ornithological, Meteorological, and Contemporary and Correlative Phenomena.

In order to secure a large number of observers, the Chairman had written to the editors of eight hundred newspapers, asking them to call attention to the work of the Committee and to state that more observers were desired. The several superintendents had also written to a large number of papers—just how many the Chairman was not aware. The Press very kindly gave the matter the prominence its importance deserved, and abstracts of the circulars, amounting in some cases to an actual reprint, and usually coupled with editorial comment, were published in several hundred newspapers. This resulted in the receipt by the Chairman of upwards of three thousand applications for circulars of information and instruction. In all, nearly six thousand circulars were distributed. By this means the Committee finally secured nearly seven hundred observers, in addition to the keepers of lights. The observers are distributed as follows:—Mississippi Valley district, Prof. W. W. Cooke, Superintendent, 170; New England district, John H. Sage, Superintendent, 142; Atlantic district, Dr. A. K. Fisher, Superintendent, 121; Middle-Eastern district, Dr. J. M. Wheaton, Superintendent, 90; Quebec and the Maritime Provinces, Montague Chamberlain, Superintendent, 56; district of Ontario, Thomas McIlwraith, Superintendent, 38; Pacific district, L. Belding, Superintendent, 30; Rocky Mountain district, Dr. Edgar A. Mearns, Superintendent, 14; Manitoba, Prof. W. W. Cooke, Superintendent, 10; British Columbia, John Fannin, Superintendent, 5; North-West Territories, Ernest E. T. Seton, Superintendent, 5; Newfoundland, James P. Howley, Superintendent (returns not yet received). Migration stations now exist in every State and Territory in the Union excepting Delaware and Nevada.

The Committee was fortunate in obtaining the co-operation of the Department of Marine and Fisheries of Canada, and of the Lighthouse Board of the United States. By this means it secured the free distribution of upwards of twelve hundred sets of schedules and circulars to the keepers of lighthouses, lightships, and beacons in the United States and British North America.

The returns thus far received from observation were exceedingly voluminous and of great value. They were so extensive, indeed, that it was utterly impossible for the Committee to elaborate them without considerable pecuniary aid.

In order to show the Union the character and extent of the labours of the Committee, the Chairman had requested the superintendents of all districts east of the Rocky Mountains to prepare reports upon five common, well-known, and widely-distributed birds, to wit: the robin (*Merula migratoria*), catbird (*Mimus carolinensis*), Baltimore oriole (*Icterus galbula*), purple martin (*Progne subis*), and nighthawk (*Chordeiles popetue*). This had been done, and the reports received were presented for examination. The Chairman directed special attention to those prepared by Dr. J. M. Wheaton and Dr. A. K. Fisher as examples of tabulated returns, and to that received from Prof. W. W. Cooke as an example of the generalisation of results.

The Chairman called attention to the action of the International Ornithologists' Congress held in Vienna last April, stating that he had been instructed (in common with the delegates from other countries) to represent the cause of the Committee in the National Government, begging it "to further to the utmost the organi-ing of migration stations," and "to appropriate a sufficient sum for the support of these stations, and for the publication of annual reports of the observations made."

The Council was instructed to memorialise the Congress of the United States, and the Parliament of Canada, in behalf of the work of the Committee on Bird Migration.

On the motion of Mr. Brewster, the Committee on Geographical Distribution was merged into the Committee on Migration as a Sub-Committee, the whole Committee to be entitled a "Committee on the Migration and Geographical Distribution of North American Birds."

The Report of the Committee on the Eligibility or Ineligibility of the European House-Sparrow in America was presented by Dr. J. B. Holder, Chairman of the Committee. Dr. Holder said that a circular of inquiry had been printed, and about one thousand copies circulated in Canada and the United States. Particular pains had been taken to secure evidence from those who advocated the cause of the sparrow. A large number of returns had been received, and the evidence for and against the naturalised exotic had been carefully sifted and summarised. The result overwhelmingly demonstrated that the sum of its injurious qualities far exceeds and cancels the sum of its beneficial qualities. In other words, it was the verdict of the Committee that the European house-sparrow is not an eligible bird in North America. The Union sustained the decision of the Committee.

The Report of the Committee on Faunal Areas was presented by the Chairman, Mr. J. A. Allen. Mr. Allen said that, for the purposes of the Committee, North America had been divided into several districts, each of which had been placed in charge of a member of the Committee as follows:—Arctic and British America and the northern tier of States bordering the Great Lakes, from New York to Minnesota inclusive, were being worked by Dr. C. Hart Merriam; Canada, south of the St. Lawrence, and New England, by Arthur P. Chadbourne; the Eastern and Middle States, from New Jersey to Florida, and west to the Mississippi River, by Dr. A. K. Fisher; the Rocky Mountain region by Dr. Edgar A. Mearns; and the Pacific region by L. Belding. It was the plan of the Committee to collate and tabulate the required data from all published sources; to avail itself in like manner of the material contained in the returns of the observers of bird migration (this privilege having been granted by the Committee on Bird Migration); to illustrate the facts thus obtained by coloured maps showing the summer and winter range of each species; and to generalise the final results and place the same before the Union, accompanied by coloured charts showing, with as much precision as possible, the exact limits of the several *faunal areas* in North America.

Dr. P. L. Sclater said he was glad to know that North America, which he knew as a *Nearctic* region, was being worked in so thorough a manner by so competent a Committee, and that the results obtained could not fail to be of great interest and value.

The matter of the wholesale slaughter of our native birds for millinery and other purposes was brought forcibly before the Union by Mr. Wm. Brewster, and a Committee was appointed for the protection of North American birds and their eggs against wanton and indiscriminate destruction.

Dr. Merriam spoke of the capture, just two weeks previously (September 19), of a second specimen of the wheatear (*Saxicola œnanthe*) at Godbout, on the north shore of the St. Lawrence, by Mr. Napoleon A. Comeau. Mr. Comeau exhibited the bird, a handsome male, and said that he shot the first specimen at the same place on May 18 last. He also spoke of the capture at Godbout of the European house-sparrow (*Passer domesticus*), thus extending the known range of the species, on the north shore, by at least 250 miles.

Dr. Leonhard Stejneger exhibited a stuffed specimen of a willow grouse from Newfoundland, which he regarded as a new geographical race, differing from the continental form chiefly in the possession of more or less black upon its primaries. Mr. Brewster said that he had recently examined 150 specimens of ptarmigan from Newfoundland, and had observed the peculiarities pointed out, but did not consider them constant. He was inclined to regard the characters mentioned as seasonal, and possibly to some extent individual. Dr. Stejneger replied that this coloration of the wing feathers could not possibly be seasonal as they (the primaries) were moulted but once a year. Dr. Merriam stated that during a recent visit to Newfoundland he had examined a very large number of willow grouse in the flesh, and was still engaged in investigating the change of colour in this species. His studies led him to disagree with Dr. Stejneger's last statement. He (Dr. Merriam) was convinced that change in colour in individual feathers did take place, both independent of and coincident with the moult. Mr. D. G. Elliot agreed with Mr. Merriam in considering the change of colour of individual feathers an established fact. An animated discussion followed, and was participated in by Messrs. Brewster, Comeau, Coues, Elliot, Merriam, Ridgway, and Stejneger.

In response to a call from the President, Dr. P. L. Sclater said:—

"I hope the members of the American Ornithologists' Union will excuse me if I offend the feelings of any one by the remarks I am about to make. It has aggrieved me much to find in this country three large and valuable collections of birds which are not under the care of paid working ornithologists. One of these is in Boston, one in New York, and the other in Philadelphia. Each contains what all ornithologists admit to be most valuable typical specimens. A grave responsibility rests upon the possessors of types of species, and the loss or injury of such specimens is a great and irreparable loss to science. The collection of the Boston Society of Natural History (known as the La Frenayé Collection) has been much damaged by neglect, and the entire collection ought to be catalogued and so arranged as to render any particular specimen readily accessible. In this building (the American Museum of Natural History in New York) are the types of the celebrated Maximilian Collection, and many other specimens of exceeding great value. A large number of these have never been properly identified, and some of them are missing and have doubtless been destroyed by insect pests. The value of others has been lost through neglect, by the displacement of labels, and by the omission of proper measures for their preservation. The same remarks would, in a general way, apply to the collections of the Philadelphia Academy of Natural Sciences. It is sad to find no paid ornithologists in charge of these exceedingly valuable collections, and I beg to suggest that the American Ornithologists' Union can undertake no worthier task than to impress upon the proper authorities the urgent necessity of immediate action in this matter."

The officers of the Union were re-elected as follows:—President, J. A. Allen, Cambridge; Vice-Presidents, Dr. Elliott Coues and Robert Ridgway, Washington; Secretary and Treasurer, Dr. C. Hart Merriam, Locust Grove, New York.

The place of meeting for next year was referred to the Council for decision.

THE CAPILLARY CONSTANTS OF LIQUIDS AT THEIR BOILING-POINTS

THE paper of Prof. Robert Schiff, published in *Liebig's Annalen*, March 1884, on this subject, marks the first successful attempt out of many that have been made to connect the surface-tension of a liquid with its molecular constitution.

It has long been known that the tension diminishes rapidly with a rise of temperature, but the importance of this fact when it is desired to make a comparative examination of different liquids has not been fully appreciated or sufficiently insisted on till now by Prof. Schiff, who has to lament that, out of the considerable array of experimental investigations on the subject which he has examined, very few results could be extracted which could be usefully employed in such a comparative study, a failure which he attributes to the completely arbitrary and dissimilar physical conditions under which the different substances in question have been examined.

Since it is impossible to compare surface-tensions at the critical point, because that is the point at which the surface-tension vanishes, it is necessary to seek some other condition in which different liquids may be physically comparable, and that which naturally suggested itself for trial to Prof. Schiff, was the boiling-point of the liquid itself, whose significance in this respect he has himself established.

The principle of his method was to select with great care two capillary glass tubes of perfectly cylindrical bore, but of different diameters, that of the wider being about 1·3 mm., and of the narrower about half as much. These two tubes are then united into a little U-tube (about 7 cm. long), which, after being partly filled with the experimental liquid, is hung in a wider vessel, at the bottom of which a little of the same liquid is kept boiling. From the difference of level of the liquid in these two connected capillary tubes, as measured at a temperature which must be very nearly the boiling-point, the surface-tension at that temperature is readily deduced, since the method of procedure involves the thorough wetting of the upper portion of the tube with condensed liquid.

In this manner Prof. Schiff has determined the surface-tension at the boiling-point of some sixty liquids, with a possible error which he estimates at 1·75 per cent. of the mean value—at the worst, 2·4 per cent. His results may be stated as follows:—

1. For isomeric liquids that are chemically comparable, the surface-tension at the boiling-point is the same (within the limits of observational error). The observations do indeed point in the case of isomers of one class to a fall in surface-tension with a fall in the boiling-point, while in another class there is a perceptible rise with a rise in the boiling-point, but these variations are within the limits of possible errors of observation.

2. The quantity which turns out to be that on which attention should be fixed is not the surface-tension itself, but the surface-tension divided by the molecular weight, a quantity to which the author gives a vivid significance by pointing out that, in the case of a capillary elevation against a vertical wall wetted by the liquid, it is proportional to and represents the *number of molecules raised above the free surface per unit length of the wall*; for, since the tension per unit length is equal to the weight of the total number of molecules lifted, this tension divided by the weight of each molecule gives the total number lifted.

To the surface-tension in milligrams per millimetre divided by the relative molecular weight (and multiplied for convenience by 1000), Prof. Schiff accordingly assigns the symbol N, and his results show that not only is this number N the same for isomeric substances (as is implied in the previous statement), but that it is often the same for liquids of very different chemical constitution. He then proceeds to examine the formulæ of such chemically different liquids which have the common property that N is the same, in the manner exemplified in the following illustration:—

"Taking all the different substances for which N is nearly 16, we find—

Hexane, C_6H_{14}	N =	16·1
Xylol, ethyl-benzol, C_8H_{10}...	N =	16·0 15·9 15·8 16·2
With the formula $C_5H_{10}O_2$ ...	N =	15·8 15·6 15·6 15·9 15·7

"This indicates that substances with the formulæ

$$C_6H_{14}, \qquad C_8H_{10}, \qquad C_5H_{10}O_2,$$

are, so far as concerns the value of the number (N) of molecules lifted, equivalent to each other.

"C_6H_{14} differs from C_8H_{10} in having C_2 less and H_4 more; accordingly, so far as concerns the constant N,

$$2C = 4H.$$

"C_8H_{10} differs from $C_5H_{10}O_2$ in having C_3 more and O_2 less, so that, with reference to the constant N,

$$3C = 2O."$$

In order to test whether these equivalences are accidental or not, he examines other series, for which N has respectively the value 10·5, 13, 27, &c., but always with the same result, so that he concludes that these equivalences are not chance coincidences, but that *it is really possible to replace a certain number of atoms of one kind by a certain number of another kind without producing in the value of* N *an alteration which comes within the limits of precise observation.*

From the equivalences $2C = 4H$ and $3C = 2O$
it follows that $C = 2H$
and $O = 3H$,
while from a similar examination of liquids containing chlorine he deduces $Cl = 7H$.

These equivalences enable him to write down what may be called the hydrogen equivalent, with respect to the value of the number N, of any compound of the four elements in question, *i.e.* the number of hydrogen atoms, which, if they existed as a molecule in the free state, would constitute a substance for which the value of N at the boiling-point would be the same as for the original substance. Thus, selecting a few substances whose hydrogen equivalents are tolerably evenly distributed over the range that he has examined, he obtains the following table :—

	H		N
CH_4O	$= H_9$	...	59·8
C_2H_6O	$= H_{13}$	...	38·4
C_3H_8O	$= H_{17}$	...	29·0
$C_3H_6O_2$	$= H_{18}$	...	27·0
$C_4H_8O_2$	$= H_{22}$	...	20·4
C_8H_{16}	$= H_{26}$	...	16·1
C_9H_{12}	$= H_{30}$	...	13·1
C_9H_{18}	$= H_{34}$	...	10·5
$C_8H_{16}O_2$	$= H_{38}$	...	8·7
$C_{10}H_{22}$	$= H_{42}$	...	7·7

From these observations as data, a curve is easily drawn of which the ordinates are proportional to the number of atoms in the hydrogen equivalent and the abscissæ to the corresponding value of N ; and it is remarkable that the curve so drawn is of equable curvature, and corresponds equally well, not only to the selected data from which it is plotted, but also to all the other observed values of N, so that by transforming the molecular formula of any liquid into its hydrogen equivalent we can at once find, by reference to the curve, the value of N for the substance, and, by multiplying this by $\frac{\text{mol. weight}}{1000}$, we obtain the surface-tension at the boiling-point.

There are only three liquids for which Prof. Schiff notices that the value of N, as calculated from the curve, differs markedly from the observed value. These are—

Amylene (C_5H_{10}), for which N (obsd.) = 22, and N (calcd.) = 23·4
Diallyl (C_6H_{10}) ,, ,, = 18·4 ,, = 20·5
Ethylene-chloride ($C_2H_4Cl_2$) ,, = 24·6 ,, = 20·5

In the first case the disagreement is explained by the presence of impurity ; in the second, impurity is very possibly the cause ; while in the third it is possible that the equation $Cl = H_7$ is not applicable to substances in whose formula more than a single carbon atom is represented, a point which the author hopes to clear up by further investigation. We observe, however, that to these disagreements should be added the case of ethyl-isobutyrate $C_6H_{12}O_2$, for which N as given by the curve is 13·1, while the observed value was 12·3, a deviation of 7·5 per cent. On this the author makes no remark.

We will venture here to call attention also to a slight error that pervades all Prof. Schiff's results. We refer to the manner in which he corrects for the meniscus. The importance of this correction is in these measures very considerable, since the total elevation observed is always less than 10 mm. and sometimes less than 5 mm , and the correction is sometimes as much as 2 per cent. of the whole. Prof. Schiff, rejecting as insufficiently accurate Laplace's correction, which is based on the assumption that the surface of the meniscus may be regarded as that of a hemisphere of the same radius as the tube, and which consists therefore in adding to the observed height one-third of this radius, prefers to measure the height of the meniscus directly and to take as the correction one-third of the arithmetical mean between the observed height and the radius of the tube. In doing this he assumes that the surface may be regarded as that of a sphere of radius very appreciably greater than that of the tube, and gives a diagram in which it is so represented ; but if this assumption or representation were correct, the laws of capillary tubes would be very different from what they are ; moreover, according to theory, the form of the meniscus, and therefore the correction, must always be the same for liquids with the same capillary elevation ; but Prof. Schiff's correction, based on the direct measurement of the meniscus, varies very considerably for elevations that are almost identical, which shows that the measures of the meniscus are not to be relied on : thus in the case of ethyl-toluol (para) (C_9H_{12}) the elevation is ·603 cm., and the correction ·013 cm., while for isobutyl-formiate ($C_5H_{10}O_2$) the elevation is ·599 cm., but the correction ·008 c.m., and in many cases one of two liquids which must theoretically have the greater correction has in point of fact the smaller. In order to see how far the empirical correction was at fault, we have selected one of Prof. Schiff's measures in which the elevation has about its mean value, and have calculated for comparison the correction of Hagen and Desains, which is based on the very approximately accurate assumption that the meniscus may be regarded as an oblate spheroid, and which is said to have been verified (? in the case of water) for tubes whose diameter attained as much as 4·6 mm. The following is the result :—

		mm.
Propyl Formiate :	observed elevation	= 6·45
,, ,,	Laplace's correction	= − 0·1046
,, ,,	Hagen and Desains' correction	= − 0·102
,, ,,	Schiff's correction	= − 0·07

Corrected value (Schiff) 6·38 ; (Hagen and Desains), 6·348 mm.

It will thus be seen that an error of about ½ per cent. in the value of the surface-tension has entered into the result on this occasion, and that more has been lost than gained by substituting the empirical correction for that of Laplace ; in some cases the error will be rather greater.

The importance in molecular physics of the step which Prof. Schiff has taken cannot easily be overrated. If it were only that he had found that isomeric substances have the same surface-tension at the boiling-point, that alone would have been a fact of great importance in reference to the interpretation of what we are accustomed to call the internal vapour-tension in a liquid ; but in the system of absolute atomic equivalences with respect to surface-tension, and the knowledge of the manner in which the surface-tension varies with variations of the atomic equivalent, he has given to the physicist now for the first time most important data for correlating the surface-tension with the molecular actions existing expectively in the mass of the liquid and in the vapour above it. A. M. W.

RESEARCHES ON THE ORIGIN AND LIFE-HISTORIES OF THE LEAST AND LOWEST LIVING THINGS[1]

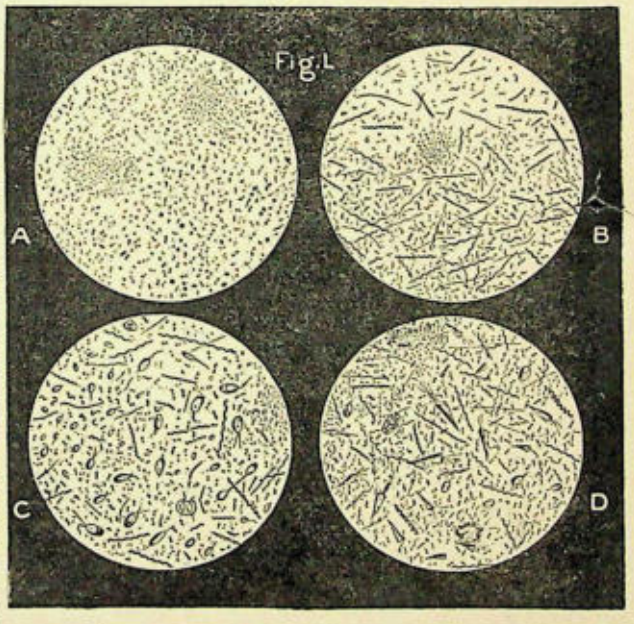
TO all who have familiarised themselves, even cursorily, with modern scientific knowledge, it is well known that the mind encounters the *infinite* in the contemplation of minute, as well as in the study of vast natural phenomena. The farthest limit we have reached, with the most gigantic standard of measurement we could well employ, in gauging the greatness of the universe, only leaves us with an overwhelming consciousness of the awful greatness—the abyss of the infinite—that lies beyond, and which our minds can never measure. The indefinite has a limit somewhere ; but it is not the indefinite, it is the measureless, the infinite, that vast extension forces upon our minds. In like manner, the immeasurable in minuteness is an inevitable mental sequence from the facts and phenomena revealed to us by a study of the *minute* in nature. The practical divisibility of matter disclosed by modern physics may well arrest and astonish us. But biology, the science which investigates the phenomena of all living things, is in this matter no whit behind. The most universally diffused organism in nature, the least in size with which we are definitely acquainted, is so small that fifty millions of them could lie together in the one-hundredth of an inch square. Yet these definite living things have the power of locomotion, of ingestion, of assimilation, of excretion, and of enormous multiplication, and the material of which the inconceivably minute living speck is made, is a highly complex chemical compound. We dare not attempt a conception of the minuteness of the ultimate atoms that compose the several simple elements that thus mysteriously combine to form the complex substance and properties of this least and lowliest living thing. But if we could even measure these, as a mental necessity, we are urged indefinitely on to a minuteness without conceivable limit, in effect, a minuteness that is beyond all finite measure or conception. So that, as modern physics and optics have enabled us not to conceive merely, but to actually realise, the vastness of spatial extension, side by side

[1] By Rev. W. H. Dallinger, LL.D., F.R.S., F.L.S., Pres.R.M.S.

with subtle tenuity and extreme divisibility of matter, so the labour, enthusiasm, and perseverance of thirty years, stimulated by the insight of a rare and master mind, and aided by lenses of steadily advancing perfection, has enabled the student of life-forms not simply to become possessed of an inconceivably broader, deeper, and truer knowledge of the great world of visible life, of which he himself is a factor; but also to open up and penetrate into a world of minute living things so ultimately little that we cannot adequately conceive them, which are, nevertheless, perfect in their adaptations and wonderful in their histories. These organisms, whilst they are the least, are also the lowliest in Nature, and are to our present capacity totally devoid of what is known as organic structure, even when scrutinised with our most powerful and perfect lenses. Now these organisms lie on the very verge and margin of the vast area of what we know as living. They possess the essential properties of life, but in their most initial state. And their numberless billions, springing every moment into existence wherever putrescence appeared, led to the question, "How do they originate?" Do they spring up *de novo* from the highest point on the area of *not-life*, which they touch? Are they, in short, the direct product of some yet uncorrelated force in nature, changing the dead, the unorganised, the not-living into definite forms of life? Now this is a profound question, and that it is a difficult one there can be no doubt. But that it is a question for our laboratories is certain. And after careful and prolonged experiment and research the legitimate question to be asked is, Do we find that in our laboratories and in the observed processes of Nature now, that the not-living can be, without the intervention of living things, changed into that which lives?

To that question the vast majority of practical biologists answer without hesitancy, *No*, we have no facts to justify such a conclusion. Prof. Huxley shall represent them. He says, "The properties of living matter distinguish it absolutely from all other kinds of things," and, he continues, "the present state of our knowledge furnishes us with no link between the living and the not-living." Now let us carefully remember that the great doctrine of Charles Darwin has furnished biology with a magnificent generalisation: one indeed which stands upon so broad a basis that great masses of detail and many needful interlocking facts are, of necessity, relegated to the quiet workers of the present, and the earnest labourers of the years to come. But it is a doctrine which cannot be shaken. The constant and universal action of variation, the struggle for existence, and the "survival of the fittest," few who are competent to grasp will have the temerity to doubt. And to many, that which lies within it as a doctrine, and forms the fibre of its fabric, is the existence of a continuity, an unbroken stream of unity running from the base to the apex of the entire organic series. The plant and the animal, the lowliest organised and the most complex, the minutest and the largest, are related to each other so as to constitute one majestic organic whole. Now to this splendid continuity practical biology presents no adverse fact. All our most recent and most accurate knowledge confirms it. But *the* question is, Does this continuity terminate now in the living series, and is there then a break—a sharp, clear discontinuity, and beyond, another realm immeasurably less endowed, known as the realm of not-life? or, Does what has been taken for the clear cut boundary of the vital area, when more deeply searched, reveal the presence of a force at present unknown, which changes not-living into the living, and thus makes all nature an unbroken sequence and a continuous whole? That this is a great question, a question involving large issues, will be seen by all who have familiarised themselves with the thought and fact of our times. But we must treat it purely as a question of science; it is not a question of *how* life *first* appeared upon the earth, it is only a question of whether there is any natural force *now* at work building not-living matter into living forms. Nor have we to determine whether or not, in the indefinite past, the not-vital elements on the earth, at some point of their highest activity, were endowed with, or became possessed of, the properties of life.

On that subject there is no doubt. The elements that compose protoplasm—the physical basis of all living things—are the familiar elements of the world without life. The mystery of life is not in the elements that compose the vital stuff. We know them all, we know their properties. The mystery consists *solely* in *how* these elements can be so combined as *to acquire* the transcendent properties of life. Moreover, to the investigator it is not a question of *by what means* matter dead—without the shimmer of a vital quality—became either slowly or suddenly possessed of the properties of life. Enough for us to know that whatever the power that wrought the change, that power was competent, as the issue proves. But that which calm and patient research has to determine is whether matter demonstrably *not living* can be, without the aid of organisms already living, endowed with the properties of life. Judged of hastily, and apart from the facts, it may appear to some minds that an origin of life from not-life, by sheer physical law, would be a great philosophical gain; an indefinitely strong support of the doctrine of evolution. If this were so, and, indeed, so far as it is believed to be so, it would speak and does speak volumes in favour of the spirit of science pervading our age. For although the vast majority of biologists in Europe and America accept the doctrine of evolution, they are almost unanimous in their refusal to accept as in any sense competent the reputed evidence of "spontaneous generation"; which demonstrates, at least, that what is sought by our leaders in science is not the mere support of hypotheses, cherished though they may be: but the truth, the uncoloured truth, from nature. But it must be remembered that the present existence of what has been called "spontaneous generation," the origin of life *de novo* today, by physical law, is by no means required by the doctrine of evolution. Prof. Huxley, for example, says, "If all living beings have been evolved from pre-existing forms of life, it is enough that a single particle of protoplasm should *once* have appeared upon the globe, as the result of no matter what agency; any further independent formation of protoplasm would be sheer waste." And why? we may ask. Because one of the most marvellous and unique properties of protoplasm, and the living forms built out of it, *is the power* to multiply indefinitely and for ever! What need, then, of spontaneous generation? It is certainly true that evidence has been adduced purporting to support, if not establish, the origin in dead matter of the least and lowest forms of life. But it evinces no prejudice to say that it is inefficient. For a moment study the facts. The organisms which were used to test the point at issue were those known as *Septic*. The vast majority of these are inexpressibly minute. The smallest of them, indeed, is so small that, as I have said, fifty millions of them, if laid in order, would only fill the one-hundredth part of a cubic inch. Many are relatively larger, but all are supremely minute. Now, these organisms are universally present in enormous numbers, and ever rapidly increasing in all moist putrefactions over the surface of the globe.



Take an illustration prepared for the purpose and taken direct from nature. A vessel of pure drinking water was taken during the month of July at a temperature of 65° F., and into it was dropped a few shreds of fish muscle and brain. It was left uncovered for twelve hours; at the end of that time a small blunt rod was inserted in the now somewhat opalescent water, and a minute drop taken out and properly placed on the

microscope, and, with a lens just competent to reveal the minutest objects, examined. The field of view presented is seen in Fig. 1, A. But—with the exception of the dense masses which are known as zoogloea or bacteria, fused together in living glue—the whole field was teeming with action. Each minute organism gyrating in its own path, and darting at every visible point. The same fluid was now left for sixteen hours, and once more a minute drop was taken and examined with the same lens as before. The field presented to the eye is depicted in Fig. 1, B, where it is visible that whilst the original organism persists yet a new organism has arisen in and invaded the fluid. It is a relatively long and beautiful spiral form, and now the movement in the field is entrancing. The original organism darts with its vigour and grace, and rebounds in all directions. But the spiral forms revolving on their axes glide like a flight of swallows over the ample area of their little sea. Ten hours more elapsed and, without change of circumstances, another drop was taken from the now palpably putrescent fluid. The result of examination is given in Fig. 1, C, where it will be seen that the first organism is still abundant, the spiral organism is still present and active, but a new and oval form, not a bacterium, but a *monad*, has appeared. And now the intensity of action and beauty of movement throughout the field utterly defy description, gyrating, darting, spinning, wheeling, rebounding with the swiftness of the grayling and the beauty of the bird. Finally, at the end of another eight to sixteen hours, a final "dip" was taken from the fluid, and under the same lens it presented as a field what is seen in Fig. 1, D, where the largest of the putrefactive organisms has appeared and has even more intense and more varied movements than the others. Now the question before us is, "How did these organisms arise?" The water was pure; they were not discoverable in the fresh muscle of fish. Yet in a dozen hours the vessel of water is peopled with hosts of individual forms which no mathematics could number! How did they arise? from universally diffused eggs? or from the direct physical change of dead matter into living forms? Twelve years ago the life-histories of these forms were unknown. We did not know biologically how they developed. And yet with this great deficiency it was considered by some that their mode of origin could be determined by heat experiments on the adult forms. Roughly the method was this. It was assumed that nothing vital could resist the boiling point of water. Fluids, then, containing full-grown organisms in enormous multitudes, chiefly bacteria, were placed in flasks, and boiled for from five to ten minutes. While they were boiling the necks of the flasks were hermetically closed; and the flask was allowed to remain unopened for various periods. The reasoning was: "Boiling has killed all forms of vitality *in* the flask; by the hermetical sealing nothing living can gain subsequent access to the fluid; therefore, if living organisms do appear when the flask is opened, they must have arisen in the dead matter *de novo* by spontaneous generation, but if they do never so arise the probability is that they originate in spores or eggs."

Now it must be observed concerning this method of inquiry that it could never be final: it is incompetent by deficiency. Its results could never be exhaustive until the life-histories of the organisms involved were known. And further: although it is a legitimate method of research for partial results, and was of necessity employed, yet it requires precise and accurate manipulation. A thousand possible errors surround it. It can only yield scientific results in the hands of a master in physical experiment. And we find that when it has secured the requisite skill, as in the hands of Prof. Tyndall, for example, the result has been the irresistible deduction that living things have never been seen to originate in not-living matter. Then the ground is cleared for the strictly biological inquiry, How do they originate? To answer that question we must study the life-histories of the minutest forms with the same continuity and thoroughness with which we study the development of a crayfish or a butterfly. The difficulty in the way of this is the extreme minuteness of the organisms. We require powerful and perfect lenses for the work. Happily during the last fifteen years the improvement in the structure of the most powerful lenses has been great indeed. Prior to this time there were English lenses that amplified enormously. But an enlargement of the image of an object avails nothing, if there be no concurrent disclosure of detail. Little is gained by expanding the image of an object from the ten-thousandth of an inch to an inch, if there be not an equivalent revelation of hidden details. It is in this revealing quality, which I shall call *magnification* as distinct from *amplification*, that our recent lenses so brilliantly excel. It is not easy to convey to those unfamiliar with objects of extreme minuteness a correct idea of what this power is. But at the risk of extreme simplicity, and to make the higher reaches of my subject intelligible to all, I would fain make this plain.

But to do so I must begin with familiar objects, objects used solely to convey good relative ideas of minute dimension. I begin with small objects with the actual size of which you are familiar. All of us have taken a naked-eye view of the sting of the wasp or honey-bee; we have a due conception of its size. This is the scabbard or sheath, which the naked eye sees.[1] Within this are two blades, terminating in barbed points. The point of the scabbard more highly magnified is presented, showing the inclosed barbs. One of the barbs, looked at on the barbed edge, is also seen. Now these two barbed stings are tubes, with an opening in the end of the barb. Each is connected with the tube of the sac C. This is a reservoir of poison, and D is the gland by which it is secreted. Now I present this to you, not for its own sake, but simply for the comparison, a comparison which struck the earliest microscopists. Here is the scabbard carefully rendered. One of the stings is protruded below its point, as in the act of stinging: the other is free to show its form. Now the actual length of this scabbard in nature was the *one-thirtieth* of an inch. I have taken the point C of a fine cambric sewing needle, and broken it off to slightly less than the one-thirtieth of an inch, and magnified it as the sting is magnified. Now here we obtain an instance of what I mean by magnification. The needle-point is not merely bigger, unsuspected details start into view. The sting is not simply enlarged, but all its structure is revealed. Nor can we fail to note that the *finish* of art differs from that of Nature. The homogeneous gloss of the needle disappears under the fierce scrutiny of the lens, and its delicate point becomes furrowed and riven. But Nature's finish reveals no flaw, it remains perfect to the last.

We may readily amplify this. The butterflies and moths of our native lands we all know; most of us have seen their minute eggs. Many are quite visible to the unaided eye; others are extremely minute. A gives the egg of the Small White Butterfly,[2] B that of the Small Tortoiseshell, C that of the Waved Umber Moth, D that of the Thorn Moth, E that of the Shark Moth, at F we have the delicate egg of the Small Emerald Butterfly, and at G an American Skipper, and finally at H the egg of a moth known as Mania Maura. In all this you see a delicacy of symmetry, structure and carving, not accessible to the eye, but clearly unfolded. We may, from our general knowledge, form a correct notion of the average relation in size existing between butterflies and their eggs; so that we can compare. Now there is a group of extremely minute insect-like forms that are the parasites of birds. Many of them are just plainly visible to the naked eye, others are too minute to be clearly seen, and others yet again wholly elude the unaided sight. The e Epizoa generally lodge themselves in various parts of the plumage of birds; and almost every group of birds becomes the host of some specific or varietal form with distinct adaptations. There is here seen a parasite that secretes itself in the inner feathers of the peacock, this is a form that attacks the jay, and here is one that secretes itself beneath the plumage of the partridge.

Now these minute creatures also deposit eggs. They are placed with wonderful instinct in the part of the plumage and the part of the feather which will most conserve their safety; and they are either glued or fixed by their shape or by their spine in the position in which they shall be hatched. I show here a group of the eggs of these minute creatures. I need not call your attention to their beauty; it is palpable. But I am fain to show you that, subtle and refined as that beauty is, it is clearly brought out. The flower-like beauty of the egg of the peacock's parasite, the delicate symmetry and subtle carving of the others simply entrance an observer. Note then that it is not merely *enlarged* specks of form that we are beholding, but such true magnifications of the objects as bring out all their subtlest details. And it is *this* quality that must characterise our most powerful lenses. I am almost compelled to note in passing that the *beauty* of these delicate and minute objects must not be considered *an end*—a purpose—in Nature. It is not so. The form is what it is because it *must be* so to serve the end for which the egg is formed. There is not a superfluous spine,

[1] A magnified image of the bee's sting was projected on the screen.

[2] A series of the eggs of butterflies were then shown, as were the objects successively referred to but not here reproduced.

microscope, and, with a lens just competent to reveal the minutest objects, examined. The field of view presented is seen in Fig. 1, A. But—with the exception of the dense masses which are known as zoogloea or bacteria, fused together in living glue—the whole field was teeming with action. Each minute organism gyrating in its own path, and darting at every visible point. The same fluid was now left for sixteen hours, and once more a minute drop was taken and examined with the same lens as before. The field presented to the eye is depicted in Fig. 1, B, where it is visible that whilst the original organism persists yet a new organism has arisen in and invaded the fluid. It is a relatively long and beautiful spiral form, and now the movement in the field is entrancing. The original organism darts with its vigour and grace, and rebounds in all directions. But the spiral forms revolving on their axes glide like a flight of swallows over the ample area of their little sea. Ten hours more elapsed and, without change of circumstances, another drop was taken from the now palpably putrescent fluid. The result of examination is given in Fig. 1, C, where it will be seen that the first organism is still abundant, the spiral organism is still present and active, but a new and oval form, not a bacterium, but a *monad*, has appeared. And now the intensity of action and beauty of movement throughout the field utterly defy description, gyrating, darting, spinning, wheeling, rebounding with the swiftness of the grayling and the beauty of the bird. Finally, at the end of another eight to sixteen hours, a final "dip" was taken from the fluid, and under the same lens it presented as a field what is seen in Fig. 1, D, where the largest of the putrefactive organisms has appeared and has even more intense and more varied movements than the others. Now the question before us is, "How did these organisms arise?" The water was pure; they were not discoverable in the fresh muscle of fish. Yet in a dozen hours the vessel of water is peopled with hosts of individual forms which no mathematics could number! How did they arise? from universally diffused eggs? or from the direct physical change of dead matter into living forms? Twelve years ago the life-histories of these forms were unknown. We did not know biologically how they developed. And yet with this great deficiency it was considered by some that their mode of origin could be determined by heat experiments on the adult forms. Roughly the method was this. It was assumed that nothing vital could resist the boiling point of water. Fluids, then, containing full-grown organisms in enormous multitudes, chiefly bacteria, were placed in flasks, and boiled for from five to ten minutes. While they were boiling the necks of the flasks were hermetically closed; and the flask was allowed to remain unopened for various periods. The reasoning was: "Boiling has killed all forms of vitality *in* the flask; by the hermetical sealing nothing living can gain subsequent access to the fluid; therefore, if living organisms do appear when the flask is opened, they must have arisen in the dead matter *de novo* by spontaneous generation, but if they do never so arise the probability is that they originate in spores or eggs."

Now it must be observed concerning this method of inquiry that it could never be final: it is incompetent by deficiency. Its results could never be exhaustive until the life-histories of the organisms involved were known. And further: although it is a legitimate method of research for partial results, and was of necessity employed, yet it requires precise and accurate manipulation. A thousand possible errors surround it. It can only yield scientific results in the hands of a master in physical experiment. And we find that when it has secured the requisite skill, as in the hands of Prof. Tyndall, for example, the result has been the irresistible deduction that living things have never been seen to originate in not-living matter. Then the ground is cleared for the strictly biological inquiry, How do they originate? To answer that question we must study the life-histories of the minutest forms with the same continuity and thoroughness with which we study the development of a crayfish or a butterfly. The difficulty in the way of this is the extreme minuteness of the organisms. We require powerful and perfect lenses for the work. Happily during the last fifteen years the improvement in the structure of the most powerful lenses has been great indeed. Prior to this time there were English lenses that amplified enormously. But an enlargement of the image of an object avails nothing, if there be no concurrent disclosure of detail. Little is gained by expanding the image of an object from the ten-thousandth of an inch to an inch, if there be not an equivalent revelation of hidden details. It is in this revealing quality, which I shall call *magnification* as distinct from *amplification*, that our recent lenses so brilliantly excel. It is not easy to convey to those unfamiliar with objects of extreme minuteness a correct idea of what this power is. But at the risk of extreme simplicity, and to make the higher reaches of my subject intelligible to all, I would fain make this plain.

But to do so I must begin with familiar objects, objects used solely to convey good relative ideas of minute dimension. I begin with small objects with the actual size of which you are familiar. All of us have taken a naked-eye view of the sting of the wasp or honey-bee; we have a due conception of its size. This is the scabbard or sheath, which the naked eye sees.[1] Within this are two blades, terminating in barbed points. The point of the scabbard more highly magnified is presented, showing the inclosed barbs. One of the barbs, looked at on the barbed edge, is also seen. Now these two barbed stings are tubes, with an opening in the end of the barb. Each is connected with the tube of the sac C. This is a reservoir of poison, and D is the gland by which it is secreted. Now I present this to you, not for its own sake, but simply for the comparison, a comparison which struck the earliest microscopists. Here is the scabbard carefully rendered. One of the stings is protruded below its point, as in the act of stinging: the other is free to show its form. Now the actual length of this scabbard in nature was the *one-thirtieth* of an inch. I have taken the point C of a fine cambric sewing needle, and broken it off to slightly less than the one-thirtieth of an inch, and magnified it as the sting is magnified. Now here we obtain an instance of what I mean by magnification. The needle-point is not merely bigger, unsuspected details start into view. The sting is not simply enlarged, but all its structure is revealed. Nor can we fail to note that the *finish* of art differs from that of Nature. The homogeneous gloss of the needle disappears under the fierce scrutiny of the lens, and its delicate point becomes furrowed and riven. But Nature's finish reveals no flaw, it remains perfect to the last.

We may readily amplify this. The butterflies and moths of our native lands we all know; most of us have seen their minute eggs. Many are quite visible to the unaided eye; others are extremely minute. A gives the egg of the Small White Butterfly,[2] B that of the Small Tortoiseshell, C that of the Waved Umber Moth, D that of the Thorn Moth, E that of the Shark Moth, at F we have the delicate egg of the Small Emerald Butterfly, and at G an American Skipper, and finally at H the egg of a moth known as Mania Maura. In all this you see a delicacy of symmetry, structure and carving, not accessible to the eye, but clearly unfolded. We may, from our general knowledge, form a correct notion of the average relation in size existing between butterflies and their eggs; so that we can compare. Now there is a group of extremely minute insect-like forms that are the parasites of birds. Many of them are just plainly visible to the naked eye, others are too minute to be clearly seen, and others yet again wholly elude the unaided sight. The Epizoa generally lodge themselves in various parts of the plumage of birds; and almost every group of birds becomes the host of some specific or varietal form with distinct adaptations. There is here seen a parasite that secretes itself in the inner feathers of the peacock, this is a form that attacks the jay, and here is one that secretes itself beneath the plumage of the partridge.

Now these minute creatures also deposit eggs. They are placed with wonderful instinct in the part of the plumage and the part of the feather which will most conserve their safety; and they are either glued or fixed by their shape or by their spine in the position in which they shall be hatched. I show here a group of the eggs of these minute creatures. I need not call your attention to their beauty; it is palpable. But I am fain to show you that, subtle and refined as that beauty is, it is clearly brought out. The flower-like beauty of the egg of the peacock's parasite, the delicate symmetry and subtle carving of the others simply entrance an observer. Note then that it is not merely *enlarged* specks of form that we are beholding, but such true magnifications of the objects as bring out all their subtlest details. And it is *this* quality that must characterise our most powerful lenses. I am almost compelled to note in passing that the *beauty* of these delicate and minute objects must not be considered *an end*—a purpose—in Nature. It is not so. The form is what it is because it *must be* so to serve the end for which the egg is formed. There is not a superfluous spine,

[1] A magnified image of the bee's sting was projected on the screen.

[2] A series of the eggs of butterflies were then shown, as were the objects successively referred to but not here reproduced.

not a useless petal in the floral egg, not an unneeded line of chasing in the decorated shell. It is shaped beautifully because its shape is needed. In short, it is Nature's method; the identification of beauty and use. But to resume. We may at this point continue our illustrations of the analytical power of moderate lenses by a beautiful instance. We are indebted to Albert Michael of the Linnean Society of England for a masterly treatise on a group of Acari, or *Mites*, known as the *Orbatidæ*. Many of these he has discovered. The one before you is a full grown Nymph, of what is known as a *palmicinctum*. It is deeply interesting as a form; but for us its interest is that it is minute, being only a millimetre in length. But it repeatedly casts the dorsal skin of the abdomen. Each skin is bordered by a row of exquisite scales; and then successive rows of these scales persist, forming a protection to the entire organism. Mark then that we not only reveal the general form of the Nymph, but the lens reveals the true structure of the scales, not enlargement merely, but detail. The egg of the organism, still more magnified, is also seen.

To vary our examples and still progress. We all know the appearance and structure of chalk. The minute Foraminifera have, by their accumulated tests, mainly built up its enormous masses. But there is another chalk known as Barbadoes earth; it is siliceous, and is ultimately composed of minute and beautiful skeletons such as those which, enormously magnified, you now see. These were the glassy envelopes which protected the living speck that dwelt within and built it. They are the minutest of the Radiolaria, which peopled in inconceivable multitudes the Tertiary oceans; and, as they died, their minute skeletons fell down in a continuous rain upon the ocean bed, and became cemented into solid rock, which geologic action has brought to the surface in Barbadoes, and many other parts of the earth. If a piece of this earth, the size of a bean, be boiled in dilute acid and washed, it will fall into powder, the ultimate grains of which are such forms as these which you see. The one before you is an instance of exquisite refinement of detail. The form from which the drawing of the magnified image was made was extremely small—a mere white speck in the strongest light upon a black ground. But you observe it is not a speck of form merely enlarged. It is not merely beauty of outline made bigger. But there is—as in the delicate group you now see—a perfect opening up of otherwise absolutely invisible details. We may strengthen this evidence in favour of the analytical power of our higher lenses, by one more *familiar* example, and then advance to the most striking illustration of this power which our most perfect and powerful lenses can afford. I fear that it may be taking too much for granted to assume that every one in an audience like this has seen a human flea! Most, however, will have a dim recollection or suggestive instinct as to its size in nature. Nothing striking is revealed by this amount of magnification excepting the existence of breathing pores, or spiracles along the scale armour of its body. But there is a trace of structure in the terminal ring of the exo-skeleton which we cannot clearly define, and of which we may desire to know more. This can be done only by the use of far higher powers.

To effect this, we must carefully cut off this delicate structure, and so prepare it that we may employ upon it the first of a series of our highest powers. The result of that examination is given here.[1] You see that the whole organ has a distinct form and border, and that its carefully carved surface gives origin to wheel-like areolæ which form the bases of delicate hairs. The function of this organ is really unknown. It is known from its position as the *pygidium*; and from the extreme sensitiveness of the hairs to the slightest aerial movement may be a tactile organ warning of the approach of enemies, the eyes have no power to see. But we have not yet reached the ultimate accessible structure of this organ. If we place a portion of the surface under one of the finest of our most powerful lenses, this will be the result.[2] Now, without discussing the real optical or anatomical value of this result as it stands, what I desire to remind you of is (1) the natural size of the flea; (2) the increase of knowledge gained by its general enlargement; (3) the relation in size between the flea and its pygidium; and (4) the manner in which our lenses reveal its structure, not merely amplify its form. Now with these simple and yet needful preliminaries you will be able to follow me in a careful study of the least, the very lowliest and smallest, of all living things. It lies on the very verge of our present powers of optical aid, and what we know concerning it will convince you that we are prepared with competent skill to attack the problem of the life-histories of the smallest living forms. The group to which the subject of our present study belongs is the Bacteria. They are primarily staff-like organisms of extreme minuteness, but may be straight, or bent, or curved, or spiral, or twisted rods. This entire projection is drawn on glass, with *camera lucida*, each object being magnified 2000 diams., that is to say, four millions of times in area. Yet the entire drawing is made upon an area of not quite three inches in diameter and afterwards projected here. The objects therefore are all equally magnified, and their relative sizes may be seen. The giant of the series is known as *Spirillum volutans*; and you will see that the representative species given become less and less in size until we reach the smallest of all the definite forms and known to science as *Bacterium termo*.

Now within given limits this organism varies in size, but if a fair average be taken its size is such that 50,000,000 laid in order would only fill the one-hundredth of a cubic inch. Now the majority of these forms *move* with rapidity and grace in the fluids they inhabit. But how? by what means? By looking at the largest form of this group you will see that it is provided with two delicate fibres, one at each end. Ehrenberg and others strongly suspected their existence, and we were enabled, with more perfect lenses, to *demonstrate* their presence some twelve years ago. They are actually the swimming organs of this Spirillum. The fluid is lashed rhythmically by these fibres, and a spiral movement of the utmost grace results. Then do the intermediate forms that move also possess these flagella? and does this least form in nature, viz. *Bacterium termo*, accomplish its bounding and rebounding movements in the same way? Yes! by a series of resolute efforts, in using a new battery of lenses—the finest that at that time had ever been put into the hands of man—I was enabled to show in succession that each motile form of Bacterium up to *B. lineola* accomplished its movements by fibres or flagella; and that in the act of self-division, constantly taking place, a new fibre was drawn out for each half before separation.

(*To be continued.*)

[1] The pygidium of the flea, very highly magnified, was here shown.
[2] An illustration of the pygidium structure seen with 1/75th immersion was given

THE PERIPATETIC METHOD OF INSTRUCTION IN SCIENCE AND ITS DEVELOPMENT[1]

THE object of this paper is to plead for the introduction of science as a part of the system of ordinary education in all public elementary schools, and to describe the method by which alone, in the opinion of the writer, it is possible that this should be accomplished. There is a general consensus of opinion that a far larger place than has hitherto been allowed in England should be assigned to science in our national system of education, as well as in our grammar-schools and Universities; but no strong conviction yet exists that a certain amount of strict and definite scientific training should be given to all the scholars in our public elementary schools as soon as they are prepared to receive it, which is practically found to be after they have passed the fourth standard. The extent of this claim for the introduction of science as a part of the ordinary curriculum of a public elementary school must be noted, in order that the worth and importance of the proposed method for securing thoroughly effective teaching may be understood.

The provision of special scholarships for those who possess exceptional intellectual power—admirable and necessary as this is—does not meet the broad claim I make. To furnish stages in the ladder by which a lad of mark, endowed with "five talents," may climb from the elementary school to the science college, is only to offer to the children of the poor opportunities to which they are justly entitled by virtue of the fact that genius, like truth, can neither be bought or sold, and is bestowed upon men entirely apart from any considerations connected with social rank and circumstances. But scholars of average ability, those who have no special endowments qualifying them for exceptional careers, ought not to be kept in ignorance of the fixed laws and the majestic marvels of the world in which they will have to labour, or to be deprived of the practical guidance, the intellectual interests, and the protection against coarse and degrading tastes, which scientific training is capable of bestowing upon

[1] Paper read at the Social Science Congress, September 22, by Henry W. Crosskey, LL.D., Chairman of the School Management Committee of the Birmingham School Board.

their lives. Only a few can rise to eminence; and it is an unmitigated misfortune for any lad to be encouraged to trust to his intellectual powers for his daily bread, unless he has a fair chance of becoming eminent; but all may possess the scientific knowledge which will give dignity to their daily toil; and the workshop itself may be ennobled.

Neither does the establishment of higher-grade Board schools, in which scientific instruction is given, meet the necessities of the case. The vexed and complicated questions involved in the general organisation of the very miscellaneous collection of schools now existing in England do not fall within the scope of this paper; but I find that many members of School Boards believe that all that is required for scientific instruction will be done when higher grade Board schools are opened; and, by means of examinations and scholarships, admission is brought within reach of a certain number of poor children unable to pay the fee.

Now, the grading of schools must educationally depend upon the time which the scholars can be expected to devote to education; and each grade of schools ought to have a curriculum, determined in its extent and balanced in its parts, according to the number of years which can be spent upon it. The public elementary school should furnish the completest possible education for those who can remain at school until the age of fourteen or fifteen; the higher-grade schools, which properly belong to the secondary system, should be adapted to the wants of scholars who can be retained a year or two longer. The higher-grade school cannot therefore supply the place of the public elementary school to the poor man, who is obliged to send his children to work at a comparatively early age; the number of subjects taught, and the relative number of hours given to them, will not be balanced in a way to suit his requirements.

My contention is that science ought not to be omitted from the educational training of the poorest of our people. The daily concern of the lives of the poor is with forces and materials upon which science throws the strongest light. Their work is bound up with scientific laws. Want of knowledge often means bad work or want of work; and even the spread of pestilence, disease, and death.

The establishment of higher-grade Board schools ought not, therefore, under any circumstances, to be permitted to lower the standard of education in public elementary schools. I speak emphatically on this point, because I believe that the working men of this country will need to take the most watchful heed lest they should be deprived of the education all their children are capable of receiving by the relegation of scientific subjects to schools placed beyond their reach by high fees, mitigated by only a small proportion of free scholarships.

Neither will the opening of technical schools suffice for the scientific instruction of our people. Technical schools cannot do their proper work if their students have had no preliminary training, and are unfamiliar with at least the elementary principles of physics. Lads who have grown into young men without being carried through any systematic and experimental course of scientific instruction will find it almost impossible, after they have left school, to prepare themselves properly for taking advantage of technical colleges, especially when, as among the working classes, their evenings only are at their own disposal.

In order that science may be effectively taught in public elementary schools, the following conditions must be observed:—

1. *It must be taught experimentally.*—Actual demonstration must accompany the lessons at every stage. At no point at which an experiment is possible must it be omitted. The minds of young lads of the type of those attending public elementary schools will be opened and enlarged by experimental demonstrations, but they will not be reached in any other way. Scholars may be able to pass examinations by getting up text-books; but unless they are made experimentally familiar with the principles of the science they are studying, their knowledge will hang as a dead weight upon their minds, impeding rather than quickening their intellectual activity. Those who have witnessed, as I have often done, the effect of an experimental lesson in science upon large classes of children, often drawn from the poorest of the poor, will not think this insistence upon a plenitude of experiments exaggerated. The demonstration thoroughly awakens their minds: their eyes glisten; there is a long-drawn "Ha" when the result accords with the theory which the teacher has expounded; and questions will soon show that they are not merely wondering at a conjuring trick, but that a new world, hidden within the world of machinery with which they are familiar through the daily avocations of their parents, is being revealed to them.

2. Science must not only be taught experimentally, but systematically and continuously. The "getting up" of some branch of science during three or four months as a "specific subject" for examination is of little use. "Passes" may be won; but no scientific training will be given.

From these considerations it directly follows that special science demonstrators must be appointed if our scholars are to receive a scientific training of any worth. It may be asked, cannot the work be done by one of the ordinary masters of the school? I am bound to reply that in my opinion—an opinion not lightly formed, but based on observations extending over a not inconsiderable area—it is absolutely impossible to obtain any training which can be called scientific, and prove of practical value, for the scholars of our public elementary schools, without the appointment of special science demonstrators.

In the first place, no man can be a good science demonstrator who does not devote to the work the greater part of his daily life. To perform experiments well is as much an art to be acquired by continuous study and practice as playing the piano. Fertility of resource, quickness of eye and hand, steadiness of mind, keenness of observation, are qualities essential to the demonstrator, which cannot be acquired without culture or retained without constant employment. The master of a school has many subjects to teach and many duties to discharge. He cannot, by any possibility, give any sufficient proportion of his time to the art and practice of scientific demonstration.

It may be said that an expert cannot be required for scholars of the age of those attending public elementary schools, and that any experiments they can understand can be easily performed by any ordinary teacher. Those who have studied any branch of physical science, however, will, I think, agree with me that no science can be well taught except by a man who has had a special scientific training; and that the simplest experiments are best performed and made the most intelligible by those capable of carrying on the more recondite and difficult investigations.

It is a great mistake to imagine that it is a light and easy matter to experiment before a class of scholars, such as those found in our Board schools. They are on the alert for any mistake; they are ready to raise the most curious and subtle doubts, and to ask the most perplexing questions. The only man capable of dealing with such a class of scholars is a man they are compelled to recognise as a master of the science he is teaching.

In the second place, even if the head master of a public elementary school were a scientific expert and managed to keep abreast with the advance of the scientific knowledge of his day, he would find it completely out of his power to act as a science demonstrator and to conduct the general work of his school. The preparation necessary for giving a good science lesson cannot be made without a larger expenditure of time than the proper management of his school will leave at his disposal. The mechanical arrangements for experiments often demand long-continued and anxious watchfulness and care. Every experiment ought to be tried over, before it is performed in the class, to avoid the risk of failure. The proper selection of experiments, as well as their performance, is in itself an art.

For the teaching of science in public elementary schools, therefore, these things are necessary: (1) sufficient apparatus, and of course a laboratory in which experiments can be prepared; and (2) a staff of special science demonstrators.

The expense of providing apparatus, building a laboratory, and supporting a science demonstrator at every single school in town and country, would be as enormous as unnecessary. By the general adoption, however, of what is known as the "peripatetic" method of instruction, all difficulties can be solved; and science can be effectively taught in every public elementary school. I do not think, indeed, that any other satisfactory method can be devised by which the whole of our elementary schools can be reached and the services of those trained scientific men, whose teaching of the elementary principles of science is alone to be relied upon, be secured for the great mass of our people. The peripatetic method has been adopted in Liverpool and Birmingham, and as I can testify so far as Birmingham is concerned, the results have been as satisfactory as remarkable.

The chief characteristics of this method are extremely simple:—

I. As regards "plant," it involves (1) the building of a laboratory in some central position; (2) the purchase of a stock of apparatus; (3) the provision of a small hand-cart by which boxes containing apparatus can be readily carried from school to school.

II. A special science demonstrator is appointed, with such assistants as the number of schools to be dealt with may require.

III. The duties of the science demonstrator are (1) to prepare a scheme of lessons and arrange the experiments for their illustration: in Birmingham, in the boys' departments, mechanics is taken as a "specific subject," and in some schools magnetism and electricity are added; in the girls' departments, domestic economy is taken, and animal physiology is in some cases added; (2) to visit the schools in succession, and give at each school a lesson profusely illustrated by experiments, the requisite apparatus being brought by the hand-cart from the central laboratory.

IV. The regular staff of the school assists the demonstrator, and is assisted by him in the following ways:—

(1) A teacher on the staff of the school is present at every demonstration, and is thus prepared to enforce and continue its lessons in the intervals elapsing between the demonstrator's visits.

(2) The scholars have opportunity given them during school hours to write answers to questions set by the demonstrator, who examines their papers.

In Birmingham a "demonstration" is given in each department once a fortnight. It would be, however, a great improvement if the demonstrator or one of his staff could visit each school once during every week. The science staff consists of a chief demonstrator (Mr. W. Jerome Harrison, F.G.S., whose services deserve the warmest acknowledgment), three assistant demonstrators, who assist in giving lessons at the schools, and a junior laboratory assistant. Two youths are employed to work the hand-cart. The whole amount of salary paid to this staff amounts to 750*l.* per annum.

Scientific instruction is given by this method in thirty boys' schools and thirty girls' schools, containing about 32,000 scholars, the numbers in the classes and the specific subjects taken being:—

Mechanics	2400 Boys
Magnetism and Electricity	300 ,,
Domestic Economy	1800 Girls
Animal Physiology	100 ,,

Objections may possibly be taken to this system in the following directions:—

1. *Its cost.*—It being granted, however, that thorough and systematic scientific instruction ought to be introduced into elementary schools, the peripatetic method is the very cheapest that can be devised. One set of apparatus serves for many schools, and one laboratory suffices for the preparation of the experiments. The services of the staff are utilised to the utmost; and the amount of salary to be charged against each school is trifling. Supposing twenty schools in a town or neighbouring villages to be grouped together, the system might be worked at a very slight expense to each. The investment of capital required would be less than 1000*l.*, viz.:—

Building of Central Laboratory[1]	£700
Apparatus	300
	£1000

The annual working expenses would be—

Salaries of science demonstrator and assistant	£400
Waste of chemicals, renewal of apparatus, &c.	50
Expense of moving apparatus from laboratory to school	50
	£500

Ample provision could be made at this cost for twenty schools, each having accommodation for 300 or 400 children, *i.e.* each of the associated schools could obtain, for about 25*l.* a year, thoroughly good experimental instruction for all scholars who have passed the fourth standard.

II. It may be asked whether, in the short time that can be allowed for any specific subject, it is possible to obtain results of sufficient educational worth to justify the expenditure of labour, thought, and money I am advocating. As a reply to this objection, I can point without fear to the results actually attained in Birmingham; an hour and a half a week being all the time which has been spared for science, including the fortnightly demonstration, the recapitulation, and preparation of exercises. The teaching being experimental, an impression is made upon the minds of the scholars which can neither be equalled or measured by the effects of ordinary class teaching, lecturing, or book work. The scholars are induced to think, and read, and prepare models of machines and drawings out of school hours; and during school hours they are found to apply themselves with a will to their scientific exercises. Prof. Poynting (of Mason College) has examined a large number of boys competing for a scholarship, and reported to the Board that "the boys showed that they had seen and understood the experiments which they described, that they had been taught to reason for themselves upon them, and that they were not merely using forms of words which they had learned without attaching physical ideas to them." Specimens of the models made by the children, their drawings, and examination papers, have been exhibited at the International Health Exhibition, of which the subjoined account is given in the *School Board Chronicle* (August 9, 1884):—"The cabinet of machines and models and copies of the science apparatus used by the demonstrators in their experiments is well worthy of a visit. It shows the extent and nature of the interest which the children take in this practical form of education. Most of the models have been made by the children at their homes, and often with very inferior tools. One lad has a copy of the Chinese windlass, another makes a little pile engine, and a third illustrates the inclined plane, a fourth the mariner's compass, and so on through a great variety of objects, until a very tolerable little collection of rough but serviceable apparatus has been brought. In cases extending the length of one of the walls of the room is a collection of specimen papers and drawings, prepared at the demonstrator's fortnightly examination of the results of his preceding lesson, and no further justification of the system than these papers can be needed."

In comparing these models and papers with others, it must be remembered that the Birmingham work was not done in any "higher-grade" institutions, with high fees and picked scholars, but indicates the kind of scientific training that may be given by the help of the peripatetic method in any public elementary school.

III. Great anxiety is felt by many lest the introduction of science into elementary schools should result in mere "cram"; and a number of hard technical words be repeated by rote to be forgotten as soon as school is left. It is not unusual to hear a laugh raised by the quotation of some technical word from an examination paper, as though its use reduced the system to an absurdity. Scientific facts are, however, most clearly expressed in scientific language. Even young scholars gain by knowing the *right words* by which physical facts and laws are described; and their intellects are bemuddled by vague expressions. The employment of scientific words is no proof of "cram." I admit, as a matter of course, that the attempt to teach science without demonstrating experimentally every fact and law, must result in cramming of the worst description; but *experimental teaching gives the death-blow to cram.*

IV. Will not, however, it is sometimes asked, the introduction of this system of scientific teaching interfere with the progress of the children in writing, reading, and arithmetic? Will not the elements of ordinary education be neglected because of the attention demanded for such scientific subjects as mechanics, magnetism, and electricity? On the contrary, it is found as a matter of fact, that the intellectual life of the school is quickened in every direction by the study of science. The scholars find that the "three R's" are not dull, dry, and abstract pursuits, but keys to a world of new marvels and interests. The schools under the Birmingham Board in which there is the keenest interest in science are certain to prove the schools in which the ordinary work is best done. Since 1880, when the science demonstrator was first appointed, the percentage of passes in the "three R's" has steadily increased, as well as the number of passes in specific subjects.

Year	Number of passes in specific subjects	Percentage of passes in the "three R's"
1880	841	84·7
1881	1724	88·4
1882	3114	92·6
1883 (New Code with higher requirements)	3150	89·6

[1] The Birmingham laboratory cost (with fittings) 1450*l.*, but it has a lecture-room and private room for demonstrator attached.

Various causes have, no doubt, contributed to this result; but the proof is positive that the introduction of science *has not interfered*, to say the least, with elementary education in the "three R's."

V. On the first introduction of the system there may be a certain amount of antagonistic feeling aroused amongst some head masters and mistresses. In Birmingham this was indeed to some small extent the case. Some head teachers feared that the demonstrator would prove a new inspector, who, having to discharge duties as a teacher, might unduly interfere with their own functions, and that some conflict of authority might occur. To the best of my knowledge, however, this feeling has entirely disappeared. The only complaints which I hear as Chairman of the School Management Committee, are when the experimental lessons are omitted at any school through any stress of examination work or accidental circumstance. The masters find that the science demonstrators render them valuable assistance and do a work which it is out of their own power to accomplish.

In order to apply the severest test to the peripatetic system, I applied to the head master of a large school, situated in one of the very poorest districts in Birmingham, and attended by children whose social surroundings are, as a rule, almost as unfavourable to intellectual development as they can possibly be. The school has accommodation for 416 boys, and an average attendance of about 350, 414 being sometimes present during the week.

The reply of the head master to my request that he would inform me of the results of the science teaching in his school, lifts the whole question out of the region of controversy.

Dartmouth Street Boys' Board School,
Birmingham, September 9, 1884.

Rev. Sir,—In reply to yours of this morning, I beg to make the following remarks:—

The results from the science lessons given in this school are very gratifying. I have seen results in a variety of ways both in and out of school.

The interest taken in these lessons, both by parents and boys, is surprising. Many a mother has, to my frequent knowledge, inconvenienced herself in her domestic duties on certain days when we have sent word for her boy to be present, as the science demonstrator was expected that morning. The day is well remembered by most of them, and eagerly looked forward to. The attendance in the uppermost class is wonderfully increased on the mornings these lessons are given.

The results in other subjects in those standards where science is taught are none the less satisfactory. A greater intelligence and thought are quickly discovered when we are dealing with the other subjects.

Teachers are more encouraged when brighter material to work with is placed in their hands.

Other important subjects have impressed me very much, viz. the desire of the boys after leaving school to continue to study some science subject at some of our science classes.

Older brothers, too, have been induced to go to science classes through seeing the growth of knowledge in those much younger than themselves.

Many persons who have reason to come in contact with the boys after leaving school, have expressed themselves in tones of great regret that such instruction was not given when they attended school.

I remain, Rev. Sir,
Your obedient servant,
Rev. Dr. Crosskey. T. H. PURCELL.

As a development of the systematic and experimental system of science training I have described—a system only rendered possible of adoption by the employment of the peripatetic method—a new kind of Board school has been opened in Birmingham, for the purpose of enabling the scientific work commenced in the elementary school to be continued by the more advanced scholars before they enter upon their respective employments in workshops and factories.

The arrangements of the peripatetic system will suffice until the sixth standard is passed; but special provision must be made for those lads who can remain a year or two longer at school, and whose future employments render the extension of their scientific training desirable. A large proportion of those who pass the sixth standard are obliged to earn their livings at once; for these various evening classes are available. But a certain number of working men can, by an effort, manage to exempt their children from toil, say for an extra two years.

The question therefore arises whether special provision cannot be made for scholars who must ultimately earn their living as working men, but whose parents can afford to keep them at school for two years after they have passed the sixth standard?

It is evident that for such scholars increased facilities for scientific study will have a peculiar, indeed almost an incalculable, importance.

They have been well grounded in the first principles of science and familiarised with the management of apparatus and the conduct of experiments during their school career. Their work in life will be largely increased, not only in pecuniary and mechanical, but in intellectual and moral value, by scientific knowledge.

To meet the wants of this class, a school has been opened as an experiment, in New Bridge Street, Birmingham, in premises belonging to the Chairman of the Board (Mr. George Dixon), who, at the cost of more than 2000*l.*, has adapted them for the purpose, and placed them rent free at the service of the Board.

The characteristics of this school are the following:—

I. It is especially intended for scholars who will have to become working men, but whose parents can keep them at school after they have passed the sixth standard, and the fee (3*d.* a week) is adapted to their means.

II. While a seventh standard school under the Code, the instruction given is largely scientific and technical; and a special staff of trained scientific men has been appointed. There is a special master for chemistry and metallurgy; another master for mechanics and physics; a drawing master; and a mathematical master; a highly qualified scientific man being placed at the head. Workshop instruction is provided, and includes a knowledge of the chief wood tools, and the properties of materials, while it supplements the mechanical drawing of the schoolroom, and is an aid to the study of theoretical mechanics.

III. The course of instruction is arranged to extend over two years. In the first year the scholars take ordinary standard work, together with mathematics, mechanics, drawing, chemistry, and workshop practice.

In the second year the study of mathematics will be continued, but it is intended that the scholars shall then specialise their studies in one of the following groups: (1) Chemistry and Metallurgy. (2) Mechanics and Machine Drawing. (3) Physics and Geometry.

The peculiarity of this scheme is that it is not an attempt to benefit a few picked scholars or to provide a higher-grade school for those able to pay high fees, but that it is a continuation of the science training given by means of the peripatetic method in every ordinary elementary school under the Board.

It has already been made evident that a large capacity for scientific investigation—amounting, I believe, almost to a special genius for the study of science—exists among our English people, which has never yet received its full and fair development. The country is undoubtedly awakening to the necessity of making better provision for the study of science, in order that our manufacturers may hold their own in the markets of the world. Other and higher blessings will follow in its train. Labour, in being made intelligent, will cease to be so loveless as it often is, and the lives of toiling thousands will be filled with larger interests, guided by finer tastes, and enriched with nobler joys.

THE ASSOCIATION OF GERMAN NATURALISTS AND PHYSICIANS

THE annual gathering of this influential Society was held this year at Magdeburg during the week ending September 23, simultaneously with the yearly meetings of the German Botanical and Meteorological Associations. The proceedings were opened by the President, Dr. Gaehde, whose address was followed with a few appropriate remarks by Prof. Hochheim on the services rendered to science by Guericke and other distinguished physicists.

The formal work of the meeting was opened with a paper by Prof. Rosenbach of Göttingen, on the microscopic organisms present in festering wounds. After a brief reference to the discoveries of Koch and Ogston, the author dwelt upon his own investigations, by which he claims to have proved that all purulent matter is primarily due to minute animal organisms. The

most widespread of these germs is a yellow micrococcus, which, owing to its bunchy disposition when seen under the microscope, he has called the "grape coccus." It displays great vitality, and even after twenty or thirty years may give rise to rheumatic affections of the bones and joints. Another common species is the "chain coccus," consisting of small granular bodies strung together and presenting the appearance of chains or wreaths (Pasteur's "*chapelets*").

Owing to the colonial policy at present agitating German political and commercial circles, great interest was taken in a paper by the African explorer, Gerhard Rohlfs, on the position of Africa with regard to Germany. It contained an historic sketch of the relations of Germany with the Dark Continent, recommended the establishment of factories or trading stations in favourable places, but uttered a warning note against any premature scheme of emigration to Africa.

The second general session opened with a memoir by Prof. Braun on the Island of Yesso and its inhabitants, dealing with its geographical features, the character and social usages of its Aino aborigines, and concluding with an expression of confident assurance that sooner or later Yesso must be drawn within the sphere of European culture. Some remarks followed by Dr. Huyssen of Halle on the deep borings in the North German lowlands. A sketch was given of the borings executed since 1868 at the expense of the Prussian Government, with special reference to the results obtained in the gypsum formations at Sperenberg, twenty miles south of Berlin. Here a bed of rock-salt was met at a depth of 283 feet, through which the boring was continued down to 4051½ feet without reaching the bottom of the deposit. An account was given of the new method of boring, by which it became possible to sink a shaft to a depth corresponding to the height of the Brocken in the Hartz Mountains. The thermometric observations made in connection with these operations were stated to have fully confirmed previous views regarding the increased rate of temperature from the surface downwards.

Universal attention was attracted by the essay of Dr. Kirchhoff of Halle on "Darwinism and Racial Evolution," in which it was argued that the physical development of peoples was intimately dependent on the natural conditions of their respective surroundings. The inhabitants of northern lands are noted for a preponderance of the pulmonary functions; those of hot, moist, tropical regions for a more marked activity of the liver. Thus the strongest lungs prevail amongst the Mexicans, Peruvians, and Tibetans, who occupy the three highest plateaus on the surface of the globe. That adaptation to the environment is a question, not of "predestined harmony," but of natural selection, is shown by the evolution of the negro, the most perfect type of tropical man, who is found only in the Dark Continent. The daily pursuits of a people are, on the other hand, constantly evoking special organic peculiarities. This is shown most clearly in the keen sense of smell, sight, and hearing observed in all hunting and pastoral tribes of the highlands and steppe-lands, as well as in the sense of locality, and the surprising physical endurance under hunger, thirst, and other privations. Sexual selection, again, operates in the development of the body—head, hair, beard, and the like; in the style of dress and love of ornament; and lastly, in the formation of the national character, valour and ferocity being mainly conditioned in the savage, the economic and domestic virtues in civilised man, by the choice of partners in life, and the rejection of unqualified wooers in the "matrimonial market." But, apart from this consideration, the principle of selection prevails in the moral as well as in the physical order. As mankind pressed northwards, irrepressible spirits alone could sustain life under the depressing influences of bleak, Arctic surroundings. Hence the remarkably cheerful temperament of the Eskimo, who are also bred to peaceful habits, for peacefully-disposed families alone could dwell under a common roof, as the Eskimo are fain to do in the total absence of fuel. Through over-population the Chinese have become the most frugal and industrious of peoples, in recent times emigrating to foreign lands and crowding out all more indolent or pretentious races. In the international struggle for existence physical and moral superiority must always tell in the long run.

Even greater interest was taken in Prof. Finkler's paper, read with demonstrations on the bacillus of cholera and its culture. An outbreak of this epidemic last July at Bonn gave Prof. Finkler and Dr. Prior an opportunity of applying Koch's method to the study of the comma-shaped bacillus, which showed a remarkable resemblance to that of Asiatic cholera cultivated by Koch. It was found associated with large masses of the spiral-shaped organism, but with no other germ of specific appearance. These forms could not be detected in preparations of normal or any other pathological excreta under the same method of treatment. But after several failures a comma bacillus was obtained, which in its nourishment, period of evolution, and temperature behaved exactly like corresponding cultures obtained by Koch from true cholera. Still differences occurred in respect of the successive stages of evolution, which inferentially affects the question of the permanent form of the germs. After some time they become thicker, and assume somewhat the form of a whetstone, while at both extremities spore-like forms make their appearance, and take the shape of spore-bearers. Both spores are presently extruded from the spore-bearers, and begin to crawl about under the microscope. They assume the form first of straight, then of crooked rods, which develop into spirals of diverse shape, length, and curvature. Becoming thicker and swollen, these spirals in their final evolution seem to consist exclusively of small comma bacilli. But whereas the comma of Asiatic cholera, at least according to Koch's investigations, develops no permanent form, these acquire a stability in the spore state capable of resisting the process of putrefaction. Their behaviour, however, when being desiccated or subjected to chemical agents has not yet been tested by Prof. Finkler. Between the prepared specimens of cholera nostras and true cholera bacilli exhibited under the microscope no optical difference could be detected. Owing to the attitude of most German physicians, who regard it as a patriotic duty to hold Koch's doctrine as unassailable, while the German scientific journals persistently ignore the objections urged by eminent foreign investigators against the theory, Prof. Finkler's statements naturally excited considerable sensation, giving rise to an animated discussion, without however arriving at any positive results. In any case a severe blow was given to the assumption of Koch's infallibility, although Prof. Finkler and Dr. Prior have so far failed to determine the true pathogenetic and pathognostic functions of their cholera nostras comma bacillus, as completely as Koch has for his Asiatic cholera comma bacillus.

In the Section devoted to Mathematics, Astronomy, and Geodesy, Dr. Spörer of Potsdam discoursed on the determination of the elements of rotation in the sun, and on the origin of the solar spots. The theory was advocated of currents setting steadily towards the surface of the sun both from within and without.

Discussing the subject of comets' tails, Dr. A. Marcuse of Berlin assumed that the sun acted like an electro-magnet, and that the normal tails of comets consisted of diamagnetic material (carburets of hydrogen), whereas the abnormal tails, that is, those directed towards the sun, consisted of paramagnetic materials, such as iron.

In the Physical Section papers were read by Prof. Knoblauch of Halle on two fresh attempts to determine the angle of polarisation of metals; by Prof. Overbeck of Halle on galvanic polarisation; by Prof. Ostwald on galvanic resistance, dividing the acids in relation to the velocity of electrolytico-chemical reaction into three sharply separated groups according as they are uni-, bi-, or tri-basic; by Prof. Spörer on eruptions breaking through the nucleus of a solar spot; and by Prof. Recknagel on atmospheric resistance, arguing against Lössel that it increases with the size of the plates when these are circular.

The Meteorological Section, coinciding with the annual meeting of the German Meteorological Society under the presidency of Prof. Neumayer, was unusually well attended. Amongst the foreign honorary members elected on this occasion were Prof W. Ferrel of Washington, Prof. H. Mohn of Christiania, and Prof. H. Wild of St. Petersburg. In his address on the development of meteorology and its importance to the State and society, Prof. Neumayer dwelt especially on the influence of Dove, Sabine, and other investigators, as well as of the various Polar expeditions and of the British Association on the general advancement of meteorological studies. In a second discourse he referred to the importance of synoptic studies in the South Atlantic Ocean, pointing to the results already obtained from observations taken in high southern latitudes, and urging the necessity of further investigation in the same regions.

Dr. Köppen of Hamburg followed with a paper on the principles determining the distribution of meteorological stations. Discussing the question of atmospheric electricity and lightning, Dr. E. Hoppe of Hamburg argued that the ascent of a warm atmospheric current must give rise to a thunderstorm as soon as it acquires sufficient velocity to prevent the equilibrium of the

electric current generated through the condensation produced by friction. Prof. Kiessling of Hamburg made some remarks on the diffraction colours in artificially-produced fog and their connection with the recent crepuscular phenomena. In the same department papers were submitted by Dr. Münter of Herford, on the cause of winds, and by Dr. Köppen of Hamburg, on barometric disturbances during storms.

In the Chemical Section the chief speakers were: Dr. Frank of Charlottenburg, on the past technical development of the alkali works at Stassfurt, where, in July 1882, 20,000,000 cwts. of carnallite were consumed in the preparation of chloride of potassium; Prof. Poleck and Dr. T. Schiff of Breslau, on the essential oil of *Sassafras officinalis*, Neer; Prof. Poleck, on talapin; Dr. Arrhenius, on the conductive force of the electrolyte; Prof. C. Willórodt of Friburg (Baden), a contribution to the study of acetonbromoform and acetonchloroform; Prof. E. Lippmann, on a new method of representing oxygenous compounds; Dr. Leuckart of Göttingen, on a synthesis of aromatic monocarbon acids, dealing with the reciprocal action of aromatic carburets of hydrogen and cyanates in the presence of chloride of aluminium.

In the Geological and Mineralogical Section papers were read by Prof. Lossen of Berlin on the peculiar features of the geology of the Hartz Mountains; by Prof. von Fritsch of Halle on the Cretaceous floras of the Hartz; by Prof. Nehring on the diluvial fauna of the province of Sachsen and conterminous districts; by Dr. Wahnschaffe of Berlin on the Quaternary formations in the neighbourhood of Magdeburg; by Engineer Petsch of Aschersleben on the subsidence of underground waters during the process of freezing.

In the Botanical Section Prof. E. C. Hansen of Copenhagen described some new researches on certain fungi of vinous fermentation found in cow-dung and on sweet succulent fruits; A. Zimmermann, on the action of the optical elastic ellipsoid of vegetable tissues in the process of expansion: from a study of the tissues of *Nitella flexilis* and some other plants, the author concluded against Noegeli that in optical respects no fundamental contrast exists between organic and inorganic substances; W. Detmer on the formation of muriatic acid in plants; Prof. Soraner on the action of artificial freezing, describing the conduct of various vegetable tissues under the freezing process; Dr. Kaiser on the results of the determination of fossil leafy plants.

In the Section for Zoology and Comparative Anatomy, Prof. Landois of Münster spoke on the development of the shell of certain birds' eggs; Dr. H. F. Kessler of Cassel, on the evolution and life-history of the blood parasite, *Schizoneura lanigera*, Hausm.; Prof. Nehring of Berlin, on the skull and skeleton of the Peruvian dogs from the Necropolis of Ancon, with remarks on their origin: on the ground of his comparative studies, the author inferred that these dogs must have sprung from some variety of the North American wolf (*Lupus occidentalis*); Dr. Müllendorf of Berlin, on the importance of the formic acid found in honey: when closing the cells of the honeycomb, the bees mix the honey with formic acid in order to give it greater consistency; Prof. Leuckart of Leipzig, on a new species of Nema ode found in the body of *Hylobius pici*, 3 mm. long, 1 mm. thick, and named *Allantiema mirabile*; Prof. W. Blasius, on some fresh data in connection with the remains of *Alca impennis*, Linn.

The excursions with which the proceedings were diversified included visits to the model Meteorological Observatory of the Magdeburg Zeitung, to the neighbouring chemical works of Stassfurt, to the University of Halle, and to the Hartz Mountains.

It was announced that the Association would hold its next annual meeting at Strasburg.

SCIENTIFIC SERIALS

Journal of the Franklin Institute, No. 3, September 1884.—Synchronous-multiplex telegraphy in actual practice, by Prof. Edwin J. Houston (illustrated).—An extraordinary experiment in synchronous-multiplex telegraphy, by Prof. Edwin J. Houston.—On the application of electricity as an illuminating agent in astronomical observatories, by W. S. Franks.—A metastatic heat regulator, by N. A. Randolph, M.D. (one figure).—The drying of gunpowder magazines, by Prof. C. E. Munroe, U.S.N.A.—On an explanation of Hall's phenomenon, by Shelford Bidwell, M.A., LL.B. (table).—Instruction in mechanical engineering, by Prof. R. H. Thurston.—Report on the trial of the "City of Fall River," by J. E. Sague, M.E., and J. B. Adger, M.E. (concluded from p. 115) (tables and diagrams).—Report of the Board of Experts on Street-paving (tables).—Surveys for the future water-supply of Philadelphia, by Rupert Hering, C.E. (tables).—Methods in physical astronomy.—Solar motor and solar temperature.—Hirn's actinometer.—Soap-roots.—Aluminium and aluminium-bronze.—Palmieri's atmospheric electricity.—New electro-magnet.—Tanning by electricity.—Gases in steel.—The volcanic ashes of Krakatoa.—Papal Observatory.—Origin of volcanic activity.—Balloon photography.

Verhandlungen des naturhistorischen Vereins der Rheinlande und Westfalens, January–June.—Report on the proceedings of the Society during the year 1883.—On the recent chalk and diluvium formations of the Mülheim district, by Dr. Deicke.—On the disposition of the stratified rocks and has in the neighbourhood of Herford, by H. Monke.—Report on the fossils of the greensand rocks in the district of Aix-la-Chapelle, by J. Böhm.—On the fishes, crustaceans, and flora of the Upper Chalk system in Westphalia, by Dr. Marck.—On the digestive organs of the spider, by Prof. Bertkau.—On the human skull found associated with the mammoth, rhinoceros, and reindeer in the loess of Podbaba near Prague, by Prof. Schaffhausen.—On some fossil remains from the Devonian rocks of Eifel, by Prof. Schlüter.—A contribution to the physiology and anatomy of *Dasypoda hirtipes* (two plates), by Dr. Hermann Müller.—On the diorite of the Upper Ruhr Valley and its association with the argillaceous schist of the same district, by Dr. A. Schenck.—On the causes of the great oscillations and disturbances in the crust of the earth, by F. F. von Dücker.—On the occurrence of fossil wood in the region of the Westphalian Coal-Measures, by W. Wedekind.—On the mutual relations of the Middle Eocene formations of Monte Postale, Ronca, and San Giovanni Ilarione, by Dr. H. Rauff.

Rendiconti del R. Istituto Lombardo, July 31.—Some reflections on the proposed laws for regulating the administration of public and private lunatic asylums in Italy, by Dr. C. Zucchi.—Various researches on the Bacillus of tuberculosis, by Prof. Giuseppe Sormani.—Description of a continuous registrar of electric energy transmitted at any given point of a circuit, by Prof. R. Ferrini.—On the geometrical surface of the third order, by Prof. E. Bertini.—Remarks on the Turin Gloss on the Institutions and Paraphrase of Pseudotheophilus, by Prof. C. Ferrini.—Meteorological observations made at the Brera Observatory, Milan, during the month of July 1884.

Rivista Scientifico-Industriale, August 15.—Results of experiments on the variations of electric resistance of argentan wire subject to tension, by Dr. Sebastiano L. Angelini.—Experiments on the compressibility of fluids, and especially of water, by Prof. Pagliani and Dr. S. Vicentini.—Observations on the struggle for existence between *Staphylinus olens* and *Lumbricus agricola*, by Silvio Calloni.

August 30.—Description of a universal anemometrograph (wind-gauge) recently invented by Prof. Michele Cagnassi.—Remarks on an elementary demonstration relating to the theory of the potential, by Giuseppe Vanni.—Remarks on the variations in the electric resistance of solid and pure metal wires under changes of temperature, by Prof. Angelo Emo.

Bulletin de la Société des Naturalistes de Moscou, 1883, No. 4.—On the seeming anomalies in the structure of the great comet of 1744, by Th. Bredichin (in French), with plates. It appears from calculations, illustrated by a plate, that the strips observed on this comet correspond to the "synchronal" curves of the author deduced in the hypothesis of repulsive force.—Some remarks on comets, by the same. The initial speed of their appendages towards the sun is approximately deduced at 2000 m. per second.—On the tail of the first type of the comet 1858 V., by A. Sokoloff (in French), being a calculation of "syndynamic" curves according to Bredichin's method.—On *Cæsona pivitorquum*, A. Br., by Ed. Kern (in German), with 4 plates.—Remarks on the geological map of the Vetluga region, by H. Trautschold.—A new Pleurotoma (*Renardii*) from the Miocene of Italy, by De Gregorio.—A new demonstration of the theorem of Lambert, by N. Joukovsky (in French); it is based on the formula of variation of action.—Materials for the geology of the Crimea, by W. Sokoloff (in Russian), being notes on the Jurassic and Neocomian deposits in the neighbourhood of Simferopol.—On the recent work of the United States geologists, by H. Trautschold.—Letter from Dr. Regel, from Tashkend.

SOCIETIES AND ACADEMIES

PARIS

Academy of Sciences, October 13.—M. Rolland, President, in the chair.—Note on the theory of the figure of the earth, by M. F. Tisserand.—On the decomposition of the oxide of copper by heat, by MM. Debray and Joannis.—Note on the sulphuret of carbon, and the application of a solution of this substance in water to the treatment of the vine attacked by phylloxera, by M. Eug. Peligot. Its solubility in water is shown to be considerably greater than that recently determined by M. Ckiandi. At the ordinary temperature water dissolves 3·5 c.c. per litre, or 4·52 grm., its density being 1·293. Its antiseptic properties have also been fully confirmed by the further investigations of M. Pasteur, who anticipates that it will become the most efficacious of all antiseptics, it being also the cheapest, costing only a few centimes per litre. It is, moreover, the best known insecticide, and has already rendered great services in the destruction of phylloxera. At present 30,000 hectares of vineyards are yearly treated with over four million kilogrammes of the sulphuret of carbon with excellent results. When applied in the form of a sulphocarbonate of potassium it has a double action, the sulphuret killing the insect, and the potassa, an essentially fertilising element, enriching the soil.—On the nitrates present in plants (continued), by MM. Berthelot and André. Their distribution during the various periods of vegetable growth, and their relation to the total proportion of the fundamental elements, potassium and nitre, contained simultaneously in the leaves, stem, root, and flower, are discussed by the authors.—Observations made at the Observatory of Marseilles during the recent total eclipse of the moon, by MM. Stéphan and Borelly. The occultations of several stars contained in the list supplied for the purpose by M. Struve of the Pulkowa Observatory were observed.—Note on the map of the erratic phenomena and ancient glaciers on the northern slope of the Swiss Alps and of the Mont Blanc range, by M. Alph. Favre. This map, drawn to the scale of 1 : 250,000, indicates the extreme development of the old glaciers, and, as far as possible, the glacial drift, erratic boulders, and moraines deposited in this region during the period of glaciation. The glacier basins, marked in different colours, by no means coincide with the present hydrographic systems of the country. Six great glaciers are enumerated: that of the Arve, stretching from Mont Blanc to Lake Bourget; that of the Rhone, running from Furca in one direction to Lyons, in another to the Rhine near Laufenburg; that of the Aar, extending from the glaciers of that name to Berne; that of the Reuss, issuing from Mont Saint-Gothard and terminating near the Rhine; that of the Limmat, stretching from the Glaris highlands to the Rhine; lastly, the vast glacier of the Rhine issuing from the Grisons, traversing Suabia, and terminating near Sigmaringen on the left bank of the Danube.—Observations made at the Observatory of Marseilles of the planets 240 and 241, and of Max Wolf's new comet, by M. Stéphan.—Description of a new galvanometer with astatic needles (one illustration), by M. E. Ducretet.—Note on the mechanical dislocation of the persistent images left on the retina of the eye after gazing on highly illuminated bodies (one illustration), by M. F. P. Le Roux.—Note on a preparation of trichloruretted camphor, by M. Cazeneuve.—Description of the first larva from the egg of *Epicauta verticalis*, by M. H. Beauregard.—Note on two new species of simple Ascidians (family of the Phallusiadeæ), by M. Roule.—On the anatomical structure of *Anchynia rubra*, by M. N. Wagner.—Account of a new insect of the genus Phylloxera (*Phylloxera salicis*, Lichtenstein), by M. J. Lichtenstein.—Note on a meteor recently observed near Royan, by M. Chapel.—Remarks on M. Paul Venukoff's new work "On the Deposits of Devonian Formation in Russia," by M. Daubrée.—Note on a block of pumice found on April 13, fifteen miles off the Madagascar coast, in 14° 35′ S. lat., 48° 2′ E. long., and supposed to have come from the Krakatoa eruption, by M. Alph. Milne-Edwards.

STOCKHOLM

Society of Natural Sciences, September 20.—Prof. Sandahls, President, in the chair.—Dr. Wille gave an account of his researches this summer at the zoologico-botanic station established at Dr. Regnell's expense at Kristineberg, in the province of Bohus, as to the mechanical power of the higher Algæ to endure strain, and thereby resist the swell of the sea. He described his method, and gave an account of the strain which strips of Algæ of certain lengths and thicknesses could bear. He found that they possessed a very high degree of resistance and elasticity, but that when the weight was removed they retained some of the additional length caused by the strain. As might be expected, the power of resistance was greater in the lower than the upper parts, as the former suffer a far greater strain than the latter from the swell of the sea. He further referred to the anatomical causes of this, which were due to the circumstance that the specific mechanical cells which had to resist the strain were preferably developed in the lower parts, and to the fact that, as the plant grew, special organs of strengthening—they might be called moorings—were successively dropped to the bottom from the sides of the Algæ, and in some cases even developed through the membrane downwards. The lecture was illustrated by means of drawings.—Dr. Thedenius exhibited a specimen of the moss *Riccia natans*, taken by him the the same day at Sundbyberg, the only spot in Scandinavia where it grows. He also exhibited a hitherto unknown hybrid of *Tragopogon porrifolius* and *T. minor*, which had grown in his garden this summer, where both grew, and referred to the hybrid of *T. porrifolius* and *T. pratensis* found some time ago at Karlskrona. He also exhibited *Bryonia dioica*, a species never before grown in Sweden, which he had found in his garden.—The Secretary referred to an article forwarded to the Society on the East Indian plant *Abrus precatorius*, according to which a particular variety of Bacillus had been discovered in the poisonous infusion of its seed, which demonstrated that infectious diseases could be transmitted by plants, and pointed out that Dr. Widmark, a Swedish botanist, had recently shown that the Bacteria were not originally in the infusion in question, but that it only served to sustain the Bacteria which had immigrated thither from the air. He concluded by mentioning the well-known but inexplicable phenomenon of *Pinguicula vulgaris* having the effect of curdling milk when the vessels containing the latter had been rubbed with the butterwort, which was most probably due to microbes.

Botanical Society, September 27.—Prof. V. B. Wittrock, President, in the chair.—The meeting was the first one of the winter term.—On the diseases of cultivated plants in Sweden, by Herr J. Eriksson.—On the geographical extension of some rare Swedish Phanerogams, by the President.—On the 13th and 14th fasciculæ of the work "Algæ aquæ dulcis, exsiccatæ, quas distribuerunt Veit Wittrock et Otto Nordstedt," which had recently appeared, by the same.

CONTENTS

	PAGE
Field and Garden Crops. By George Murray . . .	605
Our Book Shelf:—	
Cory's "How to Foretell the Weather with the Pocket Spectroscope"	606
Lynn's "Celestial Motion: A Handy Book of Astronomy"	606
Casey's "First Six Books of the Elements of Euclid, and Props. i.-xxi. of Book xi."	606
Letters to the Editor:—	
The Sky-Glows.—E. Brown; J. Edmund Clark .	607
Cole's Pits.—Joseph Stevens	607
Circular Rainbow.—W. Symons	607
The New Geological Map of Russia.	608
Earthquakes. By Dr. H. J. Johnston-Lavis. (*Illustrated*)	608
International Weights and Measures	612
Notes	613
Our Astronomical Column:—	
Wolf's Comet	615
The November Meteors	615
New Southern Double-Stars	616
The Total Solar Eclipse of 1816, November 19 . .	616
Chemical Notes	616
American Ornithologists' Union	616
The Capillary Constants of Liquids at their Boiling-Points	618
Researches on the Origin and Life-Histories of the Least and Lowest Living Things. By Rev. W. H. Dallinger, LL.D., F.R.S. (*Illustrated*) . . .	619
The Peripatetic Method of Instruction in Science and its Development. By Henry W. Crosskey, LL.D.	622
The Association of German Naturalists and Physicians	625
Scientific Serials	627
Societies and Academies	628

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE

"*To the solid ground*
Of Nature trusts the mind which builds for aye."—WORDSWORTH

THURSDAY, NOVEMBER 6, 1884

TWO BEE BOOKS

A Collection of Papers on Bee-keeping in India. Published under the Orders of the Government of India, in the Revenue and Agricultural Department, 1883. (Calcutta: Office of the Superintendent of Government Printing, India, 1883.)

The Honey-Bee: its Nature, Homes, and Products. By W. H. Harris, B.A., B.Sc. With Eighty-two Illustrations. (London: The Religious Tract Society, 1884.)

THE thin folio issued by the Indian Government is very redolent of red-tape, since it contains not only a large number of reports from forest and district officers, and other persons in various parts of India, but also the whole of the official correspondence, memoranda, and indorsements connected with the same. Moreover, it is almost a misnomer to call it a collection of papers on "Bee-keeping," since at least nine-tenths of the reports state that domesticated bees are quite unknown in their districts; and the bulk of the matter (nearly a hundred pages of close print) is occupied with accounts of native methods of taking the combs of wild bees and preparing the wax, and with very imperfect descriptions of the various kinds of honey-producing bees in each district. The general result of the inquiry, as stated in a "Resolution" of the Revenue and Agricultural Department, is the following:—

"The industry is unlikely ever to be one of great importance in India. It can only be followed in the hills, where flowers abound throughout the greater part of the year, or in forests, where food is equally plentiful. In the populous country of the plains, bee-keeping as a general industry seems impracticable. Under these circumstances there is little or no call for action on the part of the Government."

Notwithstanding this somewhat depressing outcome of a laborious inquiry, some interesting details may be found in the storehouse of facts here brought together. At the commencement of the Report attention is drawn to Moorcroft's account of bee-keeping in Cashmere:—

"Their domestication there is so general that in some parts of the country a provision is made for hiving them in every house as it is being built. Spaces are left empty in the walls about 14 inches in diameter, and 2 feet, the average thickness of the walls, in length, which are carefully lined with a mixture of mortar, clay, and chopped straw, and closed at the inner end with a flat tile. There are ten or a dozen of these hives built into the walls of every house. The bees are hived exactly as in Europe, but the comb is gathered differently and in a way well worth following at home. It is done by the father of the house removing the flat tile, and at the same time blowing the smoke of a smouldering wisp of straw he holds in the other hand vigorously through the hive, on which the bees at once leave the hive, and he gathers in their store of honey. He then replaces the flat tile at the inner end of the hive, and the bees, after recovering their stupefaction, gradually return to it. The same colony of bees thus produce honey year after year in the same hive, and generation after generation, and have probably done so from the original Aryan settlement of the Cashmere Valley. In consequence of their being thus literally domiciliated with the human race, the bees of Cashmere are milder in their manners than those of any other country, although they have a most villainous sting when unduly provoked to use it. Their honey is as pure, and clear, and sweet, Moorcroft says, as the finest honey of Narbonne."

In a statement on bee-culture in Cashmere by a zemindar, it is said that hives are now very numerous, as they have been on the increase for several years, and the method of keeping them is very similar to that described by Moorcroft. But Mr. R. Morgan, Deputy Conservator of Forests, Madras, protests against the recommendation of smoking out the bees, as barbarous. It is, however, no doubt well suited to native wants, as hives are not required to be indefinitely increased, and there is no sale for swarms.

A very simple mode of bee-keeping is described as practised by the people of Mysore:—

"In March or April they besmear the concave part of an old earthen pot with honey-wax, make holes in the pot, take it to the jungles, and place it upside-down on a piece of wood or a slab of stone. The bees are attracted to the pot by the smell of the wax, and, when the person intending to domesticate them finds, after a trial of four or six days, that they have taken to remain in the pot, he goes to the jungle on a dark night, removes the pot after

having covered it with a blanket, and places it either on a tree near or under the eaves of his house, or in any adjoining place. Each man keeps pots varying in number from one to four. He need not do anything beyond keeping the pots as aforesaid. They store honey between April 15 and June 15; and between the latter date and the end of July the keeper gathers it in, leaving a small portion to serve as food for the bees."

Mr. R. Morgan, Deputy Conservator of Forests, Madras, gives an interesting account of the honey-bees of the Wynaad. He says that the best honey-producing flower of Southern India is the Strobilanthes, of which there are numerous species, which almost all flower once in seven years, dying down entirely, and afterwards a fresh growth springing up from seed. The Strobilanthes is a shrubby genus of Acanthaceæ, mostly with blue or purple flowers, and the statement about their flowering only once in seven years is probably a popular delusion, like that of the Aloe flowering once in a century. The bees build their combs on the ledges of inaccessible precipices, often overhanging rivers, or on lofty horizontal limbs of the largest forest trees, and the combs are usually 3½ to 4 feet in length and 2 feet in diameter. The natives take the honey on dark nights by means of long cane or bamboo ladders, either erected against the tree or rock or suspended from above, and they carry torches, and knives to cut away the combs. The bees are roused by the glare of the torches, but do not sting, although in the daytime they are terribly pugnacious, and many a sportsman and traveller has barely escaped with his life after disturbing them. Mr. Morgan states that he can give numerous instances of men, cattle, horses, and even fowls and pigeons being killed by these bees.

The Deputy Conservator of Forests, East Salween, describes some remarkably large combs, one of which was 7 feet long and 6 feet deep in the widest part. The bees are fond of particular trees, and he states that on one Kanyin tree (*Dipterocarpus alatus*) he counted no less than thirty-nine combs, some of prodigious size. The trees are here ascended by means of pegs driven in the trunk, as in Borneo, and the bees are partially stupefied by a smoke torch.

These are samples of the better kind of reports that have been obtained from hundreds of districts in India. There is a monotonous similarity in large numbers of them, and it may be doubted whether the information afforded is worth the labour and cost it has entailed.

Mr. Harris's little volume on "The Honey-Bee" affords a striking contrast to the preceding work, both in its elegant get-up and excellent illustrations, its wide range of matter, and the clearness and condensation of its style. It treats in a pleasant and well-informed manner not only of bee-keeping but of the bees themselves and all that relates to them. We have a chapter on the literature of bees, from the Egyptian monuments and the Vedas to Shakespeare, Huber, and modern writers. Each subject is treated in a separate short chapter, so that we have chapters on "The Queen Bee," "The Workers," "Wax," "Bee-bread," &c., and even one on "Mead," including its use in ancient times and Queen Elizabeth's receipt for its manufacture. Hives, the Enemies, and the Diseases of Bees are all separately treated, as well as their "Intellect and Instinct," their "Relation to Flowers," and the "Superstitions connected with Bees."

From so condensed a work it is difficult to find passages suitable for extract, but the following illustration of the powers of intellect manifested by bees may be taken as a fair specimen of the author's style:—

"Again, let us revert to the manufacture of queens by the workers. If at the time of the removal or loss of the mother-bee in any way, there should be unhatched princesses in the hive, no attempt will be made to follow the course adopted in the absence of such royal progeny. In the *latter* case—that is, when there is no royal brood—there must be a distinct conception, first, of their bereavement; secondly, of the hopelessness of a sovereign appearing in the ordinary way. Then a judgment is formed of the proceedings necessary for making a queen, and action immediately follows. Not only so, but as if to secure themselves against the repetition of their calamity, they prepare not *one* queen, but *several*, so that, if the first which comes to maturity be lost, there may be others in reserve. A further act of definite judgment appears in this; for if one only were produced and lost, they would be powerless to repeat the process, as all the rest of the worker brood would, in the meantime, have advanced far beyond the stage at which its transformation would be possible. The bees then, with admirable prevision, forbear to risk all the future of their community on one hope of a queen."

In adducing the construction of the cells as a proof of pure instinct of the highest order, Mr. Harris is hardly on secure ground, since he omits to notice the researches of Mr. Darwin proving that the method of cell-building is very simple, and consists, fundamentally, in forming circular cells the size of which is determined by that of the bee's body, and gnawing away all the superfluous wax in the angles till the hexagonal form is produced. He is also hardly justified in the statement that "all these and other circumstances connected with the construction of their dwellings attest the possession of an innate faculty *needing no instruction from the elders of the hive.*" The last statement (which we have italicised) is surely unprovable, and as every young bee necessarily begins work in the midst of her elders, and has done so during the countless generations of the past, it seems more probable that a considerable portion, though not perhaps the whole, of the bees' wonderful constructive power, is due to direct imitation and instruction.

On the whole, we can recommend this little book as a very comprehensive summary of what is known about bees and bee-keeping, at once attractive to the young who wish to learn something about these marvellous little creatures, and at the same time containing all the information necessary for the beginner in apiculture. The illustrations are both well chosen and beautifully executed, and the work is altogether so daintily got up as to render it especially suited for a gift to intelligent boys and girls.

A. R. W.

DR. KLEIN ON MICRO-ORGANISMS

Micro-Organisms and Disease. By E. Klein, M.D., F.R.S. (London: Macmillan and Co., 1884.)

THERE can be no doubt of the value and excellence of this little book. Dr. Klein is one of the very few men in this country who are continually working and experimenting with Bacteria and similar forms. His

instructions and advice as to methods of study are invaluable, and his opinions on the numerous debatable questions connected with micro-organisms entitled to the highest respect. Dr. Klein has descended, as it were, from his position of experimentalist and observer, in order to place before the scientific public in a compact form a *résumé* of what is known at this moment concerning disease-producing micro-organisms. He classifies these organisms as Micrococci, Bacteria, Bacilli, Vibriones, Spirobacteria, Yeast-fungi, and Mould-fungi, and gives *seriatim* under each head, accompanied by numerous figures, often original, an account of such forms as have been found in association with disease. He refers the reader to the original writings in which this or that organism has been described, and whilst he sometimes judiciously throws doubt on a claim to pathogenic powers, he is entirely relieved from the responsibility of a critic in all cases by the disclaimer in his preface and by the fact that he obviously intends to leave the question in most cases to further inquiry. As an illustrated catalogue of reputed pathogenic Schizophytes, with references to original authorities, the work is invaluable.

At the same time Dr. Klein does, as so ripe a student of these questions must, commit himself to very definite opinions on some of the great problems of what it is convenient to term "Bacteriology." Dr. Klein clings to the belief that speaking broadly the forms known as Micrococci, Bacteria, Bacilli, Vibriones, and Spirilla breed true and are to be recognised as true genera. This opinion is traceable to the fact that his studies have been chiefly (like those of Koch, who holds a similar view) carried out on parasitic (*i.e.* pathogenic) Schizophytes. And it is highly probable that it is more difficult (in some cases impossible) to break down the specific form by change of environment of a parasitic Schizophyte than of free-living kinds. But Dr. Klein has himself shown (p. 109) that Bacillus (*B. anthracis*) when cultivated in a certain way becomes Micrococcus (torula-form), and other similar instances are to be found in his book. Had he dealt with free-living Schizophytes as well as parasitic ones, he would have found ample evidence of the transformation, in the course of growth and division, of Micrococci into Bacteria, of these into Bacilli, and of these into Vibriones and Spirilla, and of each of these directly or indirectly into the other forms. The instability of the forms presented by particular kinds of Bacteria does not however imply, as has been assumed by some writers (Billroth *e.g.*), that there is only one "species" of Schizophyte. Such use of terms would lead to the statement that there is only one "species" of organism in all creation. The instability of the forms of Schizophytes merely implies that the range of presently observable specific characters taken as a whole (which forms the true limits of what mankind at the moment calls a "species") is *not* simply and directly coincident with the range of one particular and readily observed set of characters, namely, those of form. A great deal more depends upon the question of transmutability of the forms of Schizophytes than is admitted, at present, by pathologists. We would merely warn them that the doctrine of fixity of the forms of pathogenic Schizophytes is as much an *assumption* and as much to be received with caution as is the contrary doctrine of the universal transmutability of such forms. One great fact is certain, viz. that *some* Schizophytes do exhibit the *positive* evidence of change of form in the course of growth under varying conditions.

Dr. Klein has a most interesting chapter on the conversion of innocuous into pathogenic organisms and *vice versâ*, in which he criticises with great ability the results of Buchner and Nägeli on the one hand, and of Pasteur on the other. Valuable as such critical dissertations are, Dr. Klein will agree with us in thinking his experiments of greater value. We should be sorry were the test-experiments which they suggest to be delayed in consequence of the apparently satisfactory character of the reasonings which he and others have very properly adduced. The fact is that the proportion of what we know by careful experiment and observation in reference to Bacteria and their allies—as compared with what we must soon know and can see how to know if only time and ability are directed to the research—is so small that conclusions and generalisations are not useful except as suggestions to those who are in the thick of the work. More experiment, more trial of every conceivable condition of growth and nutrition, applied to every kind of Schizophyte observed and yet to be discovered, is imperatively called for.

Who can say that much is known as yet about these organisms, when even so earnest a student of them as Dr. Robert Koch did not know that his so-called "cholera comma-Bacillus" occurs in the mouths of nearly every healthy man, woman, and child?

Dr. Klein has rendered a generous service to future students of Bacteria by the publication of this little book. The woodcuts are very abundant, and sufficient to give an idea of the forms as they appear when stained by coloured reagents. The botanical and chemical aspects of the Schizophytes are necessarily not dealt with in this treatise.

E. RAY LANKESTER

OUR BOOK SHELF

A New Method of treating Glaucoma, based on recent researches into its Pathology. By Geo. Lindsay Johnson, M.A., M.B., B.C. Cantab. (H. K. Lewis, 1884.)

THIS little *brochure* is written by a Cambridge graduate who has devoted considerable time and attention to the study of diseases of the eye, and who has devised a new and very serviceable form of ophthalmoscope. The proposition he endeavours to establish is "that the ordinary method of treatment for glaucoma by iridectomy, though highly successful in acute forms of the disease, is nevertheless both uncertain and unsatisfactory in the chronic condition of glaucoma." The truth of this proposition all those who have had large experience in the performance of operations on the eye will freely admit: the reason is less easy to give. Dr. Johnson describes the lymphatic system of the eye, and adduces evidence to show that the aqueous humour is secreted by the ciliary processes and posterior surface of the iris, whilst it is drained off by the canal of Fontana, and the meshwork at the corneo-iridal angle. Any circumstance obliterating this angle is apt to induce glaucoma. It is certainly not due to swellings of the lens, since Brailey has shown that the lens is smaller in the glaucomatous than in the normal eye, but Dr. Johnson thinks that acute glaucoma may be referred to swelling and inflammation of the ciliary processes, whilst in chronic glaucoma there are slow and gradual changes in the ciliary body and in the lesions around the angle of the anterior chamber, which in his opinion explains the

different effects of iridectomy in cases of acute and chronic glaucoma. Dr. Johnson then proceeds to describe an operation which he terms scleral paracentesis, and describes as new, but which we have seen performed both by Mr. Hancock and by Mr. Power many years ago. In point of fact, Mr. Hancock's operation was a scleral paracentesis, and his view, which is not altogether incorrect, and was based on observation, was that in glaucoma a circumcorneal depression could be seen which he imagined to be due to the ciliary muscle, and his section, made with the same instrument recommended by Dr. Johnson, namely, a Wenzel's double-edged knife, was made through the sclera with the object of dividing the ciliary muscle; and the excellent results obtained in some cases show clearly that the escape of the vitreous which followed the incision, accompanied, when the anterior chamber was opened, by the aqueous humour, was quite enough to afford relief to all the symptoms and to restore vision, even if the spasm of the ciliary muscle was quite imaginary. We do not, however, wish to deprive Dr. Johnson of the credit of having thought out this method of procedure, though he may rest assured that he will meet with many cases of chronic glaucoma that will derive no benefit from scleral paracentesis, and that he will have to be careful in promising success from his operation in such cases.

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.*]

An Unnoticed Factor in Evolution

Two observed biological facts seem to oppose great difficulties to any explanation on evolution principles; difficulties admitted by evolutionists as well as their opponents. I mean—

(1) The fact that varieties produced by artificial selection, however divergent, are always fertile among themselves, while species supposed to have been produced naturally by an analogous process are often not mutually fertile even when very slightly divergent; and

(2) The fact that species evidently derived from a common ancestor, and differing only in small points of marking, though not fertile with one another, are often found side by side in places where it would seem that cross-breeding must prevent any division of the ancestral species into divergent branches.

The first seems to require that a period much greater than that of artificial selection should be necessary to produce sterility between descendants from the same ancestor; a supposition which would require an almost incredible period for evolution as a whole. The second seems to require that many species now intermixed should once have been geographically separated, sometimes in cases where this is very difficult to imagine. Both these difficulties are completely removed if we suppose mutual sterility to be not the *result* but the *cause* of divergence.

As far as can be judged, "sports" are as likely to occur in the generative elements (ova and spermatozoa) as in other parts of the body, and from their similarity in widely unlike groups it seems certain that a very slight variation in these elements would render their owner infertile with the rest of its species. Such a variation occurring in a small group (say the offspring of one pair) would render them as completely separate from the rest of their species as they would be on an island, and divergence (as Wallace has sufficiently shown) would begin. This divergence might progress to a great or a small extent, or even be imperceptible, but in any case the new species would be infertile with the species it sprang from.

If this theory be admitted, we must distinguish between varieties and species by saying that the former arise by spontaneous variations in various parts of the body, and only gradually become mutually infertile (thus becoming species), while the latter arise sometimes in this way, but sometimes by spontaneous variations in the generative elements, and are in this case originally mutually infertile, but only gradually become otherwise divergent.

I would suggest the following tests, and should be glad of any facts, from experience or from books, which can help in applying them:—

(1) If this theory is true we ought to find species (incipient) mutually infertile, but not otherwise distinguishable; and

(2) We ought to find that island and other isolated species which have arisen not by limited fertility but by geographical instead of physiological separation are often mutually fertile even when as widely divergent as the artificial varieties of dogs or pigeons.

EDMUND CATCHPOOL

The Grove, Totley, Sheffield, October 23

Earthquake Measurement

IN an article on "Earthquakes" in last week's NATURE (p. 608), Dr. H. J. Johnston-Lavis takes exception to the records of earthquake motion which I have published, on the ground of their complexity, and pronounces the Plain of Yedo unsuitable for earthquake observations.

Now this seems to me to be a very eclectic way of treating earthquakes. We can measure earthquakes only where we find them, and I suppose the first qualification in a site for an earthquake observatory is that there should be plenty of earthquakes. The Plain of Yedo possesses this qualification in a very high degree; and if the disturbances which occur in it are of a very much more complex character than our *a priori* notions about earthquakes may have led us to expect, it is not the Plain of Yedo that is to blame.

I fully agree that on a rocky formation the results will be different from those I found on an alluvial plain, but the instruments and methods which have been successful on the one are just as applicable to the other. The seismometers which have been used in Japan will serve to measure, with equal accuracy, earthquakes of a similar degree of destructiveness in other places, whatever be the nature of the ground. And several of the types already employed need little more than a change of scale in their construction to suit them for such formidable convulsions as the Ischian earthquake, to which your correspondent refers.

In describing and figuring a number of proposed seismographs, Dr. Johnston-Lavis has very frankly disclaimed a technical knowledge of mechanical construction, and for that reason all minute criticism of his suggestions may be withheld. If however he will refer to the *Transactions* of the Seismological Society of Japan, or to my "Memoir on Earthquake Measurement," he will see that some of the devices he suggests are not new. The plan of registering the amplitude of a pendulum's motion relatively to the earth by making the bob draw up a thread through a hole in a plate fixed below it was used some years ago by Dr. G. Wagener; and a massive slab free to roll on spherical balls formed in 1876 the seismometer of Dr. G. F. Verbeck. It was reinvented a year or two ago by Mr. C. A. Stevenson, and described by him before the Royal Scottish Society of Arts. The theory of the apparatus is discussed in §§ 31-32 of my memoir. Dr. Johnston-Lavis's plan of recording the azimuth of a movement by means of numerous electric contacts and "a pile of electromagnets" is a very retrograde step from the perfectly successful method, used in Japan, of resolving all horizontal movements into components along two fixed directions, these components being independently recorded in conjunction with the time.

Speaking of the use of the common pendulum as a seismometer, the author says that by using a short pendulum we may measure oscillations of short period, and by using a long pendulum we may measure slow earth-tiltings. Almost the reverse of this is the case. A short pendulum acquires, by earth movements of short period, a swing which cannot be distinguished from the movements we wish to measure, and whose extent depends on the accidental agreement of its period with theirs; but a short pendulum can be properly used to record slow earth-tiltings, with respect to which it is sensibly dead-beat. A long pendulum can be used to measure short-period movements; it can also be used (and its only advantage over a short pendulum is greater sensitiveness) to measure slow tiltings.

For vertical motion Dr. Johnston-Lavis condemns (but without giving any reason) my own and another vertical-motion seismograph—which theory and experience agree in proving

trustworthy—and proposes an instrument in which a weight drives a clock-train furnished with a centrifugal speed-indicator. The changes of apparent weight of the driver caused by the earth's up-and-down motion are to cause fluctuations in the speed of the driven train, which are to be recorded in conjunction with the time. The plan is, I think, new, but a less direct method of measuring vertical movement could scarcely be imagined. The fluctuations in speed will follow the changes of pull exerted by the driver with diminished amplitude and retarded phase, and superposed on them there will be fluctuations following no rule, due to inconstant friction and to mechanical imperfection of the train, as well as the continuous acceleration which follows the starting of the mechanism. To interpret the records would be altogether impracticable.

The design of a seismograph is a problem in applied dynamics which has of late years received a number of very satisfactory solutions. Of instruments capable of determining earthquake movements in absolute measure, and with reasonable exactness, there is now no lack; and it would be a pity if their wider employment were in any way retarded by the publication, on the authority of Dr. Johnston-Lavis, of suggestions which may fairly be said to lie outside the sphere of practical seismology.

University College, Dundee, October 27 J. A. EWING

The Sky-Glows

THE description of the sky-glows as seen by Prof. A. S. Herschel may justify an account of some seen near the University of Virginia, Virginia, during the past spring, from notes made at that time.

February 25.—For several days before this date there were (if one may so call them) the normal glows at and after sunset. On this day there was seen a single pink ray with well-defined edges, about 4° broad, perpendicular to the western horizon, reaching half way to the zenith.

March 24.—Ten minutes before sunset, the sun being behind a small cloud, the bright oval "glare" in the west, which preceded nearly all the after-glows, was seen with its centre at an elevation of 15° (all these heights are rough estimates). It was 10° in diameter, and was surrounded by a band of a hazy reddish ashen colour (this band was usually seen with the "glare") about 5° wide, which deepened in tint towards the horizon, and there spread out on each side of the "glare" so as to form a somewhat triangular support for it. At 6.30 the sun set. No colour had yet appeared on the eastern horizon. The "glare" now seemed almost triangular in shape, with the deepest ashen tints at the lower corners. As the sun descended, the "glare" diminished in intensity from the apex of the triangle. At 6.35 there was a ruddy colour on the eastern horizon, which spread in a triangular shape, apex upward, to a height of 25° to 30°, and at 6.40 was an exact image of the "glare" in the west, except that there were clear red tints instead of ashen, which were deepest at the lower corners of the triangle. The colour triangle then gradually rose from the eastern horizon, apparently following the sun, till at 6.48 the pink tint appeared in the western sky, increased in intensity, and was deepest at an elevation of 60°. The colour in the east was now gone. (Several attempts were made to observe the passage of colour across the zenith, but in no case was there success.) The western horizon was dazzling topaz-yellow, above the yellow pale blue, then faint pink to the deepest pink. The pink gradually descended toward the horizon, and when within 20° merged into the ordinary sunset colour at 7.0. The general phases of the glow were as follows:—Triangular ashen haze with oval "glare" in west, base of triangle on the horizon at sunset. Ten minutes later, triangular ruddiness in east, with base on the horizon. Another ten minutes, pink in the west. Ten minutes more, colour disappears. This succession was also noticed on March 15. On March 4 the glow in the west reached its most intense colour twenty minutes after sunset, but lasted twenty minutes, disappearing forty minutes after sunset.

On this evening (March 24) at 6.45, a cloud in the western sky, there being then no pink there, at an elevation of 35°, was coloured pale pea-green. This colour of the clouds floating at an elevation of 35° was seen on other days, while the clouds above and below retained their ordinary appearance.

March 26.—After the same phenomena as detailed in the last, even to the colour of the clouds, twenty minutes after the disappearance of the first glows, at 7.20 there was a pale rose-glow at an elevation from the western horizon of 30° to 35°, which reached almost to the Pleiades, of which six were then visible. This second glow lasted about twenty minutes, and seemed to descend to the horizon. It was almost identical with the first, but fainter.

March 29.—Same as preceding, without second after-glow; tints extended 60° to 70° from horizon.

These after-glows were noticed more or less during April, July, and September, and here in Cambridge during this month there have been several vivid displays. W. G. BROWN

Harvard College, Cambridge, Mass., October 23

I BEG to inclose you an extract from a letter lately received by me from my cousin, Mr. Leeming, in the hope that it may interest some of your readers. ELLEN A. DAY

Greycoat Hospital, Westminster, October 24

Extract from a Letter written by Thomas Leeming, Surgeon and Naturalist on Board H.M.S. "Gulnare," on the Admiralty Survey off Newfoundland

"*Galtois, Hermitage Bay, Newfoundland, September* 12, 1884

"There is one thing I have more than once forgotten to mention to you, that is, an unusual appearance in the sky there has been now for some months, which I think must be connected with the red sunsets of last winter. In the finest weather the sun has always about it a haze (not watery) extending some 20° or 30°, white in the day-time, but as the sun nears the horizon the sky has a pale salmon or ochrey tint. In the immediate neighbourhood of the sun, the sky is of a vivid whiteness. This appearance continues some time after sunset. I have tried more than once to reproduce this effect, with water-colours, but without success. Let me know if you have observed or heard of anything of the same kind. I may also mention that there has been until lately a great scarcity of stars; even on the fairest and darkest nights very few visible under the third magnitude, and the Milky Way scarcely to be seen at all. Things, however, are mending in this respect."

Peculiar Ice Forms

WALKING up from Chamounix to the Montanvert a fortnight ago, I came upon a form of ice which I think can hardly be of common occurrence, as I have not met with any description of it, and have only once before seen it, and then also on the same mountain side, and under similar conditions of season and weather.

The bank, which in this particular spot slopes at an angle of about 45°, and faces the north, is bare of vegetation for some 30 feet in depth, and 100 to 120 feet in length, the hillside above being clothed with moss, ferns, and the usual undergrowth. This bare slope was almost covered with a coating of ice nearly four inches in depth, and of very curious structure, being formed in four layers, the three upper layers each about an inch in depth, and the lowest, which rested on the soil, being from five-eighths to three-quarters of an inch. Each layer was composed of an aggregation of filaments or elongated crystals, one-sixteenth of an inch and downwards in diameter, and all of a length equal to the thickness of the layer, ranged side by side like organ-pipes or basaltic columns, and with pyramidal ends; the bottom points of one layer resting on the top points of the one below, so that the layers could be easily detached one from the other. The whole mass was pierced by vertical cylindrical cavities from half to a quarter of an inch or less in diameter, and in most cases penetrating from top to bottom, so that a pencil-case could be dropped through endways. A horizontal section presented somewhat the appearance of Gruyère cheese, minus the colour of course, and with the solid part showing the crystalline form described above.

The mass had evidently been pushed up from below, because, while the ice itself was perfectly white and colourless, it was covered at the surface by a layer of dirt which might very likely have concealed it from observation if it had not happened to be broken. There was a good deal of snow higher up—nine inches at the Montanvert—and the weather was fine, with bright sunny days and hard frost at night. This particular part of the bank was in shade all day, and hardly thawed at all. I imagine that the porous detritus forming the surface of the bank was underlain by hard rock (though it did not occur to me at the time to ascertain if it was so, and at what depth), and that the water

resulting from the melting by the sun of the snow above had percolated down to the hard substratum, along which it had run till it reached the place where the bare earth above it no longer protected it from radiation, and it then cooled and crystallised in this curious way, pushing itself up by expansion in so doing, each layer being the work of one night's frost. If this is correct, it is not difficult to understand what I assume to be the comparative rarity of this form of ice, since it would be seldom that all the necessary conditions would co-exist.

May I add, as the result of seven seasons' experience, that no one who has not tried it knows the charm of Switzerland in October. It is too late, of course, for high ascents, and the flowers are nearly gone; but an ordinary visitor, so long as he avoids the mists and clouds of the lowlands, by keeping at an elevation of three thousand feet and upwards, will find that the brightness and crispness of the air, the *enjoyableness* of the sunshine (which in August can at best be *tolerated*), the purity of the fresh snow, giving grandeur and beauty to lower heights which in summer are mere barren rocks, and the glory of the autumn colouring, not to mention the freedom from the plagues of heat, flies, and tourists, render October in Switzerland the most enjoyable month of the year. B. WOODD SMITH

Hampstead, October 31

The Blackness of Tropical Man

A DECISIVE paper on the subject would have to be prepared elsewhere, but Hindostan presents an excellent field for amassing information with regard to the effects of an extraordinarily powerful sun on the human frame's exterior. In a very interesting article in NATURE for August 21 last (p. 401), "Why Tropical Man is Black," the cause is set down to the nerves of the skin being one and all highly sensitive to light, the optic nerves being merely some of those of the epidermis highly specialised by long-inherited modification, and the necessity for placing over them a pigment which will absorb light. Otherwise the intense nerve vibrations from a light of double degree power would soon degrade the tissues of the individual and exhaust his vitality.

It would have been all the better if a little more had been said about the way in which a patch of dark pigment cells round the transparent skin of the nerve endings, to be exalted into a special sense, heighten the rates of vibration; or how the selected tissue, at the same time securing the transmission of heat, as the constant accumulation of heat waves behind it, throws the molecular constituents of the protoplasm "into the highest rates of vibration possibly obtainable with the means at disposal."

Before turning to the experience India affords, it has to be noticed that, taking the centre of Europe as the standard of whiteness, it is not only going south that the population becomes successively blacker, but that there is a dark-skinned tendency in the races lying in the other direction, towards the Polar regions. Besides this, exposure in the bright days of August on the moors in the British Isles has the effect of browning the white skin exposed to light, and making it on the face and hands for a short time only a shade lighter than the lightest Indians. This can only be by the solar rays producing pigment in the skin.

On the contrary, the experience of Europeans in India is that the sun there does not burn; if anything, it rather whitens them and pales the complexion. It is only on certain occasions, when the sun is obscured by rain-clouds, it is cool, and the diffused light is of a particular but unascertained actinic quality, that the skin of a European is sunburnt. One may ride all day in the hottest sun and have no trace of sunburning.

Also were light the sole cause of a protection for the skin being required, this would be supplied by the clothing Europeans invariably have, except on hands and face; and they would be placed in about the same favourable position as the natives, if not more so, as those of the latter of the class of labourers prefer working almost entirely without clothes.

What is dreaded by Europeans all over India, and extending into Afghanistan, is the "Indian sun," when it is elevated more than ten or fifteen degrees above the horizon; and it is chiefly the head which it affects, and which has to be protected by non-conducting materials, forming the strange head-gear of the tropics. The playing of the sun on the rest of the body is disagreeable, but not dangerous.

Light and heat are one and the same, so that the nerves of sight are only a select number of those with which the skin is full, higher strung; but it is noticeable that, though heat is felt by any nerves of the skin indiscriminately, they are insensible to minute differences of heat, or in the periods of the heat-rays, so that no sense, so to speak, is conveyed by them. That is—though, as we know, all objects reflect as many heat-rays of different kinds as they do visual rays—we are not conscious of their form by a reception and discrimination of the varying periods of the heat-rays; we do not consciously see by heat.

The effect the Indian sun has on European health, sunstroke being said to be the work of a few minutes, shows that the nerves of the skin are sensitive to some rays besides those of light. In fact, the sun's rays of Hindostan must contain rays not found in the sunlight of most other parts of the world, which moreover penetrate the European's white skin tissues and clothing, while the natives can let it beat upon their bared heads with complete impunity.

There has never been a sufficiently minute comparison made between the pure solar diffraction spectrum, from the lowest lines to the highest, of India and that in other countries, such as Great Britain, America, the West Indies, and Australia. In many respects the West India Islands are as tropical as the East Indies, but those who have resided in the former and coming to the latter declare there is some quality they feel in the Indian sun that is absent in the West Indies; they can wear a simple straw hat in the one place, but could not attempt it anywhere throughout India. If the spectra were juxtaposed, it would no doubt be found that groups of rays in some portion of it, whether at the red or the violet end, were present to a much larger extent in the light of the Indian sun than either in Australia or the West Indies. It is of the greatest importance, in order to clear up this question, as well as to science in general, that those who have the means and time should analyse the spectra and give the results.

The only test available is sensation at present, but this is unmistakable, because, in addition to the burning feel of 140° Fahrenheit, there is a peculiarly unpleasant sensation even in the shade, whether it is that of a tree, an umbrella, a thin tent, or even a walled room with a window, if there is no veranda. This can only come from invisible rays to which all but the thickest coverings are pervious, and which the skin and tissues admit freely.

European "colonists" are, happily for themselves, unknown in India, and the race would immediately die out, as it is only by frequent visits to temperate climates that a European can preserve health. But if they did exist it is open to doubt if a white skin would ever become black. It is commonly supposed that the Black Jins of Cochin are converted Hindoos. The difference that a change in dress and diet makes in these is singular, many being termed Portuguese, for example, who are pure natives descended from converts whom the Portuguese for the most part made forcibly.

As a rule, the higher the caste and the higher in the scale a native of India is, the whiter he is; and the lower the caste and hotter the mean temperature of the place, the blacker. But this is not invariably the case, as the outcasts who work in leather in Upper India are rather lighter than some of the Brahmans. However, latitude has most effect, and wherever the sun is hottest all the year round the blacker the natives, down to the equator of heat shown on the atlases. The configuration of the country, however, shows that the shades of colour are due to successive waves of conquest from the north, and the Northern Asiatics, who were nearly white at first, degenerate the farther south they come, and are unfit for labour. A blackness of skin, therefore, confers an immunity from the effects of the sun, so that those having it can labour in the heat in a way that would soon cause the lighter races to give in.

Black radiates quicker than white, and though black coats are by no means unknown to Europeans in India, who are as often in those as in coats of any other colour, the black skin of the labourer would throw off accumulated heat much more quickly than if white, and perhaps in a ratio worth calculating. This must be one of the reasons; and it may be noticed that the exterior of buildings is frequently tinted a slate colour with this view, in India, instead of being whitewashed.

Still a more ready dissipation of heat is not the only advantage imparted by a pigmentary blackness in the human skin; and it is to be inferred that the real protection consists in there being a few of the invisible solar rays of the spectrum in tropical light injurious to man, which nevertheless possess unusual

penetrative energy, and go through a thickness of what are ordinarily considered opaque substances, but which are intercepted by the contents of the epidermic pigment cells largely developed in the African, a little more sparingly in Hindoos, and not absolutely wanting in the sunburnt excursionist or sportsman in our own country.

The Australian will tell you that he has done hard work—in a shade temperature of 100°—in the sun in a light wideawake and not felt exhausted; while continuous labour of some hours in much less heat—75° in the shade and exposed to the sun—in Hindostan would be simple destruction of the European's powers of exertion with all a Bond Street hatter could devise on his head.

A. T. FRASER

Equator of Heat, India, October 1

The Distribution of Scientific Works Published by the British Government

I HAVE read Dr. Valentine Ball's letter in your journal of October 30 (p. 634) expressing his astonishment that the scientific Reports of the British Government are not presented to the leading American scientific institutions. It may surprise Dr. Ball to learn that the Treasury recently refused to present one of the largest scientific libraries in Dublin with copies of the *Challenger* Reports on the ground that their "free list" was too limited!

G. F. B.

A NEW METHOD OF HEATING IN THE REGENERATIVE GAS FURNACE

DURING the present age, which may be called that of Electricity, the sister science of Heat is not receiving so much attention at the hands of the natural philosopher as it did formerly. But still there remain some scientific men who are giving a life-long attention to it—MM. Hirn and Berthelot in France, Herren Clausius, Helmholtz, and Frederick Siemens in Germany, Mr. Joule and Sir William Thomson in this country. During the late Sir William Siemens's lifetime, the one brother worked here in the science of Heat, the other in Germany, and the work of both was applied everywhere; now Mr. Frederick Siemens works alone, and, from the recent evidence of that work, it promises to play an important part in the economical application of fuel. Mr. F. Siemens has recently had an opportunity given him of bringing his views forward in this country, having read a paper at the Chester meeting of the Iron and Steel Institute on a new method of heating in the regenerative gas furnace, in which he treated the practical side of the question, whilst in the discussion of the same paper he gave his views on the theory of the subject. Mr. F. Siemens's investigations have led him to the conclusion that combustion can only be perfect, and be maintained perfect, if the space in which it takes place is sufficiently large to allow the gases to combine out of contact with solid materials. Having proved by actual experiment that solid substances interfere with the formation of flame and that flame injures solid substances with which it comes in contact, he brings forward an hypothesis to account for the phenomena. According to the electrical hypothesis, which Mr. Siemens prefers, flame is the result of an infinite number of exceedingly minute electrical flashes, the flashes being due to the exceedingly swift motion of gaseous particles, and a solid body which opposes itself to these flashes is cut by them, whilst, the motion being more or less arrested by the solid body, the flame is damped.

Another important deduction from these investigations is that combustion should be considered in two stages or periods, which may be respectively called active and neutral. In the first the purely chemical combination of the gases takes place, during which, as soon as the temperature of ignition has been reached, the whole of the heat of the highest possible intensity is produced, of which a large portion is given off by radiation, whilst in the second the temperature having fallen in the proportion of the heat given off by radiation, the remainder of the heat which is no longer of an active character, is best transmitted by conduction. For the purpose of utilising this portion of the heat, as well as for raising the temperature of the gas and air before combustion, the regenerators are requisite which form an essential feature of all furnaces worked at an intense heat on the Siemens principle, care being taken to design the furnace so that the gases shall have combined perfectly before the products of combustion are allowed to pass away.

Mr. Siemens in applying his investigations to practice insists that flame must not be allowed to impinge upon bodies to be heated, but must simply heat the bodies by radiation, and furnaces must be so constructed as to allow the flame to develop out of contact, not only with the substance on its bed, but with the walls and roof of the furnace itself; it thus follows that large furnaces must replace small ones, and to meet the objection that the loss of heat into the atmosphere must increase in the proportion of the area of the furnace, Mr. Siemens explains that the heat developed in the furnace increases in a much larger ratio than its increase in area, because flame radiates in every direction from every portion of its entire volume, while a solid substance radiates from its external surface only. The details of construction of metallurgical and glass furnaces and of steam-boilers are given in the paper in question, and need not be considered here; the main point is that furnaces heated on the radiation principle have been proved both in Dresden and at Landore to have been economical of fuel, whilst the saving in the materials treated from reduced oxidation and in the construction of the furnace has been found to be very great.

There is another point of view of this important question which is daily demanding and commanding more attention, and that is the abatement of the smoke nuisance. As is well known, smoke is but incomplete combustion, and the only way to get rid of it is not to produce it. Mr. Siemens insists that this can only be effected by not permitting flame to touch any substance whatever so long as it exists in the active condition; for, just as carbon is precipitated upon a glass rod put into an ordinary gas flame, so is it with any flame whatever its temperature; but the greater the difference of temperature between the flame and the body brought into contact with it the greater will be the amount of smoke produced. Mr. Siemens tells how in Dresden he succeeded in extending his works, without the production of smoke, by the application of the system of heating he recommends, and trusts that here also not only may smoke be abated, but that the public may also derive benefit by manufacturers being able to supply goods at cheaper rates owing to being able to economise their fuel and the material heated within the furnaces as well as that of which the furnaces are constructed.

THE PRIME MERIDIAN CONFERENCE

THE greatly extended and ever increasing intercourse, both commercial and scientific, which has grown up between different nations in modern times has naturally caused especial attention to be drawn to the question of assimilation of the different systems of reckoning employed. Weights and measures and money have been already dealt with more or less successfully, but always with steady advance in the direction of unification. More recently, and in like manner because of practical difficulties and inconveniences, unification of the methods of counting longitude and time has in its turn become a question pressing for solution by the establishment of some international agreement in regard to all matters relating thereto.

The subject became first systematically discussed at the Conference of the International Geodetic Association

held at Rome about a year ago, and the recommendations then formulated have since been further considered at a special International Conference recently assembled at Washington, the delegates at which, in some cases scientific men, in others the ambassadors accredited to the United States, were instructed by their respective Governments specially for the settlement of the questions of a prime meridian and universal time. Their final recommendations on the principal points involved are now before the world.

Unlike the related question of weights and measures, that of time becomes to a great extent simplified by the circumstance that no assimilation of units is necessary, since in the reckoning of time there exists one natural unit which already all nations alike employ, that of the solar day, divided in all centres of civilisation into twenty-four hours, each hour into sixty minutes, and each minute into sixty seconds, and reckoned generally from midnight to the midnight following. In the business and concerns of any single centre no anomaly arises, but if we travel to the east or west of our centre, say from Greenwich, we change—not our manner of counting time—not our unit—but only the zero from which we begin to count, that is, midnight in our new position will occur at a different absolute time. Thus midnight at Paris occurs nine minutes of time before midnight at Greenwich, and this difference between the natural time of the two places is their difference of longitude.

The practical navigator carries with him charts on which longitude is marked as reckoned from some particular meridian. Whilst some nations use the Greenwich meridian, others employ that of their own capital city or observatory, so that longitudes become differently reckoned on the charts of different nationalities. This, as regards practical navigation and in many questions of geography, was one inconvenience.

For many years all clocks throughout Great Britain have been regulated to Greenwich time. This causes no appreciable inconvenience in other parts of the country, because, on account of its small extent in the easterly and westerly direction, the natural time at any place (as referred to the sun) differs so little from Greenwich time that no violence is done to our conceptions of morning and evening as referred to the clock, whilst the advantage of having one standard time throughout the country is, in these days, enormous. Similarly the time of Paris is used in France, and so on. In the United States of America a more natural division into sections has been made, each having its own standard time, about which we shall have more to say further on. The standard time thus used throughout each particular country or section of country, whilst satisfying entirely internal needs, fails, on account of the difference existing between the standard times of adjacent countries, to meet international requirements, not only in questions of scientific interest, but also in matters commercial. The standard time counted in any district must continue to regulate its civil affairs, but for the efficient control of those of international concern, such as the railway, telegraphic, postal, and steamship services, an extension of the same principle to the whole globe by the establishment of some system of universal time, for use in conjunction with local standard time, became very desirable, for although such universal time could not be suitably employed in the ordinary way, the importance of its adoption in matters of international interest had become abundantly apparent. One other point. In civil affairs the day is counted from midnight, whilst astronomers count from the noon following, rendering troublesome conversions from one system to the other frequently necessary. These were other questions requiring consideration.

Clearly therefore the time had come for promoting a better understanding on points of this kind. The recommendations of the Roman Conference briefly stated were, that the initial meridian should be that of Greenwich, corresponding to the point midway between the piers of the Greenwich meridian circle, since such meridian fulfilled all the requirements of science, being already that most used and best likely to be generally accepted; also that longitude should be counted from the meridian of Greenwich in one direction only, from west to east, that is to say, the longitude of Berlin would be oh. 54m., and that of Dublin 23h. 35m. The Conference further recommended, for purposes for which universal time would be convenient, that the universal day should commence at mean noon of Greenwich time, and be counted from oh. to 24h., as was proposed in America in the year 1879 by Sandford Fleming and Cleveland Abbe, a proposition which had received the support also of well-known astronomers. It may be added that a proposition to assimilate the astronomical day with the civil day, and adopt it as the universal day, being scantily supported, was lost.

So far as regards the Roman Conference. Their proposals served to indicate the points requiring consideration, so that, attention having been thus directed to the whole question during the year since elapsed, the delegates attending the recent Washington Conference had full opportunity of forming deliberate opinion thereon. We are not yet in possession of the full discussions of the Conference, but we know their decision on all essential points. The recommendation of the Roman Conference that the meridian of Greenwich should be the universal prime meridian was confirmed. But on the question of reckoning longitude the Conference resolved that it should be counted from Greenwich in two directions up to 180°, the east longitude to be *plus*, and the west longitude *minus*, in this particular departing from the recommendation of the Roman Conference. The Washington Conference also disagreed with the resolution of the Roman Conference in regard to universal time, declaring the universal day to be the mean solar day to commence for all the world at the moment of mean midnight of the initial meridian, coinciding with the beginning of the civil day, and to be counted from oh. up to 24h., a proposition which, as already mentioned, had been debated at the Roman Conference. Protocols were approved which will be made the basis of an international convention fixing Greenwich as the prime meridian.

Practically, therefore, the recommendations are :—

(1) That the prime meridian be that of Greenwich.

(2) That longitude be counted from this meridian in two directions up to 180°, calling east longitude *plus* and west longitude *minus*.

(3) That the universal day be the Greenwich civil day, commencing at midnight and reckoning from oh. up to 24h.

After full discussion at two Conferences we may believe that, regarding scientific requirements on the one hand and practical considerations on the other, the conclusions arrived at are the best which, under the circumstances, were possible. We may now proceed to consider in various ways their practical bearing.

First, as affecting matters nautical and geographical. By the adoption of Greenwich as the prime meridian (which, if that of any one place were to be selected, was clearly from its extensive use the one which had by far the strongest claim to consideration), and by the retention of the system of counting longitude east and west up to 180°, all British maps and charts (already extensively used by most other nations) and all tables of longitude as hitherto prepared remain still in harmony with the recommendations of the Washington Conference. And since foreign nations thus so largely use charts which refer to Greenwich, the use of this meridian is likely in time to become universal. This being so, some labour of calculation might also be saved, for, considering that large portions of the existing astronomical and nautical

ephemerides of different countries are prepared mainly for the purposes of navigation, and that these ephemerides are calculated generally for different meridians, should charts on which longitude from Greenwich only is counted come into universal use, such separate calculation would become unnecessary. A certain uniformity has already been arrived at, our own *Nautical Almanac*, the American *Ephemeris*, and the German *Nautical Almanac* being all alike calculated for the Greenwich meridian, with the result, however, that now a mass of information for navigators—practically identical information—is repeated in three separate works. This hardly saves labour, and it seems not unreasonable to suppose, as regards the needs of navigators, that one book might in some way be made to serve for all.

It may be remarked that the counting of longitude in both directions up to 180° instead of continuously from 0° to 360° has, as regards navigation, advantages. Because, when counted in both directions, a navigator or traveller, in journeying round the world and changing his reckoning of longitude from east to west, or from west to east, as the case may be, at the same time that he makes the change of one day in his date (of course somewhere near the 180th degree of longitude) will always correctly produce the Greenwich date, necessary when the *Nautical Almanac* has to be referred to, by simple combination of his local time and longitude, whereas if longitude be reckoned from oh. to 24h., and the navigator makes, as before, the change of one day in his date in the usual way at or near the 180th degree of longitude, which he must do if his date is to be in harmony with that of the countries which he will next approach (America if voyaging east, Australia if voyaging west) it will be necessary, when between longitude oh. and 12h. west, after subtracting the longitude (always east) from the local time, to further add one day, in order to produce the correct Greenwich date. It will be understood that a chronometer, though showing Greenwich time, does not indicate the *day*, only hours and minutes, &c., so that a voyager has to depend for the correct Greenwich date on his own numeration of days and a proper consideration of his longitude.

Then as regards the question of universal time, first in relation to our own country. Greenwich mean solar time, or Greenwich time reckoning from midnight and counting from oh. to 24h., being adopted as the international universal time, is such as is shown on all railway clocks throughout Great Britain, excepting that the railway clocks require twelve hours to be added to their indications during the afternoon hours, that is, 1h. railway time is 13h. universal time, and so on. Thus the time of any circumstance or phenomenon occurring in Great Britain will be properly given in universal time by dropping the suffix a.m. or p.m., and in the afternoon adding twelve hours. October 20, 9h. a.m., and October 20, 3h. p.m., become in universal time October 20, 9h., and October 20, 15h. But independently of this the counting of hours from oh. to 24h. is desirable also in civil affairs generally as being in itself explicit, and rendering unnecessary the distinguishing a.m. and p.m. If clocks, when convenient, were constructed so as to indicate hours in this way, instead of counting from oh. to 12h. twice over, it would tend to familiarise people with the 24-hour system without at all forcing its use; or the division into twelve might be retained in clocks and watches, and two sets of hour figures engraved. The use of the system will, however, extend on account of various practical advantages. The plan could be introduced with benefit into railway time-tables, especially those dealing with long routes, in which the distinction between morning and afternoon is far from explicit. Morning hours would be 0, 1, 2, &c., afternoon hours 12, 13, 14, &c.

In other countries in which, as in England, the standard time employed is that of some one city or observatory, such time similarly reckoned from midnight, and counted from oh. to 24h., would be used for all internal affairs. But to give the epoch of any occurrence in universal time it would be necessary to subtract from the time noted the longitude east from Greenwich of the city or observatory whose time is used, or add thereto the longitude west.

Whilst it is absolutely necessary for the regulation of the internal affairs of a country that the time of one meridian should be employed throughout, as in Great Britain, it is also important that the time so used should not be violently out of joint as it were with the natural day. In our diminutive Great Britain no inconvenience arises, as has been mentioned; but in America, owing to the vast extent of the country in an easterly and westerly direction, it becomes necessary to make some arbitrary division. The railway companies of Canada and the United States, for regulation of the time on railways, have solved the difficulty in the following way:—Four different meridians being selected, those of 5, 6, 7, and 8 hours west of Greenwich, four separate districts are created, in each of which the time of one of these meridians is employed. By this means a great step in the unification of time has been made, because on this plan the minutes and seconds in each district are the same as the minutes and seconds of Greenwich time, and also therefore of universal time, the actual universal time in each district being at once found if required by simply adding 5, 6, 7, or 8 hours respectively to the local standard time.

But it may be asked, if the surface of the earth be divided into districts counting in each, for use in civil affairs, the time of some particular place or meridian contained therein, what is the particular need of universal time? The question has been already touched upon; but let us illustrate. A telegram received at a telegraph office in India in the afternoon for transmission to London would arrive in the morning, according to the local time reckoned at these places. Is there nothing here that for some considerations it might not be desirable to arrange differently? Would it not be useful to have the power of indicating universal time in conjunction with local time, if necessary? And so also in other affairs. And in matters of science, especially the observational sciences, the introduction of universal time for use when required would be in many ways beneficial. When an astronomer has gathered together for discussion a long series of observations of, say, a new comet, made perhaps at many different observatories, one of the first things that he has to do is to reduce the times of observation to that of one meridian. Again, observations of solar and other physical phenomena cannot be properly collated unless the times are reduced to one standard. Or, in magnetism, on the occurrence of a great magnetic storm, how much would the comparison of the records obtained at different places be here also facilitated by the use of universal time?

There might be some disinclination as regards fixed observatories to give results in universal time, because of the fractional difference of longitude. But in civil affairs, admitting the practicability of adopting the system inaugurated in America, of forming districts and employing as local standards of time secondary meridians distant from Greenwich by integral numbers of hours, as before described, the indication of universal time in conjunction with local standard time becomes a matter of great simplicity. Objection may be made to the system because of the variation, amounting to half an hour, which would exist, between the natural day and the clock time employed, at the extreme borders of the districts so formed, but the Greenwich time long used in Cornwall differs (without reckoning the effect of the equation of time) twenty-three minutes from the natural time without inconvenience arising. Indeed, taken in conjunction with what has been done at the Washington Conference, the

scheme is, outside of the Conference, the first really scientific step that has been taken in the practical unification of time throughout the world. Whether the number of meridians might be doubled is perhaps a question, but, as it stands, the scheme is extremely simple. For since the minutes and seconds counted in the several districts are the same as the minutes and seconds of Greenwich or universal time, the mere addition of another hour hand to the clocks in common use, placed in the proper position and travelling with the ordinary hour hand, would enable either local standard time or universal time to be read off at pleasure from the one clock. The ordinary hour and minute hands might be black and the additional hour hand of a lighter colour, in which way sufficient distinction would be produced. Such clocks should show hours from oh. to 24h. Or the conversion might be made in other ways. Referring to the American division before described, all entries might be distinguished as "local standard time," and a precept added to indicate that, to obtain universal time, 5, 6, 7, or 8 hours must be added, as the case may be. Or denoting the times as "standard times on the 5th meridian west," &c., the variation from universal time is at once shown. The reader will probably now have grasped the special merit of this system, the readiness with which either local time or universal time can be together indicated.

It may be interesting to show how the American plan of division into districts defined by hourly meridians would work if applied generally to the countries of the world. A scheme in regard to some of these countries is herewith annexed.

Countries	Longitude from Greenwich of meridian to be employed for local standard time	Local time at which universal date changes
Great Britain, France, and Spain	oh.	Midnight
Norway, Sweden, Germany, Austria, and Italy	1h. east ...	1h. morning
Western Russia, Turkey, and Egypt	2h. ,, ...	2h. ,,
Western India	5h. ,, ...	5h. ,,
Eastern India	6h. ,, ...	6h. ,,
Western Australia	8h. ,, ...	8h. ,,
South Australia	9h. ,, ...	9h. ,,
Victoria, New South Wales, and Queensland	10h. ,, ...	10h. ,,
New Zealand	12h. ,, ...	Noon
California	8h. west ...	4h. evening
Eastern America (Washington)	5h. ,, ...	7h. ,,

In east longitude decrease, and in west longitude increase, the local standard time by the hours of longitude to obtain universal time.

The scheme in fact resolves itself into adopting in any country the time of the nearest integral hourly meridian. Russia would become divided in some such way as America. In each case the minutes and seconds of local standard time would be similar to those of Greenwich or universal time, change of the hour, according to the precept given at the foot of the table, converting the local standard time at once into universal time. We are quite aware that a scheme of this kind can scarcely be expected yet to take practical shape, but it seems well to point out generally the direction in which with the least inconvenience a satisfactory solution of the problem of counting universal time in conjunction with local time may be possible.

The right hand column of the preceding table indicates, in regard to the universal day proposed by the Conference, the hour of the local civil day at which, in the several districts, the universal date would change, the civil date of course changing at midnight. It will be remarked that in all countries in east longitude as far as Australia, the change of universal date (following that of the same civil date) takes place generally in the morning hours, before the business hours of the civil day, the universal and civil dates being then in accord until civil midnight. In America the universal and civil dates are in accord from civil midnight until towards the next evening when the universal date changes (before change of the same civil date). In all these cases the change of universal date occurs at an hour well away from business hours. Only in New Zealand would there be inconvenience, the change of universal date occurring at civil noon, twelve hours after change of the same civil date. Knowing approximately the local time at which the universal date changes, a clock fitted with an additional hour hand in the way described would indicate at once the precise time of change.

The resolution of the Washington Conference further expresses a hope that as soon as practicable astronomical and nautical days may be arranged everywhere to begin at mean midnight, which would simplify any desired conversion into the proposed universal time. Passing by the nautical aspect of the question we may remark, that astronomers as a rule count their mean solar day of twenty-four hours from noon, commencing twelve hours later than the civil day of the same date, and the day is thus understood in all published observations and astronomical works. There is another consideration, somewhat fanciful perhaps, that astronomical observations being taken mostly at night it seems objectionable to make a change of date at midnight in the middle of a series of observations; but this carries now with it much less weight since attention to solar phenomena has so increased observation by day. It was perhaps felt at the Conference that the local civil and astronomical days should correspond as a matter of convenience in itself, and as simplifying the relation of both with the proposed universal day, thus promoting the use of the latter as might become convenient, either in civil or scientific affairs. To effect such correspondence, one of the days had to be altered, but since any proposition to change the local civil date at noon could not be seriously entertained, it was better that the astronomer should assimilate his day with the civil day. Indeed it was formerly the practice in France to employ the astronomical day, commencing at midnight, in the construction of planetary and lunar tables.

The proposed change in the time of commencement of the local astronomical day will involve some present awkwardness from the circumstance that the different astronomical ephemerides are calculated for astronomical time as hitherto reckoned, in addition to which our own *Nautical Almanac* is prepared several years in advance. Temporary inconvenience more or less there must be, but the new reckoning, when fully established, will be found to possess some distinct advantages. As concerns the Royal Observatory at Greenwich, the Astronomer-Royal proposes to adopt the recommendation of the Washington Conference by commencing on January 1 of next year to count the astronomical day from the midnight preceding the nominal civil date, thus bringing the Greenwich astronomical day into correspondence with the Greenwich civil day, which is the universal day of the Conference; he proposes further to alter the indication of the public clock at the entrance gate of the Observatory, so that oh. of the clock shall also commence with midnight: all being counted from oh. to 24h. The time reckoned within the Observatory and that shown on its external wall will then be in accord. So far the astronomer. If, in addition, the civilian would relinquish the use of the confusing a.m. and p.m., and instead count the hours also from oh. to 24h., beginning with midnight, all parties would then be using the same system for reckoning both days and hours of the day.

WILLIAM ELLIS

THE ILLUMINATED FOUNTAINS AT THE HEALTHERIES

NOW that the most successful of International Exhibitions has been closed, we are able to give the final result of the accumulated experience that has been obtained in connection with the working of the illuminated fountains, which excited unqualified admiration. Even on the last night we believe new experiments were tried, and next season these fountains are likely to be finer than ever.

"I wonder how it is done?" This was one of the remarks most frequently heard in the dense crowd which nightly surrounded the large fountain at the Health Exhibition, watching the many party-coloured jets of water as they rose and fell with an ever-varying combination of brilliant hues. It is believed that an account of the means employed to produce these gorgeous and novel effects, and of the way in which the water and lights were managed, cannot fail to interest our readers.

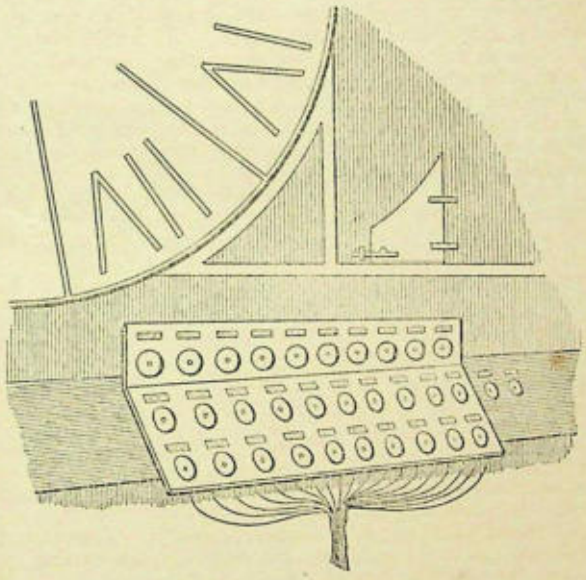
The water-supply is obtained from the West Middlesex Water Company by means of a nine-inch main, which is connected to one of their mains in Kensington Gore. As the water is paid for according to quantity used, it has to be measured, and in order to effect this with as little loss of pressure as possible, the water is passed through three eight-inch Tyler meters, which are to be seen at the north-west corner of the grounds in the vicinity of the fountains. These meters are connected at each end by a four-way junction piece to the nine-inch main, and they were afterwards supplemented by a twelve-inch one on a separate branch. From the four meters the main passes under the water into the central chamber in the basin, and it there branches into three pipes, two of nine inches diameter, and one of six inches. The two nine-inch pipes go round the two sides of the chamber, which is twenty feet square, and are connected together at the opposite side, thus forming a loop round the chamber. Off this main are taken the supplies to the four rings of jets in the basin, and also for the jets on the top of the chamber, each ring having two supplies at opposite sides in order to equalise the pressure. The third branch, which is in direct continuation of the main from the meters, is gradually reduced to three inches, and supplies the centre jet only.

All the supplies are furnished with screw valves worked by hand wheels. The jets on the top of the chamber consist of the centre jet and four other jets placed at the four corners; each of these jets is surrounded by a ring of twelve small jets, and there are also four dome and convolvulus jets placed between the corner jets. The supply to the four corner-jets is controlled by a plug-valve, so that they can be rapidly turned on and off. It is by this means that the jumping of the centre-jet is produced, the momentum of the water flowing through these jets being sufficient, on the sudden closing of the valve, to jerk the centre jet thirty feet higher than the point which it reaches from the pressure of the mains alone.

In order to light up the various jets on the top of the chamber, five circular sheets of glass two feet in diameter are let into the flat roof of the chamber, one under each jet. The pipes leading to these jets go through the roof close to the edge of the glass, and are then bent over it and upwards again, so as to bring the jet itself exactly over the centre, and it is under these panes that the lighting apparatus is placed. This consists of a simple bracket lamp with rack and pinion worked by hand for feeding the carbons, and a third-order holophote lens twenty-two inches in diameter. The carbons are placed at an angle of about 20° with the horizon, and the bottom carbon is the positive one, in order to have the crater turned upwards. The axis of the top carbon is also slightly above that of the lower one, although parallel to it. The carbons are eighteen millimetres in diameter, and the current is about sixty amperes. The five lamps are connected in parallel. Each lamp is inclosed in a case to protect the men from the light. Above each holophote is placed a frame with five grooves, in which run five frames containing the different coloured glasses by which the various colours are produced.

When first erected the jets were provided with glass bottoms, and a small lens was placed above the holophote so as to concentrate the centre portion of the ray on the interior of the rising column of water. It was however found that this arrangement considerably reduced the height of the jet, on account of the eddies produced in the chamber at the bottom of the jet, and also diminished the amount of light thrown on the spray, and it was therefore abandoned.

The principle of interior lighting of a stream of water was applied to three jets from the top of the Corinthian columns erected on each side of the statue of the late Prince Consort, and for this purpose two two-inch pipes were taken up each column, and connected with a cistern from which issue three jets, each illuminated from behind



by an electric lamp with twelve-millimetre carbons and twenty-ampere current. These lamps are in parallel arc on the same circuit as the large lamps in the centre chamber, suitable resistances being inserted. It was found that the two supplies provided did not allow of a column of water of sufficient diameter being thrown from each jet to prevent its being broken up by the wind, and as it was impossible to increase the supply while the Exhibition was open, these effects were rarely used. The current for these eleven lamps, amounting to 420 amperes, is generated by a compound shunt-wound Siemens B_2 machine placed in the electric light shed. The armature of this machine is built up of copper strips with spaces between, and is thus especially adapted for the work it has to do, which at times is very severe, as, the lamps being hand-fed, the arc is not struck as rapidly as in an automatic lamp, and the machine is therefore short-circuited for an appreciable space of time on starting or relighting any lamp. The electromotive force at the machine is eighty-four volts. From the machine the current is conveyed to the small hut near the meters by two well-insulated cables of nineteen strands of No. 12 copper wire, and from the hut it is distributed to the island lamps by an insulated cable of nineteen No. 10 wires

inclosed in a lead pipe, and to the columns by two cables of seven strands of No. 12. A separate return cable runs from each lamp to the hut, where it is connected to the necessary resistances, made of strip iron, and from there back to the dynamo through two cables of nineteen No. 12's. There is altogether very nearly a ton of copper in the various leads and branches. Besides these leads the centre chamber is connected to the circuit of the Sun light machine, so that, should any accident occur to the main circuit or machine, Sun lights could be substituted for the hand lamps.

As the falling spray cuts off the light from below when the jets are at their highest, a light is placed in the top of the clock tower to illuminate the top of the jets. This light is a focus-keeping Siemens automatic lamp, and takes a current of fifty amperes, supplied by a small Crompton-Burgin machine. The lamp is inclosed in a cast-iron casing swung on trunnions, and in front of it is a fifth-order holophotal lens by Messrs. Siemens.

The various coloured glasses are fixed in frames or sashes arranged with counterweights, in the same way as an ordinary window. Some of the best effects of colour are also obtained by sheets of gelatine, of which a large number are fastened end to end, and fixed to two rollers, so that they can be wound from the one to the other, and thus passed through the beam of light.

As the men in the centre chamber cannot see the effects they produce, it is necessary to direct them from the outside, and this is effected by an elaborate system of electric bells and disks, which are worked from the clock chamber below the last-described holophote. In this chamber sits Sir Francis Bolton, with a treble row of "pushes" in front of him, all labelled, by touching any of which a corresponding disk or bell is worked in the island. There are four bells—a call bell, an "on" bell, an "off" bell, and a lamp bell—and two indicator boards with eight disks each, and one with four. One board is for the water valves, which are each painted a different colour, with the corresponding colour on the disk, and the second board for the coloured glasses over the holophotes. The disks on the small board refer to the corner lamps, and by their means Sir Francis can direct any colour to be placed over any one of the lamps by touching the push corresponding to the lamp and the push marked with the colour which he wishes to show. The working of the holophote at the top of the clock is directed in the same way.

EXPERIMENTS WITH COAL-DUST AT NEUNKIRCHEN IN GERMANY

DURING the course of the last summer the Royal Prussian Fire-damp Commission has carried out a series of experiments in the Saarbrücken mining district with the view of ascertaining the influence which coal-dust has, alone and in conjunction with fire-damp, in propagating explosions in mines. The apparatus and the mode of experiment were suggested by retired Bergwerks-director and Bergassessor Hilt, of Aix-la-Chapelle, who is a member of the Commission, and the results hitherto obtained have been of the most interesting kind.

The experiments are conducted at the Royal Coal-Mine, König, near Neunkirchen, where there is a blower of fire-damp at a depth of 131 yards below the surface. The quantity of fire-damp given off by this blower amounts to about 0·9 cubic foot per minute, consisting of 86 per cent. of light carburetted hydrogen mixed with air, &c. It has been in existence for the last two years. The fire-damp is brought a distance of 1200 yards in pipes, and collected in a small gasometer whose capacity is 176 cubic feet.

Dr. Ad. Gurlt of Bonn lately called my attention to the fact that over two hundred experiments made with this apparatus on a large scale had proved the correctness of my theory of great colliery explosions (*Proc. Roy. Soc.*, vol. xxiv. p. 354, &c.), and at the same time suggested that a visit to Neunkirchen would be of interest.

Accordingly I proceeded to the scene of the experiments on October 25, accompanied by Mr. Wm. Thomas Lewis, one of the members of the Royal Commission on Accidents in Mines, and we were met there by Dr. Gurlt, who had travelled from Bonn for the purpose, and by Herren Prietze, Nasse, Margraf, and Kreuser, directors and assistant-directors of König Grube and other Royal mines of the neighbourhood. Herr Margraf, under whose superintendence all the experiments are and have been made, has most kindly furnished me with a detailed description of the apparatus and of the experiments witnessed by Mr. Lewis and myself, and I am glad to avail myself of, and shall endeavour to reproduce, his account as nearly as may be, allowance being made for the difficulties of exact translation.

The experiments are made in a horizontal wooden gallery 167 feet long, closed at one end, and having a horizontal branch gallery 33 feet long standing out at right angles to it at a distance of 93 feet from its closed end. Both the main gallery and the branch consist of elliptical rings of double T-iron lined internally with planks 1·6 inch thick, which abut closely together and are grooved and feather-jointed lengthwise. The greater axis of the ellipse stands vertically, and is about 5 feet 7 inches long; the lesser axis is 3 feet 11 inches long. The main and branch galleries are both embedded in the pit-heap to such a depth that the rubbish is level with their top on one side and reaches to three-quarters of their height on the other side. Along the exposed part of the latter side there is a row of windows, thirty-two, in the main gallery, and three in the branch gallery, situated somewhat more than a yard apart. They are formed of sheets of glass about $\frac{3}{8}$ inch thick set in cast-iron frames. There are also a number of openings in the top of the main gallery, one of which, near the closed end, is an ordinary man-hole, which can be closed by a man-hole door like that of a boiler, and serves as a means of ingress and egress. The others are circular, about 9 inches in diameter, and are lightly closed with wooden plugs attached to chains, which act as safety valves. All these openings assist in the removal of after-damp after an explosion.

The closed end of the main gallery is sunk about 3 feet 9 inches into a block of masonry whose dimensions are 12 feet 4 inches long, 9 feet 9 inches wide, and 13 feet high. Seven cast-iron cannon, with a bore similar to that of a shot-hole in hard ground, are built into the block in the position shown in the figure opposite, so that their mouths are flush with the face.

There are two holes near the top, two near the bottom, and three in the middle, grouped symmetrically in relation to the two axes of the ellipse. The middle hole is 37 inches deep by 1·57 inch in diameter; the others are 31½ inches deep by 1·37 inch in diameter. The axes of the two upper and of the two lower holes are placed in such a position that they form the angles of a four-sided regular prism whose apex is situated in the axis of the main gallery at a distance of 16·4 feet from the face. The axes of the three middle holes constitute a bundle of rays which meet at the same point as the last. Wooden hoops projecting inwards from the sides are placed at various distances apart in the main gallery within the first 65½ feet from the face. By fastening cloth diaphragms to these hoops, compartments of various capacity can be formed, that of the first next the face being 705 cubic feet.

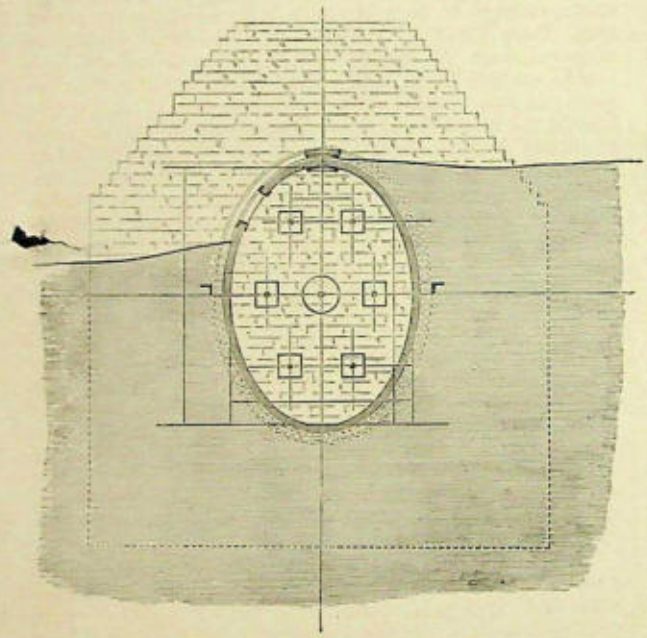
The shots are fired electrically with Abegg's fuses by means of an exploder made by Mahler and Eschenbacher of Vienna. The charge, which consists of 230 grammes, or about half a pound, of powder, occupies a length of 8·64 inches in the central hole, leaving room for rather

over 28 inches of stemming, and 11 inches in the other holes, leaving about 20 inches for stemming.

The coal-dust is strewn upon the floor of the gallery from the face towards the open end in a layer of about 1·17 inch thick immediately before firing the shots. The weight of dust in each ten yards of length is about thirty pounds. It has been found in practice that, notwithstanding the upward direction of their axes, the shots next the floor produce the greatest disturbance of the coal-dust and give rise to longer coal-dust flames than any of the others.

In all the experiments witnessed by Mr. Lewis and myself, *one shot-hole only*, namely, one of the two next the floor, was charged and fired. The charge consisted of 230 grammes of blasting-powder each time, and the tamping was damp clay. Both ends of the branch gallery were closed with a double board brattice 1·96 inch thick.

In the first experiment neither coal-dust nor fire-damp was employed, and the flame of the shot was seen through the windows to be a little over 13 feet long.



In the second experiment a length of 65 feet of the floor of the main gallery was strewn with coal-dust from Camphausen Colliery in the Saarbrücken mining district. The shot gave rise to a loud detonation, and the resulting flame filled the gallery to a distance of 88½ feet. When the thick black after-damp had been drawn off by means of two of Korting's exhausters, placed over two of the safety-holes and worked with compressed air, it was found that the inner brattice of the branch gallery had been broken, and small globules of coke were observed lying on the surface of the remaining coal-dust.

In the third experiment a length of 130 feet of the floor of the main gallery was strewn with coal-dust from Pluto Mine in Westphalia. When the shot was fired, the flame traversed the whole length of the gallery with great velocity, and came out at the open end to a distance of 16 feet, being thus altogether 183 feet long. Notwithstanding the entire absence of fire-damp, this was a true explosion of the most violent kind, and the clouds of after-damp which streamed from every opening darkened the air in the neighbourhood of the gallery for two or three minutes. The brattice at the inner end of the branch gallery had not been replaced before this experiment, and the one at its outer end was broken into small fragments, some of which were thrown to a distance of 115 feet. The flame was also seen to emerge from the branch gallery to a distance of several yards. The coal-dust remaining on the floor after the explosion was covered with a sooty film, in which coke globules were found embedded.

The brattice at both ends of the branch gallery was now replaced, and the floor of the main gallery swept clean as usual. In the fourth and last experiment coal-dust from Pluto Mine was strewn on the floor for a distance of 65 feet from the face. A diaphragm of prepared canvas was fastened in the gallery at the point where the space inclosed between itself and the face amounts to 705 cubic feet.

A volume of 35¼ cubic feet of fire-damp was introduced into this space, and complete diffusion was effected by beating the air with cloths. The mixture of fire-damp and air thus obtained is not inflammable or explosive by itself, and shows a cap of only $1\frac{5}{16}$ inch high on the reduced flame of a safety-lamp. The firing of the shot produced a flame 190 feet long, accompanied by a report like a thunder-clap. The inner brattice of the branch gallery was broken, and drawn several yards into the main gallery, but the outer one remained intact.

Some idea of the great force of the two last explosions may be gathered from the following facts:—An ordinary mine railway, beginning on a level with the floor of the main gallery, extends away from its open end in the direction of its length, and ascending at an angle of 4°. An ordinary mine waggon, loaded with iron so as to weigh altogether 15½ cwt., was standing on the rails at the mouth of the main gallery when the shots were fired. When the third shot was fired, it was driven up along the rails to a distance of 23 feet, and when the fourth shot was fired, it was literally hurled along the railway by the force of the explosion to a distance of 52½ feet, being driven off the rails and running on the ground for the last six feet. The boards constituting the end of this waggon next the gallery were broken, but not torn off. A small beam 4 inches square, bolted across the rails at the mouth of the gallery, so as to form a stop for the waggon, was torn from the bolts which held it, and sent flying after the train. Lastly, a shower of stones and debris was raised by the blast which swept out of the mouth of the gallery, and some of the pieces carried upwards of 100 feet.

The foregoing facts appear to me to be well worthy of the attention of all who have any interest in the prevention of explosions in mines. W. GALLOWAY

FLOWERS OUT OF SEASON

THE untimely flowering of trees and shrubs, like the occurrence of the extraordinary gooseberry, is a subject which crops up at such regular intervals as almost to belie the epithet applied to it. Nevertheless, the very frequency of the comment is an indication that the matter is ill understood.

The ordinary time-rate for the production of new cells, new leaves, new flowers, and so on, varies as we see within wide limits. Equally obviously those limitations are imposed by the conjoint effects of inheritance and of external conditions, such as climate or food, or both. An annual plant rushes through its life in hot haste as it were: save and except in the seeds of such plants there is comparatively little building up or maturing of new tissues to be done, and proportionately still less stores of potential food to be accumulated. If, on the one hand, the requirements of such plants are less than in the case of perennials, their exigencies are, on the other hand, more pressing. What they take from the soil, or atmosphere, what power they derive from solar light and heat, must be got quickly or not at all. One illustration of this is afforded by the paucity of annual species in the Arctic regions or at high altitudes. Neither heat nor light is absolutely deficient in such situa-

tions, but the length of time during which they are available is too short to allow annuals to profit by a sufficiently large aggregate to enable them to mature their seeds. Before they can accomplish their purpose, they are overtaken by frost and their activity is put a stop to. The energy of perennials, it is true, may be checked in the same manner, but they have been enabled, before the evil day arrived, to lay up stores of nutriment available for use when the increasing heat and light of the following year shall once more quicken their activity. The work to be done is spread over two or more seasons instead of one, and the chances of success are thus correspondingly enhanced. But if we suppose the conditions to be uniformly and continuously favourable, the abrupt cessation of growth will no longer be manifest, the annual will cease to be an annual, the perennial will not die down in winter, the growing points of the buds will not incase themselves in scales, vegetation will be continuous. Such halcyon conditions find their nearest realisation in moist equatorial climates like that of the Malay peninsula and adjacent islands. But even there the realisation is not perfect. Something happens to disturb the balance; and even if the conditions are generally uniform there is always the idiosyncrasy of individual plants to form a disturbing factor. Again, such conditions, though favourable to the continuance of vegetation, are less propitious to the establishment of fructification. The formation of stem, leaf, flower, even of fruit, is one thing, the maturation of the seed and of the embryo-plant within it is another; and the conditions propitious to either are correspondingly different. The ripe seed makes in proportion larger demands on the plastic matters formed as a result of metabolism, and has almost invariably the same composition according to its species, but this cannot be said with equal truth of any other part of the plant.

Again, the conditions for growth, that is, mere increase in bulk, are different, in degree at least, from those which favour progressive development or metamorphosis. Speaking in general terms, it may be said that vegetation approaches its end where fructification shows signs of commencement. There is indeed no fixed line of demarcation to be drawn, but while morphologically there are gradations and intermediate forms, physiologically there are also transitions, and periods of instability. It is easy to understand how this happens, and how it is the divergences are not greater. These matters indeed partake so much of the nature of truisms, that some apology might almost be needed for insisting on them, were it not that they are absolutely essential for the due comprehension of the phenomena of untimely blooming.

It is also desirable to draw attention to the fact that there is naturally a wide range in the period during which vital activity manifests itself even in individuals of the same species, and as these individuals vary in colour, stature, &c., even when derived from the same stock, so others may vary in their "time-rates." This is specially noticeable in the case of the horse-chestnut, and is perhaps more often manifest in the form of precocious development in spring than in that of tardy growth in autumn. In most cases the plant has to attain a certain age before it produces flowers, but occasionally we find individuals so precocious that they are scarce out of the seed before they burst into flower. A cocoa-nut has thus been seen in flower while the husk of the fruit was still attached to it. Gardeners, according to their requirements, have freely availed themselves of these individual differences by selecting for perpetuation late or early varieties. The whole subject of the "chronometry of life," it may here be mentioned, formed the text of a valuable lecture by Sir James Paget, at the Royal Institution, many years ago.

Cases of unseasonable blossoming may be ranged under three heads, according as growth and development are: (1) prolonged beyond the ordinary time; (2) premature or manifested aforetime; (3) renewed after a short interval of arrest. Categories (2) and (3) differ in detail rather than in essence, as will be explained further on.

Taking the cases of continuous or prolonged growth first, it is easy to see that many of them are due to a continuance of favourable conditions. A long spell of summer without excessive heat or drought will insure a longer period of blooming; flower will succeed to flower so long as the weather and the natural changes in the tissues of the plant, according to age, are held in abeyance. How small are the exigencies of some plants in these matters may be illustrated by the fact that there are few days in the year when a daisy or a white deadnettle may not be found in bloom, at least in the southern half of England. It is necessary, however, to introduce some qualification, because one has only to look into one's garden to see that in spite of apparently favourable conditions many plants are not to be induced to continue blooming. Although in duration perennial, in the matter of flowering they behave as annuals. Something in their organisation forbids the prolongation of the blooming period. That this is so is at least rendered highly probable by the circumstance that the same reticence is exhibited under cultivation. As an illustration of an opposite character, may be mentioned the prolongation of the blooming period even under relatively adverse circumstances which has been brought about by the art and selection exercised by the gardener. Take roses, for instance, only one of many that might be cited. Our fathers had to be content with what we now call summer roses, roses of great beauty and exquisite fragrance, but which they must have wept to see "haste away so soon." Nowadays, the case is very different, there is a whole legion of so-called "hybrid perpetuals" marked in the catalogues of the nurserymen as H.P. By their agency a second crop of roses is assured, while some will continue in favourable seasons to expand their blooms in succession up to Christmas. This prolongation of the flowering season has been brought about by combining by means of hybridisation the robust qualities of European roses with the continuous blooming tendencies of the Indian rose. Many varieties of pear, the common laburnum, the Wistaria, Weigela, the hybrid *Berberis stenophylla*, some rhododendrons, currants (*Ribes*), exhibit this phenomenon, the flowers being produced on the ends of more or less prolonged shoots, as strawberries under like circumstances produce their flowers on the ends of the "runners" of the year.

The premature development of flowers in autumn has a better title to be called unseasonable, because the phenomenon is really due to the unfolding of flowers which, under ordinary circumstances, would remain passive till the following spring. There is not, as in the former case, a new formation or a continuous growth, but merely what the French appropriately call *fleuraison anticipée*. And here for a moment it may be allowable to call attention to an essay of Linnæus entitled *Prolepsis Plantarum*, little read nowadays, although based on facts, and containing much that is still worthy of consideration. For him a flower was a shoot with lateral outgrowths, a morphological conception that would still satisfy a German transcendentalist. But, further, this shoot and its outgrowths were supposed to represent the outcome of six ordinary years' work contracted into one. A flower was, according to this theory, a shoot in which the differentiation of parts instead of being spread over six years was hurried on and completed within one season. For Linnæus leaves represented the work of one year, bracts that of the following one, sepals of the third, petals of the fourth, stamens of the fifth, and the pistil that of the sixth year. It is not necessary to discuss the morphological aspects of this theory, but it is relevant to our present purpose because it emphasises the relation of leaf-shoot to flower—a relation enunciated about the same

time, and independently one of the other, by Wolf and by Linnæus, and thirty years before Goethe propounded a similar notion. Moreover, it brings into prominence not only the morphological relation of shoot and flower, but one manner in which the time of production of the shoot and of the flower respectively may be varied, a subject having an immediate bearing on the question of unseasonable flowering. If, says Linnæus (*Prolepsis*, § iii.), "a shrub which has been grown in a pot, and has borne flower and fruit every year, be transferred to richer soil in a hot-house, it will produce for many years numerous leafy shoots, but no fruit. From which it may be inferred that the leaves are produced from the same source whence the flowers previously sprang, and so in turn what now tends to form leaves would, by this agency of Nature, be converted into flower if the same tree were again placed in a pot so as to confine the roots; hence gardeners desirous of obtaining a more plentiful crop of strawberries, cut the fine roots of the plants in spring before they transplant them, in the hope that they will produce more abundant flowers and fruit." Here we see the same principle laid down as that upon which gardeners act when they wish to secure flower and fruit by cutting off the supplies, and thus making the plant, to a greater degree, dependent on the elaborated reserve stored up in their tissues. This is effected by growing plants in small pots, root-pruning, transplanting, ringing, and other processes, all of which tend to diminish root-absorption, and by disturbing the balance between it and other processes, to check vegetation, and in so far to promote the formation of flower. Charles Martins relates the production on a very large scale of inflorescence on the Agave, in Algeria, as the direct consequence of the excision of the leaf-buds by a troop of French cavalry, who hacked the plants with their sabres as they passed, and thus, by preventing or checking growth in one direction, stimulated it in another. In like manner I have seen flowers produced on the "suckers" of *Ailanthus glandulosa* when the plant was quite young, on the roots of *Pyrus japonica*, and on a sucker of Agave, as the result of injury, probably in all, certainly in some, of the instances.

The frequent production of flowers out of season on newly transplanted trees is accounted for in like manner. But many trees are flowering this autumn which have not been slashed with sabres nor moved by more peaceful weapons. One such tree, a horse-chestnut, I lately (September) saw, in which one limb, and one only, was full of young leaves and flowers, while the remaining limbs were fast losing their foliage. The reason for this partial production of bloom I was not able to divine; possibly it may have had some relation to injury to a certain portion of the root-system in more or less direct connection with the particular branch, but I have no evidence to offer in support of such a guess.

In speaking previously of one modification of unseasonable flowering dependent on activity protracted beyond the customary period, it was mentioned that the flower was in such instances developed at the ends of long slender shoots formed during the course of the summer. In such cases the shoot ends in a flower-bud instead of a leaf-bud as is usually the case. The conditions are no longer favourable for the extension of the shoot, and the energy of growth is diverted to the production of flower. But in the laburnum, in many fruit-trees, such as the apple and pear, the fruits are normally borne on short thick branches called by the gardeners "spurs." These are very interesting physiologically, as possessing intermediate transitional characteristics, such as those before alluded to, between vegetation and seed-production. In form, these spurs are short and thick, with very narrow interspaces between the leaves, and they bear a cluster of buds which ultimately all develop into flowers, or in which the central and terminal one is a leaf-bud. Internally these spurs are soft and spongy, with a great preponderance of cellular over fibro-vascular or woody tissue. The cells are moreover filled with starch. We have evidently here got to do with store-places, analogous to that furnished by the tuber of the potato and other formations, in which food, or matter capable of conversion into food, is stored up for future use at the growing points; in this case for the formation of fruit. Flowers are occasionally produced on these spurs out of due season: the flower-bud destined for a following season bursts into activity this year, affording an instance of a true *floraison anticipée*; but more often, according to my observations, when an untimely flower is produced (especially in the apple), it is from the development of a flower in the central bud of the spur, which is usually a leaf-bud as above stated. In such a case, then, we have not only an alteration in the character of the bud, but a change in the period of its expansion. A converse illustration to that just given is afforded by a case recorded by Mr. Berkeley, in which a bud of a walnut, which in the ordinary course of things should have produced a female inflorescence in the following spring, was developed in the autumn as a leafy shoot.

Renewal of growth after temporary arrest, "recrudescence" as it is sometimes called, occurs normally in the pine-apple, Eucomis, Metrosideros, and other plants. Abnormally, I have met with it in *Cytisus nigricans*, the common wallflower, Œnothera, and many others. It hardly differs from the first category mentioned in this note except in the fact that the new growth is the direct continuation of the old and not an entirely new lateral formation. It differs from the terminal bud of a "spur," in that the latter is normal as to position even if developed out of season, whereas in the class of cases now under consideration the activity of the growing point, which usually ceases with the development of the last flower, is exceptionally continued.

One other circumstance deserves mention, and that is the rarity with which true fruit, or at least ripe seed, is produced as a result of these untimely flowers. Sometimes, of course, ripe seed is produced; a plum is before me as I write the seed of which is as perfect, to all appearance, as that of the first crop could have been. But in the majority of the pears and apples which come under one's notice at this unseasonable period, the fruit is there (in the popular sense), but the core, which is in a botanical sense the true fruit, is absent, or, if present, the seeds it contains are usually abortive. Botanical readers will readily see the morphological reason why, and physiologists will recognise that in such cases the deviation from the ordinary course is not so great as it appears upon the surface, and the action of the "environment" is not so potent as it appears to be at first sight.

To sum up: these cases of unseasonable flowering appear to be due either to continuous growth and development, to renewal of growth after a longer or shorter period of arrest, or to the development of a flower-bud in the place of a leaf-bud. What produces these changes? To this no more precise answer can be given than has already been afforded. The absolute nature of the change, structurally and morphologically, depends upon the nature of the inducing causes, and varies accordingly; the degree of change may depend simply on the increased or prolonged intensity of action of the same causes which promote natural growth.

MAXWELL T. MASTERS

NOTES

THE Washington Prime Meridian Conference closed on November 1. Protocols were approved, which will be made the basis of an international convention, fixing Greenwich as the prime meridian.

MANCHESTER is determined to have the British Association in 1886, and its invitation will almost certainly be accepted.

THERE is no truth in the statement which is being repeated so often that Baron Nordenskjöld intends to lead an expedition into the Antarctic regions.

IN a letter from the Sagastyr Meteorological Station on the Lena, dated March 20, and appearing in the last issue of the *Izvestia*, M. Yurgens informs the Russian Geographical Society that twenty-six years ago a mammoth was discovered in the delta of the Lena, twenty-three miles from the station. Its head and tusks had already been taken away by a Russian merchant at the time of the discovery of the body, and the Yakuts of the neighbouring settlement have taken a leg, several ribs for making spoons, as also parts of its skin for straps, and fat for painting their sledges The body is lying on the right side in the lower part of a crag of alluvial deposits thirty feet high. The interior is said to be quite safe. Dr. Bunge went to the place pointed out by the Yakuts, and undertook regular excavations for a distance of 350 feet, the expedition not being sure that the Yakuts have shown the right place: they consider it a sin to take from the earth what it does not give itself. The work is very hard, the excavations being made in a frozen mass of snow, "as hard as sugar," M. Yurgens says. While the work was at a lull, news was received of another mammoth's body discovered only six years ago on the Moloda River, left bank tributary of the Lena, joining it thirty-five miles above Siktyakh, which has remained still untouched. If the news is confirmed, M. Yurgens will make an excursion to discover it.

IN a subsequent letter, dated April 16, M. Yurgens writes that M. Eigner has made magnetic measurements to the east of the station as far as Ust-Yansk. Full measurements were made at ten places, notwithstanding frosts of $-30°$ to $-40°$ C. Mr. Yurgens will make the same measurements to the west of the station. Preparations are already made for the return journey. Several magnetic instruments had to be packed at the end of April and sent on sledges to Bulun. M. Eigner proposed to leave the station at the same time, while MM. Bunge and Yurgens intended to stay at Sagastyr until June 15.

THE following papers were entered to be read, *Science* states, at the Newport meeting of the National Academy of Sciences, Oct. 14 to 16:—On the columella auris of the Pelycosauria, E. D. Cope; the brain of Asellus and the eyeless form of Cecidotæa, A. S. Packard; on the theory of atomic volumes, Wolcott Gibbs; on the complex inorganic acids, Wolcott Gibbs; notice of Muybridge's experiments on the motions of animals by instantaneous photography, Fairman Rogers; notice of Grant's difference-engine, Fairman Rogers; on the thinolite of Lake Lahontan, E. S. Dana; on the Mesozoic coals of the North-West, R. Pumpelly; on the work of the Northern Trans-Continental Survey, R. Pumpelly; the grasses mechanically injurious to live-stock, William H. Brewe; on gravitation survey, C. S. Peirce; on minimum differences of sensibility, C. S. Peirce and J. Jastrow; researches on Ptolemy's star-catalogue, C. H. F. Peters; on the operations of the U.S. Geological Survey, J. W. Powell; the motion of Hyperion, Asaph Hall; remarks on the civilisation of the native peoples of America, E. B. Tylor; some results of the exploration of the deep sea beneath the Gulf Stream by the U.S. Fish Commission steamer *Albatross* during the past summer, A. E. Verrill; recent progress in explosives, H. L. Abbot; on an experimental composite photograph of the members of the Academy, R. Pumpelly; report on meridian work at Carlsruhe, W. Valentiner; on the algebra of logic, C. S. Peirce.

THE meeting of the Cambridge Philosophical Society next Monday at 3 p.m. will be marked by the number and importance of the biological papers communicated. One will be by a lady, Miss F. Eves, Lecturer at Newnham College, on some experiments on the liver ferment. Mr. W. F. R. Weldon will contribute a paper on the supra-renal bodies, on which he has previously made valuable contributions. The remarkable recent development of the study of vegetable morphology and physiology under Dr. Vines will be further evidenced by Mr. Walter Gardiner's paper on the supposed presence of protoplasm in the intercellular spaces, and Mr. J. R. Green's, on a proteid occurring in plants. Prof. Michael Foster is the new President of the Society; Mr. Trotter, Mr. Glazebrook, and Dr. Vines are the Secretaries; and Prof. Cayley, Prof. Macalister, and Mr. Glaisher are the new Members of Council.

THE Statistical Society has issued in one handsome quarto a Catalogue of their most useful collection of books. The Catalogue has been compiled with great care, and on a simple and intelligible plan. The library is deemed to be a class library, and no classification therefore is attempted, the books being arranged in alphabetical order, with reference to size, under their authors' names or otherwise, as described in the preface. Secondly, their are no "*blind entries*," *i.e.* each entry, including cross-references, gives sufficient particulars, including size, to enable any person to recognise the book he is looking for, if there, and at the same time indicate to the attendant, without further reference to the Catalogue, where the book is to be found. Such features are a great comfort to the student.

MICHIGAN, like most other States, is going in for economic entomology. We have received a pamphlet of 31 pages on Injurious Insects, emanating from the Entomological Laboratory of the Michigan Agricultural College, in which Prof. A. J. Cook and Mr. Clarence M. Weed are the principal writers. Several of the usual American pests are noticed, and some are figured. We are sorry to say the figures are original, for although the practice of borrowing *cliché* has extended in the States to a degree that is almost nauseating, the results are usually satisfactory, and had the practice been followed in this instance it would have been to the advantage of this Michigan College. Probably for the first time in America the ubiquitous "Painted Lady" (*Vanessa cardui*) is stigmatised as "injurious"; it is accused of devouring hollyhock, centaurea, and borage. The same insect in Europe, a few years ago, was driven to extremes in order to find anything that would agree with it, and nearly caused a panic with the worshippers of "absinthe," by destroying the wormwood crop in the Canton of Neufchâtel (Switzerland). There are some very useful and suggestive statistics (by Mr. Weed) on the food relations of birds, frogs, and toads (the paper being a "Thesis for the degree of Master of Science"). The first part deals with the food of *young* birds, in which the American robin (a thrush, and not to be confounded with *our* redbreast) figures largely, as do also the "blue bird" and others. Lepidopterous larvæ are the main food, but apologies have to be made (especially in the case of the blue-bird) for the number of spiders destroyed. In the case of young "robins" the molluscous element is small; probably it would be equally small in this country with regard to *young* thrushes or blackbirds, their beaks not being sufficiently strong to enable them to do the shell-breaking. The statistics with regard to frogs and toads do not appear to be of importance one way or the other. Frogs and toads destroy insects (or "Arthropods" in the broad sense), but we fancy the particular food depends upon the conditions under which the individual Batrachian finds itself.

WE have much pleasure in calling attention to the issue, from the Breslau house of Eduard Trewendt, of four new numbers of that comprehensive work, the "Encyclopædia of Natural Sciences"—the 38th number of the first, and the 23rd to the 25th numbers of the second division. The 38th number of the first division brings the "Dictionary of Zoology, Anthropology, and Ethnology" as far as Gewöhnung (Habitua-

tion), and we need only refer in particular to the history of arthropology, of our knowledge of the Mollusca, Reptilia, and Amphibia, the writers of which occupy the front rank in their respective departments. The map of the "Zoological Regions," appended to Reichenow's interesting article on the "Geographical Distribution of Animals," will be much appreciated. The new numbers of the second division contain a continuation of Ladenburg's "Alphabetical Manual of Chemistry," with which might close two goodly volumes of this work. As physical chemistry has found an excellent representative in Prof. Eilhard Wiedemann, so is also industrial chemistry set forth by men of the first ability, whose contributions here will be prized by a wide circle: "Chlorine," by Prof. Heumann (with numerous woodcuts), "Chinoline," by Dr. L. Berend-Kiel, and "Cyanic Compounds," by Prof. Jacobsen. Nor must we omit mentioning the "History of Chemistry" (in No. 23), written for the "Alphabetical Manual of Chemistry" by Prof. G. Hoffmann of Kiel. The "Alphabetical Manual of Mineralogy, Geology, and Palæontology," continued with No. 24 of the second division, has now advanced to the end of the article "Krystallgestalten und Krystallographie" (Crystal Formations and Crystallography), which, along with the preceding article on "Crystals," by Prof. Kenngott, furnishes a very handsome contribution to the work in question, both articles being, moreover, very copiously illustrated. Finally, we have to announce that there will next appear a new botanical number which, among other things, will contain the beginning of a treatise on "Schleimpilze," by Dr. W. Zopf.

SOME 154 prehistoric tombs near Santa Lucia by Tolmein, (Gorizia), have been lately examined by Dr. Marchesetti, the director of the Trieste Museum. Their contents were conveyed to Trieste; the excavations will be continued at the instance of the Adriatic Natural History Society, for a period of about two years. During last year Dr. Marchesetti examined another burial-ground, viz. that of Vermo, near Mitterburg (Istria), which belongs to quite another period.

MR. T. MELLARD READE, C.E., F.G.S., in his presidential address to the Liverpool Geological Society this session, "On the Denudation of the Two Americas," showed that 150,000,000 tons of matter in solution are annually poured into the Gulf of Mexico by the River Mississippi; this, it was estimated, would reduce the time for the denudation of one foot of land over the whole basin—which time has hitherto been calculated solely from the matter in suspension—from 1 foot in 6000 years to 1 foot in 4500 years. Similar calculations were applied to the La Plata, the Amazons, and the St. Lawrence, Mr. Reade arriving at the result that an average of 100 tons per square mile per annum are removed from the whole American continent. This agrees with results he previously arrived at for Europe, from which it was inferred that the whole of the land draining into the Atlantic Ocean from America, Africa, Europe, and Asia contributes matter in solution which if reduced to rock at 2 tons to the cubic yard would equal 1 cubic mile every six years.

FOR several years the Director of Telegraphs at Haugesund (Norway), Herr A. Reitan, has been making experiments for the purpose of solving the problem whether fish seek places in the sea which are artificially illuminated. In order, however, to make experiments on a larger scale than hitherto, and if possible to demonstrate the value of such illuminations at great fisheries, he has received some specially-constructed electric lamps from Brussels, with which he will continue his experiments during the autumn.

THE Natural History Society of Rhineland and Westphalia held their autumn meeting at Bonn. Among the papers read we note those on the forest vegetation of the extreme north-western portion of the Himalayas, by Dr. Brandis, and on the present state of the Phylloxera question in the Rhenish vineyards, by Prof. Bortkau.

AT Schrems (Lower Austria) a violent shock of earthquake was felt on the night of October 8–9 at ten minutes past midnight. It was preceded by a subterranean rolling noise, lasting several minutes. The phenomenon was also observed at Zwettl and at Gmünd.

THE glaciers in the Dachstein Mountains have again diminished considerably at their lower extremities. Prof. Simony has recently taken a large number of photographs of the summit of the Hohe Dachstein, of the Gosau Glacier, and the Karls ice-field, in order to execute future measurements. The surface of the lowest layers of the Karls ice-field has sunk between 2·5 and 3·2 metres since last year, and the lower end of the Gosau Glacier has receded more than twice that amount. Since about 1849 this glacier has receded more than 600 metres.

WE have repeatedly referred to Hayek's "Grosser Handatlas der Naturgeschichte" (published by Moritz Perles, Vienna), which has now reached its completion.

THE death is announced of Prof. Eugenio Balbi, Professor of Geography at Pavia University, a son of the celebrated geographer, Adriano Balbi. Born at Florence on February 6, 1812, he died at Pavia on October 18 last.

THE Natural History Museum, established by the Committee of the International African Society at Brussels, grows in extent daily. The most recent additions are the skeletons of a chimpanzee, a gorilla, a crocodile, and a sea-cow. The Director of the Karema Station on Lake Tanganyika has forwarded a large collection of birds.

"A NORWEGIAN" writes to point out two errors in Mr. Mattieu Williams's note on the northernmost promontory in Norway. "To call the Knivskjærodde a 'low glaciated tongue of rock' is hardly correct. The ridge is a couple of hundred feet high at least. I have before me a photograph of the cape, taken last summer by Dr. Sophus Tromholt, and which will shortly be placed before the public. The elevation is very considerable. Mr. Williams further states that there are magnificent capes abounding around the North Cape; others are above 1000 feet. This is incorrect. The highest mountain on the *coast* of Arctic Norway is the North Cape, viz. 974 feet. A belief has for many years prevailed in Norway that Knivskjærodden jutted further into the ocean than the North Cape, but it has only been *proved* this summer."

THE additions to the Zoological Society's Gardens during the past week include two Rhesus Monkeys (*Macacus rhesus*) from India, presented respectively by Mr. Richard Armytage and Mrs. E. A. Russell; a Roseate Cockatoo (*Cacatua roseicapilla*) from Australia, presented by Miss N. Simonds; a Northern Mocking Bird (*Mimus polyglottus*) from North America, presented by Mr. Thomas G. Venables; a Grand Eclectus (*Eclectus roratus*) from Moluccas, presented by Miss Lawson; two Herring Gulls (*Larus argentatus*), British, presented by Mrs. Pigou; an Undulated Grass Parrakeet (*Melopsittacus undulatus*) from Australia, presented by Mr. F. Hale, F.Z.S.; a Water Rail (*Rallus aquaticus*), a Moorhen (*Gallinula chloropus*) from Norfolk, presented by Mr. T. E. Gunn; a Common Chameleon (*Chamæleon vulgaris*) from North Africa, presented by Mr. W. G. Brinkley; an Alligator (*Alligator mississippiensis*) from the Mississippi, presented by Mr. R. M. Middleton; a Greater White-crested Cockatoo (*Cacatua cristata*) from the Moluccas, deposited; a Black-headed Caique (*Caica melanocephala*) from Demerara, purchased; a Cape Ant Bear (*Orycteropus capensis*) from South Africa, received on approval.

OUR ASTRONOMICAL COLUMN

BARNARD'S COMET.—The following ephemeris of this comet for Greenwich midnight is deduced from the elliptical elements of Dr. Berberich, of Strasburg, which assign a revolution of 5¼ years :—

1884	R.A. h. m. s.	N.P.D. ° ′ ″	Log. distance from Earth	Log. distance from Sun
Nov. 6	22 5 32	101 27·8	0·0041	0·1985
8	— 10 28	100 50·3	0·0147	
10	— 15 20	100 13·3	0·0253	0·2054
12	— 20 8	99 36·8	0·0358	
14	— 24 51	99 0·7	0·0463	0·2122
16	— 29 30	98 25·2	0·0567	
18	— 34 6	97 50·1	0·0670	0·2191
20	— 38 38	97 15·5	0·0772	
22	22 43 7	96 41·4	0·0874	0·2259

The theoretical intensity of light on November 6 is 0·39, and on November 22, 0·24. As previously remarked, it is very desirable that observations of this comet for position should be continued as long as practicable, that its mean motion may be determined with sufficient precision to enable a trustworthy estimate of past planetary perturbations to be obtained. The general resemblance of the elements to those of the short-period comet of De Vico in 1844 will render such an investigation one of much interest.

THE NOVEMBER METEORS.—The earth arrives at the descending node of the first comet of 1866 on the afternoon of Thursday, November 13, and a watch may be favourably instituted on the night of that day for meteors of the stream which appears to lie in the comet's track. Oppölzer's definitive elements give for the radiant point, R.A. 150°·2, N.P.D. 67°·2 (equinox of 1866).

THE LICK OBSERVATORY, CALIFORNIA.—The following is an extract of a letter from Prof. Edward S. Holden, Director of the Washburn Observatory, University of Wisconsin, dated October 17 :—"I have just returned from the Lick Observatory, where I have mounted a beautiful meridian-circle by Repsold of 6 (French) inches aperture. It has north and south collimators of the same aperture, and its axis is a telescope of 2·5 inches aperture, which is viewed by an east (or west) collimator for controlling the azimuth, &c. There are two circles, each divided to 2′, one fixed, the other movable by a wheel and pinion, so that it is not *essential* to determine the division errors of any lines except those for each 1°, and those 2′ lines belonging to 4 degrees, 90° apart. The room is double throughout, a wooden building 40 × 40 feet inside of a structure in louvre-work, which gives a continuous air space all around ; and this air space is connected with a tall ventilating tower which enables the free circulation of air to be maintained. It appears to me to be in all respects satisfactory. The Lick Observatory now needs only its 36-inch refractor to be complete, and they hope for this within three years."

It will be remembered that this Observatory is situate on the top of Mount Hamilton.

VARIABLE STAR IN THE ORION-NEBULA.—The late Prof. Schmidt found that the star which he distinguishes as J" (Bond 822 = Liapunov γ), which follows θ Orionis 34·3s., and 5′ 5" to the south of it, disappeared at minimum in his 5-feet refractor, and at maximum reached 9·5m. On April 3, 1878, it was estimated 12·8, equal to Bond 784, but before the end of the month it rose to 9·7. The star may deserve frequent observation.

GEOGRAPHICAL NOTES

THE Rev. Francis A. Allen has issued a reprint of the paper read by him at the late Congress of Americanists in Copenhagen on Polynesian antiquities. The stupendous Cyclopean monuments, platforms, terraces, walls, colossal statues, scattered over the South Sea Islands are graphically described, and regarded as forming a connecting link between the ancient civilisations of Asia and America. The theory is that America was mainly peopled by two streams of migration from Asia—a nomad Mongolic, proceeding directly by the Straits of Behring, and now represented by the Apaches, Utes, Comanches, and other wild tribes of California, Oregon, Colorado, &c. ; and a semi-civilised, proceeding from Further India and China across the islands of the Pacific Ocean to Mexico, Central America, and Peru. On their way across the archipelagoes these peoples left traces of their presence in Micronesia, Hawaii, Tahiti, and especially Easter Island, the last-named distant only some 2600 miles from the mainland of South America. The resemblances between these monuments and those of Peru and Mexico are dwelt upon, and they are further compared with those of Java (Boro-Boro), Cambodia (Angkor-Vaht), and others in Southern Asia. The theory, which is not altogether novel, is supported by other arguments based on considerations of traditions, usages, religions, languages, and the like, brought together from various sources not always of a trustworthy character. It is suggested that the Chinese tradition of the discovery of Fusang by the monk Hoën-Shin may not be altogether an idle tale. Allusion is made to Schoolcraft's exploded legend of Hiawatha ; and some more than doubtful authorities are referred to in proof of the affinities between the American languages and those of Japan, North-East Siberia, and Indo-China. Nevertheless, if not always critical, the paper is learned and lucid, and worth reprinting, if only for the great number of data here brought together as bearing directly or indirectly on the point at issue.

HERR VON HAARDT contributes an instructive memoir to the last number of the *Proceedings* of the Vienna Geographical Society on the services rendered to the progress of the geographical sciences by the Austrian navy. A brief historical survey is given of the famous *Novara* Expedition round the world (1857-59) ; of the survey of the Adriatic coastlands by Capt. T. Ritter (1871) ; the simultaneous determination of the magnetic relations in the same waters by Lieut. J. Schellander ; the expedition of the *Friedrich* and *Donau* to the East Asiatic seaboard (1868) ; the second voyage of the *Donau* to Asia and South America (1874-76) ; the circumnavigation of Borneo by Capt. T. F. von Oesterreicher ; the circumnavigation of Africa by the *Helgoland* and *Friedrich* (1874-75) ; the voyages of the *Pola* to Jan Mayen and the Arctic Ocean (1882-83) ; Weyprecht's discovery of Franz-Josef Land, &c. The memoir concludes with a brief reference to the expeditions now in progress or promised in the near future, such as that of the *Saida* to Australasia (1884-86) ; of the *Aurora* to South America (1884-85) ; of the *Helgoland* to the West African seaboard, and of the *Frundsberg* to the Indian Ocean.

THE same periodical contains the first part of what promises to be a very valuable contribution to the physiography of Caucasia. Much useful information is here brought together from the latest sources regarding the orography, river systems, administrative divisions, and statistics of that region. The present area of the northern section (Cis-Caucasia) is given at 4037 German geographical square miles, of the southern (Trans-Caucasia), 4400 ; total, 8437, or 2740 more than that of the British Isles.

TO this journal F. Blumentritt also sends an account of the little-known Negrito tribes of the district of Principe in the Island of Luzon, Philippine Archipelago. These aborigines, collectively known as Atas (Aetas), and showing distinct physical resemblances to the non-Malay wild tribes of Malacca, are being gradually evangelised by the Spanish missionaries stationed at Baler. Hemmed in between the semi-civilised Tagalas and the fierce Ilongotes, both of mixed Malay stock and speech, they have already been largely affected by Malay influences. But although their language contains numerous Tagala words, expressions, and even grammatical forms, its fundamentally distinct character has been clearly determined. For the purpose of comparison useful vocabularies of about 150 words are appended in five languages: Spanish, Tagala, Negrito of Mariveles (Bataan), Negrito of Zambales, and Negrito of Baler (Principe).

AT the opening meeting of the Royal Geographical Society on Monday, Mr. Joseph Thomson gave an eloquent and highly interesting account of his recent explorations in the country of the Masai. Both the country and the people are of the greatest interest to science; and, as was shown last week, Mr. Thomson's botanical collections are decidedly novel. One or two zoological novelties he has also obtained, and we shall be glad to have the detailed account of his discoveries, which will appear in his forthcoming work.

IT appears from the *Anglo-New Zealander and Australian Times* that Mr. H. O. Forbes, F.R.G.S., is organising a scientific expedition with the view of exploring the botany and zoology of the Mount Owen Stanley Mountains, the great cen-

tral range of the eastern peninsula of New Guinea. Mr. Forbes has been allowed 400*l.* by the British Association and 250*l.* by the Royal Geographical Society towards the expense of the expedition. The party will start early in December, though it is not expected to get into active working before May next, in consequence of the necessity for procuring trusty carriers from the Moluccas. Mr. Forbes will break his journey at Batavia, in order to proceed to Amboyna, where he hopes to find his men. He will then return to Batavia, and sail for Thursday Island, proceeding thence to Port Moresby. He proposes to ascend the course of one of the rivers which flow from the mountains to Redscar Bay. Should the natives prove friendly and the food-supplies sufficient, Mr. Forbes does not despair of reaching the other coast of the peninsula; but in any case the exploration of the Mount Owen Stanley Range would be of itself a satisfactory achievement. The mountain travelling is declared to be dangerous to any but very experienced travellers.

News has reached St. Petersburg from Col. Prjevalsky, the indefatigable explorer in Thibet, whose expedition appears to be distinguishing itself in feats of arms as well as discoveries of science. A telegram *viâ* Kiatcha, dated August 20, says:—"The difficult task of the expedition has been successfully accomplished. During the three summer months we traversed 1000 versts of North-Eastern Thibet. We first descended from Zaidam, 400 versts south, over the sources of the Yellow River to the Blue River, which it was found impossible to cross, and then we explored the large lakes in the upper course of the Yellow River. One lake was named 'Russian,' another 'Expedition' Lake. Their height was 13,500 feet, the surrounding country being a mountain plateau 1000 feet higher. Along the Blue River lies a mountainous, but woodless and Alpine country. The climate of the localities passed through was terrible. The whole of the summer was cold, with rain and snow; at the end of May there was sharp frost, in July we had snowstorms like those of winter, while the amount of alluvium deposited by south-western monsoons from the Indian Ocean is so great that in summer Northern Thibet is converted into an almost continuous marsh. Wild animals and fish are abundant, the birds and flora poor, but original. The Tanguts live on the Blue River, and near the lakes of the Yellow River. Here we were twice attacked by about 300 mounted marauders, and the heroic conduct of my companions, armed with Berdan rifles, saved the expedition. We soon repulsed the first attack on July 25, and subsequently destroyed the Tangut camp. A week later a fresh party from another Tangut tribe attacked us. For two hours on the banks of the Yellow River we repelled the mounted brigands with repeated volleys from our rifles; and when we took the offensive the Tanguts retreated behind the knolls, and in turn began volley-firing. We were most fortunate, all coming off safe and sound, only two of our horses being wounded, while forty of the brigands were killed and wounded in the two encounters. We now go to Western Zaidam. We shall establish a depot at Hast, and during the winter explore the surrounding localities."

Dr. Gerhard Rohlfs leaves for the West Coast of Africa by one of the German war-ships under Admiral Knorr, and has been intrusted with a special mission by the German Government.

Capt. Becker and some other Belgian officers are about to proceed to Zanzibar, thence to start for Lake Tanganyika. They intend to cross this lake, and to found a station on its western shore. Thus the line of stations across Africa, which the International African Society has planned, will be completed. On the eastern side of Lake Tanganyika, between this and the sea-coast, there are four stations: Kondoa, in Usagara; Tabora, in Unyanyembe; Kakoma, in Uganda; and Karema, on the shore of the lake. On the western side there are over fifty stations between the lake and the Atlantic.

The subject of trade-routes into South-Western China is now engaging attention in France, and has caused much discussion in the periodical press. The various methods of reaching Szechuan and Yunnan which have from time to time been suggested by explorers are dismissed in their turn as impracticable. From the side of India we have the Brahmaputra, which is navigable almost to the Chinese frontier, and the Irrawaddy *viâ* Bahmo. These are described as useless on account of the obstacles offered by lofty and almost impassable ranges of mountains; the Meinam from Bankok would only land us in the Shan States; the Meikong, through Cambodia, was tried by Lagrée, but was found quite unfit for navigation on account of its numerous rapids and cataracts. In China we have the Sikiang—which offers an almost straight line from Canton into Southern China, and was followed by Mr. Colquhoun in his recent attempt to cross through the Shan States into British Burmah—and the Yang-tsze-kiang, but both of these routes, according to French writers, are closed to trade by Chinese hostility. Thus every possible route has been tried and found wanting, with one exception, viz. that by the Songkoi or Red River of Tonquin. By means of this new possession of France the trade of the two great provinces of South-Western China, say the French writers, can be tapped, and in no other way. Their wealth, it is said, will be poured down the valley of the Red River into the hands of the French traders at Hanoi and Haiphong. With regard to routes mentioned only to be dismissed as impossible, nothing need be said here. Their merits and defects may be found described in a score of English works by explorers on the spot; but so far as the Red River is concerned, no proposition either way can be laid down with safety. Beyond Hanoi it is but little known, and its upper waters above Honghoa are almost wholly unknown to Europeans. But one Frenchman has ever ascended or descended the river, and when M. Dupuis made his courageous journeys more than ten years ago, he did so under circumstances which rendered geographical observation impossible. All that M. Dupuis can say (and European knowledge is confined to his information) is that with an escort, and with Chinese passports, he was able to come down the river in a small junk, and to ascend it again with several junks laden with arms and ammunition. Even at the present moment the whole river from Honghoa to Laokai on the Chinese frontier is in the hands of the Black Flags. Moreover it has been stated that after leaving the Red River the route would have to cross a lofty mountain range, and pass through the most desolate region in Yunnan. The river may offer an excellent trade route; but in the present state of our geographical knowledge of Upper Tonquin all that can be said with certainty is that nobody knows whether it is so or not. Happily the French lose no time in thoroughly studying the countries which they occupy, and as soon as a state of peace has been reached in Indo-China we shall be in a position to decide the question; until then anything written about the navigation of the Red River above Honghoa is mere speculation, and valueless for practical purposes.

The last number of the *Izvestia* of the Russian Geographical Society contains three interesting papers by M. D. Ivanoff on the Pamir, embodying the results of the last year's expedition, and giving a lively summary of our present knowledge as to this very interesting region. A. E. Regel contributes to the same number a note on his journey to the Shugnan; A. Wysheslavtseff describes the burial customs of the Tchuvashes; and P. A. Putyatin contributes a note on the pottery of the Stone Age. The same issue contains, moreover, accounts of the geodetical and cartographical work done in 1883 by the military topographers and by the Hydrographical Department, and several notes.

NATURAL SCIENCE IN SCHOOLS[1]

HOWEVER fully it may be admitted by the few that it is important, nay essential, that all members of the community, whatever their station or occupation, should during their school career receive some instruction in the elements of natural science, the general public have not as yet had brought home to them with sufficient clearness that, just as a knowledge of foreign languages is essential to all who are brought into intercourse with foreigners, so in like manner is a correct knowledge of the elements of natural science of direct practical value to all in their daily intercourse with Nature, apart from the pleasure which such knowledge affords. In fact, judged from a purely utilitarian standpoint, the advantages to be derived from even the most elementary acquaintance with what may be termed the science of daily life are so manifold that, if once understood by the public, the claims of science to a place in the ordinary school course must meet with universal recognition. To quote Huxley[2]:

[1] "On the Teaching of Natural Science as a Part of the Ordinary School Course, and on the Method of Teaching Chemistry in the Introductory Course in Science Classes, Schools and Colleges." Paper read at the Educational Conference of the International Health Exhibition by Henry E. Armstrong, Ph.D., F.R.S., Sec.C.S., Professor of Chemistry in the Finsbury Technical College.

[2] This writer's "Introductory" to Macmillan's Science Primers, and his "Physiography: an Introduction to the Study of Nature," should be studied by all who wish to know what science is and how it should be taught.

"Knowledge of Nature is the guide of practical conduct; . . . any one who tries to live upon the face of this earth without attention to the laws of Nature will live there for but a very short time, most of which will be passed in exceeding discomfort: a peculiarity of natural laws, as distinguished from those of human enactment, being that they take effect without summons or prosecution. In fact, nobody could live for half a day unless he attended to some of the laws of Nature; and thousands of us are dying daily, or living miserably, because men have not yet been sufficiently zealous to learn the code of Nature."

But it is also and mainly on other and far higher grounds that we should advocate universal practical teaching of the elements of natural, and more particularly of so-called physical, science: viz. that it tends to develop a side of the human intellect which, I believe I am justified in saying, is left uncultivated even after the most careful mathematical and literary training: the faculty of observing and of reasoning from observation and experiment. It is entirely from this latter point of view that I shall venture to propound a scheme for teaching the elements of that branch of physical science with which I am most intimately acquainted.

This Exhibition affords some few noteworthy illustrations of the way in which the importance of teaching the elements of natural science has received practical recognition in our schools. Thus we have indications of the work being done by the Birmingham School Board; the London School Board call attention to their system of training pupil-teachers in science; Mr. Robins shows plans of one of the best, if not the best equipped school chemical laboratory—that of the Manchester Grammar School. Also, it is well known that at many of the larger schools, such as Clifton College, Eton, Harrow, Rugby, St. Paul's, Giggleswick, and the North London Collegiate School for Girls, ample provision is made for teaching one or more branches of natural science; and not a few other examples might be quoted. But in how large a proportion of the schools throughout the country is such training neglected? and there is much cause for complaint in the fact that, in those schools in which science is taught, it is after all in most cases but a kind of "refuge for the destitute," only those who have failed on the classical side and those judged to be inferior in intellect being turned over to the so-called modern side. This is probably due to a variety of causes: to the ignorance already referred to of the public of the importance and value of such training, or it would be demanded of the schools; to the ignorance of even the barest elements of science of the majority of teachers in charge of schools; to the want of good science teachers and of suitable books; to the supposed expense of teaching science; and lastly—and I believe this to be the most important of all the causes which operate against the teaching of science—to the imperfection of our method of teaching: there can be little doubt, in fact, that the majority of teachers of the generally recognised subjects who have themselves no scientific knowledge see clearly enough that very little good comes of teaching science in the manner in which it is commonly taught in schools.

The great objection to the method at present in vogue appears to me to be that it is practically the same whether science is taught as a part of the general school course, or whether it is taught professionally; in other words, a lad studies chemistry, for example, at school in just the same way as at a science college, the only difference being that he does not carry his studies so far at school as at college. This, I believe, is the primary fault in our present system. In my opinion, no single branch of natural science should be selected to be taught as part of the ordinary school course, but the instruction should comprise the elements of what I have already spoken of as the science of daily life, and should include astronomy, botany, chemistry, geology, mechanics, physics, physiology and zoology—the *ollæ podridæ* comprehended by Huxley under physiography, but which is perhaps more happily expressed in the German word *Naturkunde*—in so far as is essential to the understanding of the ordinary operations and objects of Nature, the teaching from beginning to end being of as practical a character as possible, and of such a kind as to cultivate the intelligence and develop the faculties of observing, comparing and reasoning from observation; and the more technical the course the better. The order in which these subjects should be introduced is matter for discussion; personally, I should prefer to begin with botany, and to introduce as soon as possible the various branches of science in no particular order but that best suited to the understanding of the various objects or phenomena to which the teaching for the time being had reference. The extent to which instruction of this kind is given must entirely depend on the class of scholars.

There are few teachers capable of giving such instruction, and fewer books of a character suited to ordinary requirements. The development of such a system will, in fact, require the earnest co-operation of a number of specialists; but apart from the difficulty of securing efficient co-operation, there is no reason why some such scheme should not be elaborated at no distant date. If action is to be taken, however, there must be no delay, or the opportunity will be lost. I trust that this meeting will be prepared to give much attention to this question, and that it may be possible to continue the discussion on other platforms, as it is fundamentally important and deserving of the most serious consideration of educationalists. No doubt it will be said that the object of introducing the teaching of science into the school course is to afford mental training of a particular character, not the inculcation of useful knowledge, and that this end can be secured by teaching well some one branch of science. Admitting that this has been the case, however, there is no reason why it should be in the future: if while developing the intellect it be possible—and it certainly is—to impart much valuable information; and if—as it certainly is—the teaching be rendered easier and more attractive because it has direct reference to the familiar objects and operations of Nature. We cannot, indeed, any longer afford to grow up ignorant of all that is going on around us, and without learning to use our eyes and our reasoning powers; we cannot afford to be unacquainted with the fundamental laws of health; but we must ever remember "that knowledge of Nature is the guide of practical conduct," and no effort must be spared to render our system of education an effectual preparation and truly adapted to the exigencies of practical life. The female educators appear already to have grasped the importance of such teaching, and under the guise of domestic economy much that I advocate is being taught in girls' schools; it is to be hoped that ere long something akin to the domestic economy course in girls' schools will find a place in boys' schools.

To pass now to the consideration of the mode of teaching my own special subject in science classes, such as those held under the auspices of the Science and Art Department, and in the introductory course for students in science schools and colleges generally. To deal first with the former. Inspection of the syllabus for the elementary stage, together with the study of the examination papers of the past few years, will show that the student is mainly required to have an elementary knowledge of the methods of preparing, and of the properties of, the commoner *non-metallic* elements and their chief compounds. There is thus practically no distinction to be drawn between the knowledge required of students under the Science and Art Department, and of those who are making the study of chemistry the business of their lives. But surely it is not the function of the Science and Art Department to train up chemists, and I am satisfied that it is neither their desire nor their intention to do so; their object undoubtedly is to encourage the teaching of chemistry as a means of cultivating certain faculties, and in order that the fundamental laws of chemistry may be understood and their commoner applications realised. It is not difficult to understand how the system has grown up and why it is maintained; I not believe it is because the Department consider it a satisfactory one; but they know full well that a better system is not yet developed, and that it would be unwise to legislate far in advance of the intelligence and powers of the majority of the teachers. With all deference, however, I venture to add that the programme has been drawn up too much from the point of view of the specialist, and that too little attention has been devoted to it from the point of view of the educationalist. The course I am inclined to advocate would be of a more directly useful character. There is no reason why in the beginning attention should be confined to the non-metals, especially when certain of the metals enter so largely into daily use; and provided that it involve no sacrifice of the opportunities of developing the faculties which it is our special object to cultivate by the study of chemistry, there is no reason against, but every reason for, selecting subjects of every-day importance rather than such as are altogether outside our ordinary experience, such, for example, as the oxides of nitrogen: even chlorine, except in relation to common salt, might be omitted from special study. The presumed distinction between so-called inorganic and organic chemistry should be altogether put aside and forgotten, and the elements of the chemistry of the carbon compounds introduced at a very early stage in order that the phenomena of animal and plant life might come under consideration. To give the barest possible outline of a programme, I would include such subjects as the following in the syllabus:—

The chemistry of air, of water, and of combustion; the

distinction between elements and compounds; the fundamental laws which regulate the formation of compounds and the chemical action of bodies upon one another (*i.e.* the nature of so-called chemical change); the chemical properties of the metals in ordinary use, with special reference to their uses and the action upon them of air, water, &c.; the composition of natural waters; the distinction between fats, carbohydrates and albuminous substances in so far as is essential to the understanding of the relative values of different foods and respiration and growth in animals and plants (outlines of the chemistry of animal and plant life, in fact); the nature of the processes of fermentation, putrefaction, and decay.

The instruction in these subjects should in all cases be imparted by means of object-lessons and tutorial classes; lectures pure and simple should, as far as possible, be avoided. The students should by themselves go through a number of practical exercises on the various subjects. I would abolish the teaching of tables for the detection of simple salts, the teaching of analysis as at present conducted being, I believe, in most cases of very little if any use except as enabling teachers to earn grants.

In schools and colleges in which chemistry is taught as a science, and ostensibly with the object of training young people to be chemists, it is the almost invariable practice that the student first devotes more or less time to the preparation of the commoner gases, and then proceeds to study qualitative analysis; quantitative determinations are made only during the later period of the course. I believe that the system has two great faults: it is too mechanical, and does not sufficiently develop the faculty of reasoning from observation; and actual practice in measurement is introduced far too late in the course. It is of great importance that the meaning of the terms equivalent, atomic weight, molecular weight, should be thoroughly grasped at an early stage, but according to my experience this is very rarely the case; there is no such difficulty, however, if the beginner is taught to make a few determinations himself of equivalents, &c., as he very well may be. It is not necessary here to enter into a more detailed criticism, but I propose instead to give a brief description of a modification of the existing system which in my hands, in the course of about four years' experience, has furnished most encouraging results, and which I venture to think is worthy of an extended trial.

Instead of merely preparing a variety of gases, the student is required to solve a number of problems experimentally: to determine, for example, the composition of air and of water; and the idea of measurement is introduced from the very beginning, as the determination is made quantitatively as well as qualitatively. Each student receives a paper of instructions—two of which are printed as an appendix to this paper—which are advisedly made as bare as possible so as to lead him to find out for himself, or inquire, how to set to work; and he is particularly directed that, having made an experiment, he is to enter in his notebook an account of what he has done and of the result, and that he is then and there to ask himself what bearing the result has upon the particular problem under consideration, and, having done so, he is to write down his conclusion. He is thus at once led to consider what each experiment teaches: in other words, to reason from observation. Apart from the mental exercise which this system affords, if the writing out of the notes be properly supervised, the literary exercise which it also affords is of no mean value.

In illustration, I may here very briefly describe the manner of working out the second problem in the course. The problem being to determine the composition of water, the student receives the instruction:—1. Pass steam over red-hot iron brads, collect the escaping gas, and apply a light to it. (N.B. The gas thus produced is called hydrogen.) He is provided with a very simple apparatus, consisting of a small glass flask containing water, joined by a narrow bent glass tube to an iron tube (about 9 inches long and ½ to ¾ inch wide) in which the brads are placed, a long glass tube suitably bent for the delivery of the gas being attached to the other end of the iron tube. Plaster of Paris is used instead of corks to make the connections with the iron tube. The iron tube is supported over a burner, and heated to redness; the water in the flask is then heated to boiling, and the steam thus generated is passed over the brads; the escaping gas is collected over water in the usual manner. Having made this experiment, and observed that, on passing steam over red-hot iron, the gas hydrogen is produced, the student proceeds to consider the bearing of this observation. The hydrogen must obviously be derived either from the water or from the iron, if not from both. Those who already know that iron is iron, so to speak, at once infer that the hydrogen is derived from the water: it is, however, pointed out that, even if it be known that iron is a simple substance, this observation taken alone does not prove that hydrogen is contained in water.

2. The student next learns to prepare hydrogen by the ordinary method of dissolving zinc in diluted sulphuric acid, and makes a few simple experiments whereby he becomes acquainted with the chief properties of the gas.

3. Having done this, he is instructed "to burn dry hydrogen at a glass jet underneath a cold surface and to collect and examine the product." The product is easily recognised as water, and the immediate answer to the question, "What does this observation teach?" is, that since iron is absent, taken in conjunction with Experiment 1, the production of water on burning hydrogen in air, the composition of which has already been determined, is an absolute demonstration that hydrogen is contained in water.

4. Having previously studied the combustion of copper, iron, and phosphorus in air, and having learnt that when these substances burn they enter into combination with the oxygen in air, the student is also led to infer from the observation that hydrogen burns in air producing water, that most probably it combines with the oxygen, and that water contains oxygen besides hydrogen. It may be however, it is then pointed out, that the hydrogen, unlike the phosphorus, &c., combines with the nitrogen instead of with the oxygen, or perhaps with both. He is therefore instructed to pass oxygen over heated copper, weighing the tube before and after the operation, and subsequently to heat the "oxide of copper" in a current of hydrogen. He then observes that water is formed, the oxygen being removed from the copper: and since nitrogen is absent, it follows that water consists of hydrogen and oxygen, and of these alone.

5. By repeating this last experiment so as to ascertain the loss in weight of the copper oxide tube and the weight of water produced, the data are obtained for calculating the proportions in which hydrogen and oxygen are associated in water.

In practice the only serious difficulty met with has been to induce students to give themselves the trouble to consider what information is gained from a particular observation; to be properly inquisitive, in fact. I cannot think that this arises, as a rule, from mental incapacity. When we consider how the child is always putting questions, and that nothing is more beautifully characteristic of young children than the desire to know the why and wherefore of everything they see, I fear there can be little doubt that it is one of the main results—and it is indeed a lamentable result—of our present school system that the natural spirit of inquiry, inherent to a greater or less extent in every member of the community, should be thus stunted in its growth, instead of being carefully developed and properly directed.

Having in the manner which I have described studied air, water, the gas given off on heating common salt with sulphuric acid, and the ordinary phenomena of combustion, the student next receives a paper with directions for the comparative study of lead and silver (see Appendix). The experiments are chosen so as to afford an insight into the principles of the methods ordinarily employed in qualitative and quantitative analyses, and the student who has conscientiously performed all the exercises is in a position to specialise his studies in whatever direction may be desirable.

The system I have thus advocated undoubtedly involves far more trouble to the teacher than that ordinarily followed, but the student learns far more under it, and I assert with confidence that the training is of a far higher order, and also of a more directly useful character. I believe it to be generally applicable, and that it would be of special advantage in those cases in which only a short time can be devoted to the study of chemistry, as in evening classes and medical schools. At present the only practical teaching vouchsafed to the majority of students in our large medical schools is a short summer course, during which they are taught the use of certain analytical tables: as a mental exercise the training they receive is of doubtful value; the knowledge gained is of little use in after life, and the course certainly ought not to be dignified by being spoken of as a course of Practical Chemistry; *test-tubing* is the proper appellation. It is not a little remarkable also that even the London University Syllabus nowhere specifies that a knowledge even of the elements of quantitative analysis will be required of candidates either at the Preliminary Scientific or First M.B. Examination, and this, too, when, as is well known, an analysis to be of any practical

value must almost invariably be quantitative. It is little less than a disgrace to the medical profession that a subject of such vital importance as chemistry should be so neglected.

If, however, we are to make any change in our method of teaching science, if we are to teach science usefully throughout the country, two things are necessary: teachers of science must take counsel together, and the examining boards must seriously consider their position. There can be little doubt that in too many cases the examinations are suited to professional instead of to educational requirements; and that the professional examinations are often of too general a character, and do not sufficiently take into account special requirements.

APPENDIX

Problem: to Determine the Composition of Air

N.B.—Immediately after performing each experiment indicated in this and subsequent papers, write down a careful description of the manner in which the experiment has been done, of your observations and the result or results obtained, and of the bearing of your observations and the result or results obtained on the problem which you are engaged in solving. Be especially on your guard against drawing conclusions which are not justified by the result of the experiment; but, on the other hand, endeavour to extract as much information as possible from the experiment.

1. Burn a piece of *dry* phosphorus in a confined volume of air, *i.e.* in a stout Florence flask closed by a caoutchouc stopper. Afterwards withdraw the stopper under water, again insert it when water ceases to enter and measure the amount of water sucked in. Afterwards determine the capacity of the flask by filling it with water and measuring this water.

N.B.—The first part of the experiment requires care and must be done under direction.

2. Allow a stick of phosphorus lashed to a piece of stout wire to remain for some hours in contact with a known volume of air confined over water in a graduated cylinder. After noting the volume of the residual gas, introduce a burning taper or wooden splinter into it.

N.B.—The residual gas is called *nitrogen*.

3. Burn a piece of dry phosphorus in a current of air in a tube loosely packed with asbestos. Weigh the tube, &c., before and after the experiment.

4. Repeat Experiment 2 with iron borings moistened with ammonium chloride solution. Preserve the residual gas.

5. Suspend a magnet from one arm of a balance; having dipped it into finely divided iron, place weights in the opposite pan, and when the balance is in equilibrium, set fire to the iron.

6. Pass a current of dry air through a moderately heated tube containing copper. Weigh the tube before and after the experiment; also note the alteration in the appearance of the copper.

7. Strongly heat in a *dry* test tube the red substance obtained by heating mercury in contact with air. At intervals plunge a glowing splinter of wood into the tube. Afterwards note the appearance of the sides of the tube. (Before performing this experiment ask for directions.)

N.B.—The gas obtained in this experiment is named *oxygen*.

8. Heat a mixture of manganese dioxide and potassium chlorate in a dry test tube, and at intervals plunge a glowing splinter into the tube. This experiment is to acquaint you with an easy method of preparing oxygen in quantity.

9. Prepare oxygen as in Experiment 8, and add it to the nitrogen from Experiment 4 in sufficient quantity to make up the bulk to that of the air taken for the latter experiment. Test the mixture with a burning taper or splinter.

10. Dissolve copper in nitric acid and collect the escaping gas (nitric oxide); add some of it to oxygen and some of it to air.

11. Fill a large flask provided with a well-fitting caoutchouc stopper and delivery tube with ordinary tap water and gradually heat the water to the boiling-point; collect the gas which is given off in a small cylinder and add nitric oxide to it. Also collect a sufficient quantity in a narrow graduated cylinder and treat it as in Experiment 2.

Comparative Study of Silver and Lead

Silver.—*Symbol*, Ag. (*Argentum*). *Atomic weight*, 107·67. *Specific heat*, ·05701.

Lead.—*Symbol*, Pb. (*Plumbum*). *Atomic weight*, 206·47. *Specific heat*, ·03140.

1. Determine the relative density of lead and silver at a known temperature by weighing in air and in water.

2. Separately heat known weights of lead and silver for some time in the air, allow to cool, and weigh.

3. Separately convert known weights of lead and silver into nitrates, and weigh the latter. From the data thus obtained calculate the *equivalents* of lead and silver.

4. Convert the known weights of nitrates thus obtained into chlorides, and weigh the latter.

5. Compare the action on lead and silver of chlorhydric acid; of dilute and concentrated sulphuric acid, using the acid both cold and hot; and of cold and hot nitric acid.

6. Using solutions of the nitrates, compare their behaviour with chlorhydric and sulphuric acids, hydrogen sulphide, potassium iodide, and potassium chromate. Ascertain the behaviour of the precipitate formed by chlorhydric acid when boiled with water, and when treated with ammonia solution.

7. Compare the behaviour of lead and silver compounds on charcoal before the blowpipe.

8. Tabulate the results of your experiments with lead and silver in parallel columns.

9. Ascertain whether the substances given you contain lead or silver.

10. Determine silver in an alloy of lead and silver by cupellation.

11. Study the method of determining silver volumetrically by means of a *standard solution* of ammonium thiocyanate. Determine the percentage of silver in English silver coinage.

12. Determine silver as chloride by precipitation.

13. Dissolve a known weight of lead in nitric acid, precipitate it as sulphate, collect and weigh the latter.

14. What are the chief ores of lead and silver? How are lead and silver extracted from their ores? How is silver separated from lead? How is it separated from burnt Spanish pyrites? What are the chief properties and uses of lead and of silver? State the composition of the chief alloys of lead and silver.

TRANSACTIONS OF THE NEW ZEALAND INSTITUTE

VOLUME XVI. of the *Transactions and Proceedings of the New Zealand Institute* contains the more important memoirs laid before its eight incorporated Societies during the year 1883 and the first weeks of 1884. It forms a bulky volume of about 650 pages, and is illustrated by 44 plates. It speaks a great deal for the energy of the able editor, Dr. James Hector, F.R.S., that he has in so short a time reduced such a mass of material into order, and that the volume should be issued in May of this year. While we think the illustrations still leave something to be desired as to their general style and execution, this volume is extremely creditable to the colony, and the amount of accurate research recorded will, if continued, soon make New Zealand one of the most completely investigated regions of the world. Of the 57 articles selected from the papers read before the local Societies, 25 relate to zoology, 22 to botany, 5 to geology, 1 to chemistry, and 4 to miscellaneous subjects. While of the titles of these papers we append a classified list, some few of them merit a more particular reference.

Mr. E. Meyrick contributes a third series of his descriptions of New Zealand Microlepidoptera, treating this time of the Œcophoridæ. This is the principal family of the Tineina in New Zealand, as is also the case in Australia. Some 67 species are recorded, of which 55 are particularly described, but the total number of species it is thought will be much more considerable. In New Zealand the family constitutes about a sixth of the entire Microlepidoptera, in Australia it forms more than a fourth, whilst in Europe it is about a thirtieth. It seems strange that, while this family occupies so prominent a position in both New Zealand and Australia, no species as far as is yet known is common to both. Fourteen genera are found in New Zealand; of these ten are endemic, three occur also in Australia, and one is cosmopolitan. Of the three genera shared with Australia, two (Eulechria and Philæopola) are large and typically Australian genera, represented in New Zealand by three species, obviously mere stragglers; the third (Trachypepla) is a typical New Zealand genus, probably of considerable extent, and is represented in Australia by two species only, evidently also stray wanderers. Of the ten endemic genera, none are very closely related to Australian forms. It would therefore appear that, while it is not improbable that a slight interchange of species has taken place at some not exceedingly remote period, it seems nearly certain that the group is of

much more ancient origin, and was derived from another and quite distinct region. Incidentally Mr. Meyrick suggests an affinity with South America, but in a collection made by the Rev. T. Blackburn in the Hawaiian Islands, the Œcophoridæ appeared to be altogether absent, their place being taken by a peculiar group of Gelechiidæ.

Mr. Meyrick also contributes a monograph of the New Zealand Geometrina. He does this with some diffidence, owing to the difficulties he has laboured under of consulting type specimens and of the absence of works of reference. A large number of published names are reduced to the rank of synonyms; some 60 species are added to the list, which now stands at 89. In addition to the description of both genera and species, analytical tables of these are given throughout, and the monograph appears to be such as will enable the student to easily identify his captures and will still induce him to the further study of this group, and especially to the transformations of the species contained in it.

Capt. F. W. Hutton gives a very important revised list of the land Mollusca of New Zealand. From the ample collections that have passed under his examination, he has been enabled to determine satisfactorily all but a very few of the described species, as well as to indicate fairly their distribution in the islands. The list contains 116 species, of which 13 remain unknown to the author. Seven have been introduced from England. The dentition of 60 and the internal anatomy of 26 species have been described by Capt. Hutton in vols. xiv. and xv. of the *Transactions*. So far as at present known, one-half of the species are confined to the North Island, one-quarter to the South Island, and one-quarter are common to both. The closest connection of the land molluscan fauna would appear to be with North Australia, but there is a considerable generic affinity with the faunas of New Caledonia, Polynesia, and South America.

An interesting paper on the habits of earthworms in New Zealand is contributed by Mr. A. T. Urquhart. The species are not named, but with such wonderful opportunities as Mr. Urquhart possesses for making a collection of these, may we hope that, in addition to his following out his painstaking observations as to their habits, he will also advance science by making a careful collection of the forms and placing them in the hands of some of the able naturalists of the Auckland Institute for description? It will be remembered that Darwin assumes that in old pastures there may be 26,886 worms per acre, and that Henson gives 53,767 worms per acre for garden ground and about half that number in cornfields. Mr. Urquhart gives, as the result of his investigations of an acre of pasture-land near Auckland, the large number of 348,480 worms as found therein. It being suggested to him that in his selection of the spots for examination he may have unconsciously selected the richest, the experiment was again tried in a field seventeen years in grass. A piece was laid out into squares of 120 feet, and a square foot of soil was taken out at each corner; worms hanging to the side walls of the holes were not counted, and in one hole, where the return of worms was a blank, the walls were crowded with worms. As a result there was an average of 18 worms per square foot, or 784,080 per acre. Although this average is very striking when compared with that of Henson, it is worthy of note that the difference between the actual weight of the worms is not so marked. According to Henson, his average of 53,767 worms would weigh 356 pounds, while Mr. Urquhart finds that the average weight of the number found by him came to 612 pounds 9 ounces.

Apropos of a description of the head in *Palinurus lalandii*, by Prof. T. Jeffery Parker, founded on specimens which happened to be brought on board at the Cape of Good Hope during his voyage to New Zealand, we have a very natural classification of the species of this genus offered to us. The genus Palinurus, Fabr., would contain three subgenera. For the species in which the stridulating organ is absent and the procephalic processes are present Prof. Parker proposes the very appropriate generic name of Jasus; while for those forms in which the stridulating organ is present and the procephalic processes are absent he would reserve the name Palinurus, Fabr., retaining Gray's subgenus Panulirus for the longicorn species. He notes that, omitting *P. longimanus* and *P. frontalis*, of which he could obtain no definite information, all the species of Jasus are confined to the Southern Hemisphere (Ethiopian and Australian Regions); and those of Palinurus are restricted to the Northern Hemisphere; while those of Panulirus occur in both Hemispheres.

Dr. Walter Buller furnishes a series of notes on some rare species of New Zealand birds. *Sceloglaux albifacies*, the laughing owl, has been found by Mr. W. W. Smith in deep fissures of the limestone rocks at Albury, near Timaru. After many futile efforts Mr. Smith bethought himself of smoking them out; after a few whiffs the owls began sniffing, and then in a few moments quietly walked out; four were captured. They soon became quite tame. On waking up at nightfall, their call was "precisely the same as two men cooeying to each other from a distance." The male is the larger and stronger bird, with a harsher cry. The female performs most of the duty of hatching. They showed a decided perference for young rats, but would eat beetles, lizards, mice, or mutton. The crannies of the rocks in which they make their nests and live during the day are dry, very narrow at their entrance, and often five or six yards in depth. While casting their feathers they become almost naked, and two of Mr. Smith's birds while in this state were stung to death by a swarm of bees which passed through the wire netting of their cage.

Mr. R. H. Govett gives some startling facts as to the bird-killing powers of *Pisonia brunoniana* or *P. sinclairii*. A sticky gum is secreted by the carpels when they attain their full size, but is nearly as plentiful in their unripe as in their ripe condition. Possibly attracted by the flies which embalm themselves in these sticky seed-vessels, birds alight on the branches, and on one occasion two Silver-eyes (Zosterops) and an English sparrow were found with their wings so glued that they were unable to flutter. Mr. Govett's sister, thinking to do a merciful act, collected all the fruit-bearing branches that were within reach, and threw them on a dust-heap. Next day about a dozen silver-eyes were found glued to them, four or five of the pods to each bird. She writes:—"Looking at the tree one sees tufts of feathers and legs where the birds have died, and I don't think the birds could possibly get away without help. The black cat just lives under the tree, a good many of the birds falling to her share, but a good many pods get into her fur, and she has to come and get them dragged out." In a note Mr. T. Kirk says that *Pisonia umbellifera*, Seeman, = *P. sinclairii*, Hook.f., is found in several localities north of Whangerei, both on the east and west coasts, also on the Taranga Islands, Arid Island, Little Barrier Island, and on the East Cape, possibly in the last locality planted by the Maoris. The fruiting pericarp is remarkable for its viscidity, which is usually retained for a considerable period after the fruit is fully matured. It can be readily imagined that small birds tempted to feed on the seeds might easily become glued to a cluster of fruits.

Among new species of plants collected on Stewart Island by Mr. Kirk, he describes a beautiful new Olearia (*O. traillii*), called after his old and valued friend C. Traill, who has done so much for the natural history of Stewart Island. It forms a large shrub from five to twelve feet high. The terminal panicles are from four to nine inches long. The disk florets are purple. It is one of the most striking plants in the New Zealand flora, and one we hope we may soon see in cultivation. Mr. Kirk also, among other important contributions, publishes notes on Carmichaelia with descriptions of new species, one of which, *C. uniflora*, seems to be the same as a new species, with the same specific name, described in a paper read the same night before the Wellington Philosophical Society by Mr. J. Buchanan.

Mr. J. Buchanan gives an interesting account of Campbell Island and its flora. The island, thirty miles in circumference, is three good days' steaming from Wellington. Peat abounds, and the soil is extremely damp in the low-lying regions. The highest altitude is 1500 feet. Only a day and two half-days were available for botanical research, but five species were added to the flora, of which three were new. Many of the species had large and showy flowers, such as *Celmisia vernicosa*, Hook. f., and the various species of Pleurophyllum. These and the like were confined within an altitudinal range of 500 feet above sea-level, but the shrubby forms, such as species of Coprosma, Drachophyllum, Veronica, and Myrsine, ranged from sea-level, where they were most abundant, to the highest altitude. An Alpine flora may also be recognised, as a few plants were only found at the highest altitude, such as *Gentiana concinna*, Hook. f., and *Trineuron spathulata*, Hook. f.

Mr. T. F. Cheeseman contributes a very valuable revision of the New Zealand species of Carex, admitting 40 species, of which 25 are peculiar to the country; of the other fifteen found elsewhere, eleven are recorded from Tasmania and Australia, nine of these are found in Europe, North and West Asia, and North America, seven in Southern or Eastern Asia, six

in temperate North and South Africa, and four or five come from extra-tropical South America.

We can only direct general attention to Mr. Justice Gillies' important paper giving the result of his experiments in 1882-83 on the production of sugar from Sorghum, which seem to have been most successful, and to give promise of a good future for sugar-making in the colony; and to Mr. W. Arthur's report on the brown trout introduced into Otago.

Zoology.—E. Meyrick, New Zealand Microlepidoptera and Geometrina; R. W. Fereday, new species of Cidaria; T. H. Potts, on a species of Mantis; W. M. Maskell, on new Coccidæ; Geo. M. Thomson, new Crustacea and Pycnogonida; C. Chilton, New Zealand sessile-eyed Crustacea; T. Jeffery Parker, on Palinurus; A. T. Urquhart, habits of earthworms; Capt. F. W. Hutton, revision of land Mollusca, of recent Rhachiglossate Mollusca, new species of Mollusca; H. B. Kirk, Anatomy of *Sepiotcuthis bilineata*; Dr. J. von Haast, occurrence of the Red Phalarope in New Zealand; Dr. W. Buller, notes on rare birds; Prof. T. J. Parker, on the occurrence of some rare fishes; Dr. Hector, notes on New Zealand ichthyology.

Botany.—W. Colenso, further contributions to New Zealand botany; J. D. Enys and T. Kirk, *Botrychium lunaria* in New Zealand; T. Kirk, botanical notes, descriptions of new species of plants; J. Adams, the botany of the Thames goldfields; A. T. Urquhart, the spread of the Eucalyptus; J. Buchanan, notes of new and rare plants, Campbell Island and its flora; Charles Knight, Lichenographia of New Zealand; T. F. Cheeseman, additions to New Zealand flora, revision of the genus Carex (New Zealand species).

Chemistry.—J. A. Pond, the pottery clays of Auckland district.

Geology.—R. M. Laing, thermal springs at Lyttelton; H. Cox, new minerals; Captain F. W. Hutton, the lower gorge of the Waimakariri; D. Sutherland, discoveries near Milford Sound.

Miscellaneous.—W. Arthur, brown trout introduced into Otago; Mr. Justice Gillies, Sorghum experiments, 1882-83; Coleman Phillips, the law of gavelkind, a reply to Messrs. George and Wallace.

SOCIETIES AND ACADEMIES

PARIS

Academy of Sciences, October 27.—M. Rolland, President, in the chair.—Remarks on the first volume of the late M. Dumas' "Discours et Éloges Académiques," presented to the Academy by M. J. Bertrand.—Note on contaminated waters in connection with the spread of cholera, by M. Marey. A careful study of this epidemic since its first appearance in Europe, together with some personal observations in Paris and other parts of France, have convinced the author that the disorder is propagated chiefly through the medium of water. All other influences are of secondary importance, so that to secure the purity of drinking-water in every affected locality should be the first care of the sanitary authorities.—On the formation of saltpetre in plants, by MM. Berthelot and André.—On the oxidation of copper, by MM. Debray and Joannis.—On the laws determining the penetration of the rolled plates of ironclads by projectiles, by M. Martin de Brettes.—On the employment of the aqueous solution of the sulphuret of carbon for the destruction of Phylloxera, by M. A. Rommier.—Account of an easy process for rapidly preparing solutions containing sulphuret of carbon in large quantities, by M. Ach. Livache.—Observations of the lunar eclipse of October 4, made at the Observatory of Lyons (Brunner 6-inch equatorial), by M. Gonnessiat.—Observations of the comets of Barnard and of Wolf made at the Observatory of Lyons (Brunner 6-inch equatorial), by M. Gonnessiat.—On a representation of the exponential function by an infinite product, by M. R. Lipschitz.—On the equilibrium of a homogeneous segment of a revolving paraboloid floating on a fluid, by M. Em. Barbier.—Measure of the horizontal component of terrestrial magnetism by the method of amortisement, by M. J. B. Baille.—Note on the relation between temperatures and pressures of the protoxide of liquid carbon, by M. V. Olszewski.—On some reactions of chlorochromic acid, by M. Quantin. The oxide of carbon acting alone on chlorochromic acid changes it to a green sesquioxide of chromium and to a violet sesquichloride. The simultaneous action of the oxide of carbon and of an excess of chlorine changes integrally the oxychloride of chromium to a sesquichloride.—Chemical analysis of the apatite (phosphate of calcium) occurring at Logrozan in Spain, by M. A. Vivier.—On a graphic granite with large crystals of chlorophyllite from the banks of the Vizézy near Montbrison (Loire), by M. F. Gonnard.—Heat of combination of the compounds of hydrogen and oxygen, by M. A. Boillot.—On the phenomena accompanying the solar corona at present visible in the Alps, by M. Duclaux. These phenomena are regarded as purely atmospheric, the sun being merely the luminous source. The solar corona itself is attributed to normal although rare causes, and is considered as analogous to the halo so often observed round the moon, when the atmosphere is charged with moisture.—Observation of the solar coronas during the aerostatic ascents of October 23 and 24, by MM. A. and G. Tissandier.—Note on solar energy and the oscillations of the magnetic needle, by M. Duponchel. From the observations made from the middle of the sixteenth century down to the present time the author infers that the secular variations of the needle are due to the action of a new ultra-Neptunian planet which he names the *Ocean*, and which may have a revolution of about 467 years. This planet must have passed through the longitudes 80° and 260° about the years 1580 and 1813, and should now be in the longitude of 314° in the constellation of Capricorn.—Note on the employment of hydrosulphuric acid for discharging colours, by M. A. Gérardin. This acid, discovered by M. Schützenberger, and now extensively employed, produces remarkable effects, acting by reduction, contrary to chlorine and oxygen, which act by oxidation. This property seems capable of important industrial application.—Note on distilled water used for drinking-purposes, by M. A. Hureau de Villeneuve. The author argues that the price of distilled water might be greatly reduced by obtaining it from steam-engines at work in mills; that it is neither unpalatable nor difficult to digest; that it generally contains a sufficient quantity of air, and that the absence of calcareous salts is rather an advantage than a drawback.

CONTENTS

	PAGE
Two Bee Books	1
Dr. Klein on Micro-Organisms. By Prof. E. Ray Lankester, F.R.S.	2
Our Book Shelf:—	
Johnson's "New Method of treating Glaucoma"	3
Letters to the Editor:—	
An Unnoticed Factor in Evolution.—Edmund Catchpool	4
Earthquake Measurement.—Prof. J. A. Ewing	4
The Sky-Glows.—W. G. Brown; Mrs. Ellen A. Day; Surgeon Thomas Leeming, R.N.	5
Peculiar Ice Forms.—B. Woodd Smith	5
The Blackness of Tropical Man.—Lieut.-Col. A. T. Fraser, R.E.	6
The Distribution of Scientific Works Published by the British Government.—G. F. B.	7
A New Method of Heating in the Regenerative Gas Furnace	7
The Prime Meridian Conference. By William Ellis	7
The Illuminated Fountains at the Healtheries. (*Illustrated*)	11
Experiments with Coal-Dust at Neunkirchen in Germany. By W. Galloway. (*Illustrated*)	12
Flowers out of Season. By Dr. Maxwell T. Masters	13
Notes	15
Our Astronomical Column:—	
Barnard's Comet	18
The November Meteors	18
The Lick Observatory, California	18
Variable Star in the Orion-Nebula	18
Geographical Notes	18
Natural Science in Schools. By Prof. Henry E. Armstrong, Ph.D., F.R.S.	19
Transactions of the New Zealand Institute	22
Societies and Academies	24

THURSDAY, NOVEMBER 13, 1884

WORLD-LIFE

World-Life; or, Comparative Geology. By Alex. Winchell, Professor of Geology in the University of Michigan. Pp. 642. (Chicago: Griggs, 1883.)

At the present day cyclopædic knowledge has become very rare, and a scientific man is generally like a miner intent on his own special shaft, and too often careless or ignorant of the general plan of the whole mine of science. The work of the collator and summariser is thus continually rising in importance, and care, patience, and judgment are now more requisite than ever before. Although these scientific "consolidation acts" can hardly fail to be open to criticism, yet every man of science must receive them with gratitude, for they afford him a general view of his science, and furnish him with a useful repertory of reference.

In this work Prof. Winchell's field is very wide, when he undertakes to collate astronomy, cosmogony, and geology, in the widest acceptation of these terms. So many subjects does this book touch on that it will only be possible within the limits of an article to give a general view of its scope. The author's reading has been extensive, and we are glad to observe that copious references are provided. He expounds with care, although perhaps sometimes too diffusely, the views of many writers, and thus brings to a focus a great mass of literature, and his own speculations are generally interesting, although not always above criticism.

As already indicated, this work is intended to give a general survey of stellar and planetary systems, to note the marks of evolutionary processes revealed by the telescope, to discuss various cosmogonic theories, to examine the probable life-histories of nebulæ, suns, planets, and satellites, and to consider the influences under which the surfaces of planets are modelled and transformed.

Modern cosmogony is properly a department of physics and dynamics; but when states of matter irreproducible in the laboratory, and the mechanics of systems too complex for rigorous mathematical treatment, are dealt with, moderation in the general reasoning employed has not always been duly observed. No one can doubt that speculation is of the highest scientific importance, but it is also equally certain that in work of this kind a descending scale may be formed, beginning with speculations founded on rigorous mechanical principles and ending with wild and lunatic fancies. Every writer on such topics must, I suppose, sometimes question himself with misgiving as to where in such a list his name would stand. Mr. Winchell appears to treat all speculations with judgment, although one is sometimes tempted to think the exposition over-elaborate and the consideration too patient.

The first part or book is entitled "World-Stuff," and begins with a good account of meteors and meteoric dust. The author thinks that, according to Mr. Aitken's theory of the formation of fog, the highest clouds in our atmosphere reveal the presence there of a very fine dust, probably of cosmic origin. The sunset-glows of last winter appeared to illuminate clouds at an unusual altitude: may not these clouds have owed their existence to the very dust which caused the glow?

The zodiacal light is then described, and is attributed to swarms of meteorites circulating round the sun, and the visibility of the light on both horizons simultaneously is taken as showing that the orbits of some of them are greater than that of the earth. The author also suggests the probability that swarms of meteorites circulate about the planets as satellites.

Comets, whose association with meteorites is now generally accepted, are described. Later (p. 77) the author writes:—

"The phenomena of the tail, especially in the vicinity of aphelion, are such as would result if we could conceive the nucleus of the comet surrounded by an aura extending on all sides as far as the remotest limits of the tail, and could recognise the tail as merely a *luminous shadow* cast by the nucleus in intercepting certain radiant energy proceeding from the sun. . . . The tail would be, therefore, not a material form moving with the comet, but something perpetually renewed, while the older and more distant emanations disappear from visibility."

That theory which divides the tails of comets into three classes, according to the gas of which they are formed, is not given.[1]

The nebulæ are then passed in review, and are well illustrated by drawings. They are classified as amorphous, spiral, spiro-annular, annular, and planetary, and the class is taken as giving an indication of the stage of evolution.

In the case of a spiral nebula, such as that in Canes Venatici (Fig. 8, *op. cit.*), it seems difficult to believe that we view the whole. And we suggest that the great mass of the gas is non-luminous, the luminosity being an evidence of condensation along lines of low velocity, according to a well-known hydrodynamical law. From this point of view the visible nebula may be regarded as a luminous diagram of its own stream-lines.

In the second chapter the author enters on the generation of heat in nebular masses. The discussion appears unsatisfactory, and as it is a matter of primary importance, I propose to make some criticisms thereon. The usage of mechanical and thermic terms is loose, so that it is somewhat difficult to determine the author's meaning.

The question is concerning the generation of heat in a contracting nebular mass, and on p. 86, § 9, he concludes:—

"It is true, then, that contraction develops heat, and that its development delays final refrigeration; that is, the progress toward final refrigeration is not as rapid as the amount of radiated heat implies. But it is not true that contraction (from cooling) can have developed the whole amount of heat at any time existing in the mass, or can even maintain a body at a constant temperature."

From this conclusion I venture to dissent, and in order to show my grounds I will give a paraphrase of the author's argument, as far as I am able to grasp it.

Let there be two similar planetary spheres with layers of equal density similarly arranged, and let the linear dimensions of the smaller (or say configuration β) be $1/n$th of those of the larger (or say configuration α); or,

[1] This was sketched by Prof. Ball in his late lecture at Montreal, but I have unfortunately forgotten the originator's name

in other words, let a and a/n be any corresponding radii of α and β.

Let the mass, however, contained within radius a of α be equal to that within radius a/n of β; so that β might be formed from α by simple contraction; and suppose both systems to be in hydrostatic equilibrium. Then it is easy to show that if ρ be the density at any point of α, the corresponding density of β is $n^3\rho$; and if p be the pressure at the same point of α, the corresponding pressure of β is n^4p; and lastly, the modulus of elasticity being $\rho dp/d\rho$ at any point of α, the corresponding elasticity of β is $n^4\rho dp/d\rho$.[1]

Now if we suppose the mass to have contracted from a state of infinite dispersion to the configurations α or β, there must in each case be a certain exhaustion of potential energy of mutual attraction of matter, developing heat in the mass. Then it may be shown that if h is the exhaustion of energy of the matter within a radius a in passing from infinite dispersion to configuration α, the exhaustion of energy of the matter within a radius a/n in passing from infinite dispersion to configuration β is nh.[2] The same is also true of any stratum in course of its contraction. If we take a succession of configurations with radii infinity, 1, $\frac{1}{2}$, $\frac{1}{3}$, &c., in harmonic progression, a constant amount of heat will be generated in passing from any one configuration to the next.

Now let us suppose that in course of contraction neither convection, conduction, nor radiation takes place; then if the temperature in the condition of infinite dispersion be zero, and if the specific heat be constant, the temperature of any stratum a of α being θ, that of stratum a/n of β will be $n\theta$. In this case $\rho\theta$, being density multiplied by absolute temperature, becomes, in passing from α to β, $n^4\rho\theta$. If, therefore, the modulus of elasticity varies as density multiplied by temperature, we have the elasticity in β n^4 times that of α. But we have already seen that $\rho dp/d\rho$ is augmented in passage from α to β by the factor n^4. Hence the hypotheses as to arrangement of strata, specific heat, and law of elasticity are such as to insure equilibrium in every configuration, if it holds in any. This law of elasticity is that of the *isothermal* contraction of a so-called perfect gas.

Now Mr. Winchell's argument appears to me to be that, when there is loss of heat by radiation, there is necessarily deficiency of temperature to make up the elasticity, and thus equilibrium is impossible unless we look for heat from other causes. He does not seem to notice, however, that it will be far nearer the truth (if any such physical hypotheses can be said to be near thereto) to take the elasticity from the adiabatic contraction of the perfect gas, which we know to vary as $\rho^\gamma\theta$, where $\gamma = 1{\cdot}408$. With this law the argument breaks down. In any case the constancy of specific heat, the similarity of successive configurations, and the law of elasticity of "perfect" gases are untenable. In order, however, to do justice to the author I must point out that he attributes later the supply of heat to "conglomeration," which differs I presume from "contraction" in the supposed absence of hydrostatic equilibrium in successive stages, and in the irregularity of the masses concerned.

The paragraph in this chapter on nebular rotation appears to clothe the matter in an unnecessary mystery. Surely we may admit that the existence of a nebular mass with an absolute zero of resultant moment of momentum is highly improbable; and if the expanded nebula has finite resultant moment of momentum, then *must* the agglomerated nebula rotate. Even with zero momentum the nebula might perhaps divide into two portions with equal and opposite momenta.

We next come to paragraphs on nebular annulation and the "spheration" of rings. The intractability of these problems to mathematical treatment renders the discussion highly speculative, but the author seems to treat his subject with discretion.

The second main division of the work bears the title of "Planetology." An elaborate survey of the solar system is given, with a consideration of the arguments for and against the nebular hypothesis. The fact that the inner satellite of Mars revolves in a period shorter than that of the rotation of its planet is regarded as a great difficulty in the acceptance of Laplace's theory. Our author, whilst suggesting as an explanation a diminution of the primitive period through the influence of a resisting medium, refers favourably to the theory that solar tidal friction has retarded the planet's rotation whilst leaving the period of the satellite unaltered. I have myself regarded the fact of which we speak as a very striking confirmation of the importance of tidal friction in planetary evolution.

Faye's modification of the nebular hypothesis, in which the planetary annuli are supposed to arise in the interior of the nebula, is criticised by Mr. Winchell with some success. An account is also given of Spiller's theory. That author rejects the annuli entirely, and supposes the planets to arise by a combination of tidal action with centrifugal force. The formation of the planet is supposed to take place after the central mass has reached the condition of igneous fluidity.

"It is manifest that a separated planetary mass must produce a tidal swell of some magnitude upon the fluid central mass. . . . At some perihelion of the planet therefore—concurring perhaps with a conjunction of planets—the centrifugal tendency of the equatorial portion of the central fluid mass would exceed gravitation, and the tidal swell would be lifted bodily from connection with the central mass. . . ."[1]

Neptune generated Uranus, Uranus Saturn, and so on.

Now I venture to say that Spiller could not have made any numerical estimate of the efficiency of a planet's tidal action on the sun, or he could not have proposed this fantastic theory.[2] It would therefore hardly have seemed to me worth while to have referred to this passage had not Mr. Winchell stated that this theory might be regarded as a prototype of one of my own.

I had suggested that when the earth, then without a satellite, was rotating in four or five hours, the free period of oscillation of the fluid planet would be almost the same

[1] The reader acquainted with Laplace's theory of the earth's figure will have no difficulty in proving this, or even a simple acquaintance with hydrostatic principles will suffice.

[2] The exhaustion of a homogeneous sphere of mass M and radius a is $\frac{3}{5}\mu M^2/a$, where μ is the attractional constant. Hence for a heterogeneous sphere we have $\frac{8}{3}\pi^2\mu\int_0^a \rho^2 a^4 da$. If ρ becomes $n^3\rho$ and a becomes a/n, obviously the exhaustion becomes n times as great as before.

[1] P. 215, *op. cit.*

[2] For such an estimate see a paper "On the Tidal Friction of a Planet attended by several Satellites, &c." (*Phil. Trans.* Part 2, 1881). On p. 515 it is shown that, supposing the coefficient of viscosity in the sun to be the same as that in the earth, then the increase of earth's orbital moment of momentum due to earth's tides in the sun is 1/11300oth part of that due to sun's tides on the earth. See also Table III. p. 526.

as the period of the solar semi-diurnal tide, and that the solar tide might undergo such kinetic augmentation as to rupture the planet. A piece torn off might form the moon. The suggestion was only thrown out tentatively, and it might perhaps have been better had it been suppressed. The whole essence of the suggestion lies, however, in the approximate identity of the free and forced periods of oscillation, and this reasoning has no place in Spiller's theory.

In considering the history of a cooling planet, the author is opposed to Sir William Thomson, and concludes that the surface would harden into a crust. It seems to me that the time is hardly ripe for a very confident opinion on the point.

A large place is given in this book to the influence of tides in the evolution of a planet. A description is given of the tidal retardation of planetary rotation and the recession of the satellite; and the chapter is in fact principally a *résumé* of my own papers. The author is at one with me in rejecting Prof. Ball's view, that an enormous exaggeration of marine tides can have taken place within geological history. He is inclined to adopt the view that the trends have been imparted to our great continents by means of the wrinkling consequent on tidal friction in a primitively viscous mass; but he hardly notes, as I pointed out, that if this be so we have to accept a continuous adjustment of the general ellipticity of the earth to a figure of equilibrium, without obliteration of the wrinkles. The suggestion is thus perhaps placed in almost too favourable a light.

On p. 282 Mr. Winchell speaks as though solar tidal friction is adequate to cause a sensible lengthening of the year, so that in earlier ages it was sensibly shorter. It is impossible to admit the correctness of this view, as I have elsewhere shown.[1]

In a section on orogenic forces we have, amongst much other interesting matter, an account of M. Favre's experiment, in which a layer of clay is placed on a tense elastic membrane, which is then allowed to contract: an illustration of many of the facts of mountain geology is thus furnished.

In the following chapter the author follows the various lines of argument by which limits are placed on the age of a planet, and by a subsequent geological discussion endeavours to derive a time scale; but I feel incompetent to judge of the worth of the conclusion. We may regret to find the revival in this place of Prof. Haughton's argument, viz. that the absence of a measurable nutation of 306 days proves the enormous antiquity of the elevation of Europe and Asia. The argument is, I think, worthless, as I believe that Prof. Haughton now admits.[2]

The principal topics dealt with in the rest of the book are the geology of the moon, the physical condition and habitability of other planets, and the final effects of tidal friction.

The fourth main division of the book is historical, and contains a review of the evolution of cosmogonic theories, with an exposition of the speculations of Kepler, Descartes, Leibnitz, Swedenborg, Kant, Lambert, William Herschel, and Laplace.

From the account which has now been given of this work it must be evident that Mr. Winchell set before himself a task of portentous magnitude, and that he has performed it conscientiously. The criticisms which have been made should not impair the conviction that the student of this group of subjects will find his work of great value.

G. H. DARWIN

[1] *Phil. Trans.* Part 2, 1881, p. 524: "From this it follows that, if the whole of the momentum of Jupiter and his satellites were destroyed by solar tidal friction, the mean distance of Jupiter from the sun would only be increased by 1/250oth (*misprinted* 1/2500th) part. The effect of the destruction of the internal momentum of any other system would be very much less."

[2] See *Proc. R.S.* February 19, 1878, No. 186, p. 1, "On Prof. Haughton's Estimate of Geological Time."

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 Pentacrinoid Stage of Antedon rosaceus

IN compliance with Prof. Herdman's request, I have to state that my experience—acquired during seven years of consecutive dredging in Lamlash Bay (1855-61)—is in entire accordance with his own. Although the most active period of reproduction in *Antedon rosaceus* is undoubtedly (as stated by Sir Wyville Thomson) the *early* part of the summer, so that the Pentacrinoids which spring from the ova then matured and fertilised are ready to drop off their stems in the succeeding autumn, yet I never failed to obtain *Pentacrinoids* in all stages, as well as *Antedons* still "in fruit," throughout the months of August and September. In fact, the whole of my study of this type—which, as regards the skeleton, is fully recorded in my memoir in the *Philosophical Transactions* for 1865, and of which, as regards the soft parts, a general account is given in the *Proceedings* of the Royal Society for 1876, was carried out during those months; my official duties keeping me in London until after the first week in August.

I may take this opportunity of directing the attention of those interested in Crinoidal structure (1) to a communication I have recently made to the Royal Society (*Proceedings*, May 29) on the Nervous System of the Crinoids; (2) to a paper by Prof. A. Milnes Marshall in the *Quarterly Journal of Microscopical Science* for July last; and (3) to a paper by Dr. Carl Jickeli of Jena, in the *Zool. Anzeiger*, 7 Jahrgang, No. 170.—The doctrine I propounded on this subject nearly twenty years ago (that the quinquelocular organ contained in the centro-dorsal basin of *Antedon* is a *nerve-centre*, and that the radial cords issuing from it, which traverse the calcareous segments of the arms and pinnules, and give off branches to the successive pairs of muscles, are *nerve-trunks*), though supported by the experimental evidence which I published in 1876, and by the careful microscopic investigations of my son, Dr. P. Herbert Carpenter, has not been accepted by Zoologists generally; being for the most part either ignored altogether, or pooh-poohed as "evidently" fallacious, because inconsistent with homological theory. When I made my recent communication (1) to the Royal Society, summing up the very remarkable confirmatory evidence afforded by my son's inquiries, and referring (as Prof. Marshall had kindly enabled me to do) to the then unpublished results of his experiments (2), which entirely tallied with my own, Prof. Huxley, while admitting the strength of my case, remarked that the position I assign to the nervous system of the *Crinoidea* is as anomalous (in relation to that of Echinoderms generally) as it would be for a Vertebrate animal to have its spinal cord lying along its ventral surface. In reply, I asked, "What more proof *can* you ask for, of the nervous function of the quinquelocular organ and radial cords?" The only additional evidence that Prof. Huxley could suggest, was the result of electric stimulation. Before my paper was published in the *Proceedings*, I learnt (3) that this experiment had been actually tried four years ago by Dr. Jickeli, whose results entirely confirmed my doctrine.

It is to be hoped, therefore, that those who have so confidently and persistently clung to a homology, which is in direct contradiction to the most complete and conclusive proof that experiment can afford—supported as this is by the large body of

anatomical and histological evidence summarised in my recent paper—will now see that unless they can disprove the statements of Prof. Marshall, Dr. Jickeli, Dr. P. Herbert Carpenter, and myself, they are bound to admit my doctrine, and to show how their theoretical homology is to be reconciled with it.

WILLIAM B. CARPENTER

56, Regent's Park Road, London, N.W., November 3

Natural Science for Schools

THE thoughtful and suggestive paper of Prof. Armstrong in the last number of NATURE (p. 19) is to be commended to the attention both of science teachers and of the head masters of our schools. It is undoubtedly true that, with few exceptions, science is still either completely neglected by our schools or handled in a way which does not at all tend to advance its interests. When it is made a "refuge for the destitute," or considered only fit for those intellectually unequal to the study of classics and mathematics, no wonder that observant head masters conclude that little good is to be got from it.

As a science master of many years' experience (having been in fact responsible for the introduction of science into *two* of the schools named by Prof. Armstrong as exceptions to the universal indifference), you will perhaps allow me to call attention to the importance of Prof. Armstrong's paper, and to give the conclusions to which my own experience has led me.

The importance of clearly understanding the purpose with which science is to be studied, and the distinction to be borne in mind between the best curriculum for those who are to be professed chemists and those who will not carry the study of chemistry beyond their school-days is obvious; but I wish to point out how entirely science masters are at the mercy of examiners, both of University examiners, periodically examining a school, and of examiners for open scholarships. My own experience is to the point. Fully persuaded of the uselessness of attempting to make an analytical machine out of the ordinary school-boy giving two or three hours a week to chemistry for two or three years, and of the very small amount of education to be obtained from such a course, I endeavoured to model my instruction in practical chemistry much upon the lines adopted by Prof. Armstrong, and exemplified in the appendix to his paper. When the examinations came, it was duly explained to the examiner that the course of instruction adopted had been unusual, but, all the same, the papers set were of the usual kind:—"Analyse the mixture A," "Determine the metals and acids present in the solution B," &c. On such a paper, of course, the boys failed, and a depreciatory report was sent up by the examiners, with the result that the governors of the school thought it their duty to interfere, and request that "more attention should be given to practical chemistry." Consequently my attempt had to be abandoned, and we returned to our "test-tubing."

Scholarship examinations, being presumably of those who will carry the study much further, may more reasonably demand a knowledge of the ordinary methods of analysis, but I am glad to see that a considerable change has taken place in the papers set, and that now the questions proposed are often such as to place the mechanical analyst at a disadvantage, and to encourage the intelligent observation and interpretation of phenomena.

Prof. Armstrong of course writes as a chemist. But there can be no doubt that certain portions of physics are educationally more useful, and it seems to be only the difficulty of arranging practical work in physics which has led to the present state of things, where practical science work in schools means nearly always practical chemistry. But Prof. Armstrong's protest against allowing this to degenerate into "test-tubing" should not be disregarded. There seems also no reason why *elementary* instruction in science—whether chemistry, or botany, or physiography—should not deal *first* with the familiar things of every-day life. I think much more training is to be got by determining, as Prof. Armstrong suggests, the composition of air, the relative combining weights of silver and lead, &c., than by seeing made any number of oxides of nitrogen, and listening to a description of their properties. There is, however, considerable difficulty in arranging easy methods of determining chemical equivalents which, in inexperienced hands, shall give results not *too wide* of the mark.

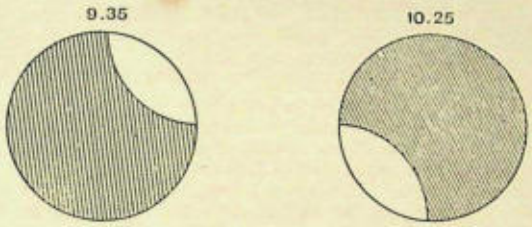
If a boy gets out the atomic weight of oxygen as 9 when the book says it is 16, or finds the latent heat of steam to be 300 and something when it ought to be 536, he begins to disbelieve in the precision of the statements made, and it is unfortunately impossible for a beginner to make *accurate* determinations of combining weights. Less erratic results can, in fact, be obtained in certain selected physical measurements.

The "bareness" of printed instructions is, as Prof. Armstrong remarks, a distinct advantage to the good student, by compelling him to think for himself, but it is fatal to the unintelligent student, to whom "thinking" is the very hardest work he is called upon to do.

SCIENCE MASTER

The Recent Lunar Eclipse

My object in writing is to confirm in some degree the peculiar appearance of the disk, noticed in your last number (vol. xxx. p. 632). The eclipse was seen here under the most favourable circumstances: the obscuration was so great that the disk could barely be discerned with the naked eye, and the copper colour usually seen was not noticed. Having watched the moon well into the umbra, my attention was diverted for a while, but, on looking again, at 9.35 G.M.T., I was surprised to see a portion of the north-east quadrant pretty strongly illuminated; my attention was again diverted, but on looking a second time at 10.35 G.M.T., I observed a portion of the south-east quadrant



illuminated in a somewhat similar manner. At both times the moon was well within the geometrical umbra. But the remarkable feature was that on both occasions the boundaries of the illuminated portions were, approximately, circular, and convex toward the axis of the umbra, indicating that the refracted solar rays producing these illuminations had crossed the axis of the shadow-cone previous to impinging on the lunar disk. The portions of the refracting annulus of the earth's atmosphere concerned in producing these effects were those superincumbent on the Southern Indian Ocean and the North Atlantic.

WENTWORTH ERCK

Shankill, Co. Dublin, November 4

The Sky-Glows

IN using the word "corona" to designate the coloured glare which has accompanied the sun during the past year, I had no intention of employing it in its astronomical sense, but in its ordinary meteorological meaning—which "G. M. H." (NATURE, vol. xxx. p. 633) has overlooked—as referring to the coloured circles on cloud and haze frequently to be seen round the sun and moon, and classed by some observers with halos. By calling the circle now visible round the sun a "corona," I mean that in appearance and probable optical cause it is more like a meteorological corona than like a halo.

May I be allowed to point out a misprint in the first paragraph of my last letter (vol. xxx. p. 633), where it should read "unusual sky phenomena"—the world *universal* having been printed for *unusual*.

T. W. BACKHOUSE

Sunderland, November 8

AFTER sunset this evening there was a peculiar pink flush in the western sky here similar to that which attracted so much attention in England last year. Twenty-five minutes after the sun had gone down, the colour was so vivid as to be reflected from the snows of Mount Baker (10,700 feet), which is about seventy-five miles east of this place. Shortly afterwards it disappeared, but reappeared thirty-five minutes later, prolonging the twilight and making the stars look green, finally dying away very gradually. The weather for the past twelve days has been very wet, and to-night's is the first clear sunset in that time.

Fourteen days ago, when on the Fraser River, eighty miles from here, I saw after sunset a very brilliant aurora borealis. I write this thinking there may be a repetition of the phenomena in England, in which case this note may possess interest.

G. W. LAMPLUGH

Victoria, Vancouver Island, October 13

Peculiar Ice Forms

THE ice structures observed by Mr. Woodd Smith (November 6, p. 5) are evidently the same as were described in vol. xxi. p. 396. I have often seen such fibrous masses since, under circumstances which left no doubt of their being mainly due to prolonged condensation of aqueous vapour from the air; the fibres, white like asbestos, and covered only by a very thin layer of earthy particles, rising from a hard subsoil. The absorption of aqueous vapour by the soil, especially on mountains, seems not yet to be duly appreciated, although it is proved by the many springs issuing at short distances below the summits, and has been insisted upon already in Er. Darwin's "Botan. Garden" and "Phytonomia" (chap. xi. 2). "Rainfall being the source of all water-supply" (NATURE, vol. xxx. p. 375) is a statement hardly to be maintained.

W.

Freiburg, Badenia, November 8

Seismographs—An Apology

I AM just in receipt of the inclosed letter from Mr. Charles A. Stevenson, in which he claims the original idea of the actuating mechanism in the *horizontal component seismograph* I have lately described in these pages, and he includes a copy of his paper to justify his remarks. I therefore think it my duty to offer my apologies to him for not having given him full credit for his invention so far as it goes, although I have *unconsciously* done him wrong. Naples is unfortunately very badly off for modern scientific works and *Proceedings* of Societies, both as regards the National and the University libraries, and as far as I know no copy of Mr. Stevenson's paper exists in the town, except the one he has now sent me.

Perhaps I may be permitted to point out that Mr. Stevenson's seismograph, so far as it is described, would be almost useless for the following reasons:—

(1) The inertia of the upper glass plate would be insufficient not to be affected by the slight movement conducted through the ivory balls to it. This is the reason I use the very heavy lead disk.

(2) No earthquake shock is perfectly horizontal, so that Mr. Stevenson's instrument would only be fit to register the horizontal component of the earth-wave, and would fail to do this, since if the angle of emergence was appreciable it would be jerked up off its supports, and consequently would simply register a series of interrupted lines. This is why I introduced the upper balls and resistance plate.

(3) If the instrument was disturbed by an earth-wave of large amplitude, the registering arm would pass beyond the border of the smoked plate (unless the apparatus was of very great dimensions, so failing to fulfil the conditions of the British Association), where the needle would drop out, or fall so low as to prevent the return of the arm over the plate.

(4) If the earthquake was of some seconds' duration and composed of many varying movements, as is generally if not always the case, a network of irregular curves would remain on the glass that would be quite unintelligible.

If a thing is to be done, it is advisable to do it well, and it is less possible to have accurate registers of earthquake shocks than of the force and direction of the wind, barometric pressure, or any other meteorological phenomena. The requirements of the British Association with regard to expense, size, and portability of seismographs, will not permit anything like an accurate investigation of geodynamics.

In conclusion, should I have overlooked and appropriated the ideas of any other inventor, I shall be happy to fully acknowledge them if sufficient evidence is given (as in the above case) of priority of publication.

H. J. JOHNSTON-LAVIS

November 7

45, *Melville Street, Edinburgh, November* 3

I NOTICED recently in NATURE (vol. xxx. p. 608) an article by you in which you describe a seismograph for recording earthquake shocks, which would appear to be your own invention from reading the paper. No doubt the method of making the record, springs, and upper balls are your own invention, but the *principle* on which the seismograph there described acts is, as far as I know, mine or my father's. I inclose the paper in which it was first described, and I would be glad to learn from you if you forestalled me.

CHARLES A. STEVENSON

Dr. Johnston-Lavis, Naples

Fly-Maggots Feeding on Caterpillars

A FEW months ago I had a caterpillar of *Papilio erythronius*, which I found on a lemon-tree. I put it into a card-box, and fed it daily on lemon-leaves. The box was covered with cloth *tied tightly all round the opening*. After some days, the caterpillar fixed itself to the side of the box, and turned into a chrysalis in the usual way. One day on opening the box, instead of finding the chrysalis changing into its usual colours and markings, it was dark all over. A few days more, on re-opening the box, I found six fully-developed cream-coloured maggots at the bottom of the box. I was rather puzzled to conjecture how these maggots got into a box three inches high, with a bit of cloth tied all round the opening. I put the maggots into a little box with some earth under a tumbler. They immediately buried themselves in the earth. In a few days I found six chrysalides, and some days later there were six ordinary house-flies buzzing within the tumbler. I then examined the dark chrysalis of the *P. erythronius*, which was evidently dead, and found it only a *shell*. All its interior had been consumed by the six maggots. It is evident that these maggots in their infant stage had already been in the body of the caterpillar when I boxed it. The latter had gone through its transformation as if nothing was the matter with it, although, if one could have interrogated it, probably it would have complained of mysterious gnawings and creepings in its interior. A time, of course, came when, for want of nerve-centres and other organs, the chrysalis could not go on with its development into the perfect Papilio. The six maggots having had a full meal, found their way out of the Papilio's chrysalis in order to undergo *their* transformation.

I knew that the larvæ of the Ichneumonidæ fed on the live bodies of caterpillars, but I did not know that the larvæ of the house-fly did so also.

E. BONAVIA

Etawah, India, October 18

THE CRYSTALLINE ROCKS OF THE SCOTTISH HIGHLANDS

EVER since the discovery of Silurian fossils in the rocks of North-West Sutherland, it has been recognised that in that region lies the key to the structure of the Scottish Highlands. Accordingly, when in the progress of the Geological Survey, the mapping of the Highlands had to be undertaken, I determined that a detailed survey of the Sutherland ground on the scale of six inches to a mile should be made as a basis for the work. In the summer of last year a surveying party under the charge of Mr. B. N. Peach was stationed there, with instructions to begin by mapping the Durness Basin. This duty was satisfactorily accomplished before the end of the season. The Silurian series of Durness was ascertained to be about 2000 feet thick, and to consist of numerous successive zones, which were traced on the six-inch maps and discriminated in such a way as to be recognisable should they be found to occur in the more complicated region to the east. With this necessary groundwork well established, the Eriboll tract was attacked this summer by Messrs. Peach and Horne. I had never myself had an opportunity of studying the Eriboll sections, which, from the days of Macculloch down to the present time, have been such a fruitful subject of discussion. It was a special injunction to the officers now intrusted with the detailed survey of the region to divest themselves of any prepossessions in favour of published views and to map the actual facts in entire disregard of theory. By the close of this last season the structure of the Eriboll area had likewise been traced upon the six-inch maps, and I then went north to inspect the work. From time

to time during the summer, reports had been made to me of the progress of the survey, but, though from the published descriptions of that tract, I was aware that its structure must be singularly complicated, and although apprised of the conclusions to which the surveyors, step by step and almost against their will, had been driven, I was hardly prepared for the extraordinary geological structure which the ground itself presented, or for the great change necessitated in the interpretation of the sections as given by Murchison.

No one cursorily visiting the ground could form any notion of its extraordinary complication, which could only be satisfactorily unravelled by patient detailed mapping such as had never yet been bestowed upon it. With every desire to follow the interpretation of my late chief, I criticised minutely each detail of the work upon the ground; but I found the evidence altogether overwhelming against the upward succession which Murchison believed to exist in Eriboll from the base of the Silurian strata into an upper conformable series of schists and gneisses. The nature of this evidence will be best understood from the subjoined report, which, at my request, Messrs. Peach and Horne have prepared. As the question of the succession of the rocks in the North-West Highlands is still under discussion, I think it right to take the earliest opportunity of making this public declaration. It would require more space than can be given in these pages to do justice to the views of those geologists, from Nicol downwards, by whom Murchison's sections have been criticised, and to show how far the conclusions to which the Geological Survey has been led, have been anticipated. When the official memoirs are published, full reference will be given to the work of previous observers, to which, therefore, no further allusion is made at present.

The most remarkable features in the Eriboll area are the prodigious terrestrial displacements, to which there is certainly no parallel in Britain. Beginning with gentle foldings of the rocks, we trace these becoming increasingly steeper on their western fronts, until they are disrupted and the eastern limb is pushed westwards. By a system of reversed faults, a group of strata is made to cover a great breadth of ground and actually to overlie higher members of the same series. The most extraordinary dislocations, however, are those to which for distinction we have given the name of Thrust-planes. They are strictly reversed faults, but with so low a hade that the rocks on their up-throw side have been, as it were, pushed horizontally forward. The distance to which this horizontal displacement has reached is almost incredible. In Durness, for example, the overlying schists have certainly been thrust westwards across all the other rocks for at least ten miles. In fact, these thrust-planes, but for the clear evidence of such sections as those of Loch Eriboll, could not be distinguished from ordinary stratification-planes, like which they have been plicated, faulted, and denuded. Here and there, as a result of denudation, a portion of one of them appears capping a hill-top. One almost refuses to believe that the little outlier on the summit does not lie normally on the rocks below it, but on a nearly horizontal fault by which it has been moved into its place. Masses of the Archæan gneiss have thus been thrust up through the younger rocks and pushed far over their edges. When a geologist finds vertical beds of gneiss overlying gently inclined sheets of fossiliferous quartzite, shale, and limestone, he may be excused if he begins to wonder whether he himself is not really standing on his head.

The general trend of all these foldings and ruptures is from north-north-east to south-south-west, and the steep westward fronts of the folds show that the terrestrial movement came from east-south-east. Corroborative evidence that this was the direction of the movement is furnished by a series of remarkable internal rearrangements that have been superinduced upon the rocks. Throughout the whole region, in almost every mass of rock, altogether irrespective of its lithological characters and its structure, striated planes may be noticed which are approximately parallel with the thrust-planes, and are covered with a fine parallel lineation, running in a west-north-west and east-south-east direction. These surfaces have evidently been produced by shearing. Again, many of the rocks near the thrust-planes, and for a long way above them, are marked by a peculiar streaked structure which reminds one of the fluxion-lines of an eruptive rock. The coarse pegmatites in the gneiss, for example, as they come within the influence of the shearing, have had their flesh coloured feldspar and milky-quartz crushed and drawn out into fine parallel laminæ till they assume the aspect of a rhyolite in which fluxion-structure has been exceptionally well developed. The gneiss itself coming into the same powerful mill has acquired a new schistosity parallel with the shearing-planes. Hornblende-rock has been converted into hornblende-schist. Moreover, new minerals have likewise made their appearance along the new divisional planes, and in many cases their longer axes are ranged in the same dominant direction from east-south-east to west-north-west.

Murchison believed that the Silurian quartzites and limestones of Eriboll pass up under, and are conformably overlain by, his upper gneiss. It is quite true that they are so overlain; but the overlying rocks, instead of having been regularly deposited on them, have been pushed over them. What, then, are these overlying rocks? Though they have undergone such intense alteration during the process by which they were moved into their present position that their original characters have been in great measure effaced, lenticular bands occur in them which can certainly be recognised. Some of these bands are unquestionably parts of the Archæan gneiss; others are Silurian quartzite, and in one case we can detect a large mass of the Upper Durness limestone. Traced eastwards, however, the crystalline characters become more and more pronounced until we cannot tell, at least from examination in the field, what the rocks may originally have been. They are now fine flaggy micaceous gneisses and mica-schists, which certainly could not have been developed out of any such Archæan gneiss as is now visible to the west. Whether they consist in part of higher members of the Silurian series in a metamorphic condition remains to be seen. The occurrence of a band of crystalline limestone and calcareous schist, which has been traced for many miles above the great thrust-plane, certainly suggests that it represents the upper part of the calcareous Durness series attenuated and altered by the intense shearing which all the rocks have undergone. This much at least is certain, that the schistose series above the thrust-plane is partly made up of Silurian strata, and has received its present dip and foliation since Silurian time.

Having satisfied myself that Murchison's explanation of the order of sequence could not be established in Eriboll, I was desirous to see again, in the new light now obtained, some of the Ross-shire sections for the description of which I am responsible. Had these sections been planned for the purpose of deception they could not have been more skilfully devised. The parallelism of dip and strike between the Silurian strata and the overlying schists is so complete as to prove the most intimate relationship between them; and no one coming first to this ground would suspect that what appears to be a normal stratigraphical sequence is not really so. But the clear coast-sections of Eriboll, where every dislocation is laid bare, have now taught me that I have been mistaken, for the parallelism in question is not due to conformable deposition. The same kind of evidence of upthrust and metamorphism which these coast-sections reveal can be traced southwards for a distance of more

than ninety miles. The task of unravelling the geological structure of these southern regions will be much facilitated by the remarkable persistence of the Sutherland Silurian zones, some of which, with their characteristic features and fossils, are as well marked above Loch Carron as they are at Loch Eriboll.

In south-western Ross-shire the platform on which the Silurian rocks rest is a thick mass of Cambrian red sandstone. In the great upthrow, it is this sandstone platform which has there been pushed over the limestones and quartzites. On the west side of Loch Keeshorn, the red sandstones, in their normal unaltered form, rise up into the colossal pyramids of Applecross; but on the east side, where, at a distance of little more than a mile, they overlie the limestones, they bear so indurated an aspect that they have naturally been classed with the quartzose members of the Silurian series. Traced eastwards they present increasing evidence of intense shearing; fluxion-structure makes its appearance in them, with a development of mica along the divisional planes, until they pass into frilled micaceous schist, in which, however, the original clastic grains are still recognisable. They finally shade upwards into green schists and fine gneiss which merge into coarse gneiss with pegmatite. The short space within which ordinary red felspathic sandstone and arkose acquire the characters of true schists is a point of some importance in regard to the change from the unaltered Silurian strata of the Southern Uplands into the metamorphic condition of the Highland phyllites, grits, &c.

Obviously the question of chief importance in connection with the structure now ascertained to characterise the North-West Highlands relates to metamorphism. That there is no longer any evidence of a regular conformable passage from fossiliferous Silurian quartzites, shales, and limestones upwards into crystalline schists, which were supposed to be metamorphosed Silurian sediments, must be frankly admitted. But in exchange for this abandoned belief, we are presented with startling new evidence of regional metamorphism on a colossal scale, and are admitted some way into the secret of the processes whereby it has been produced.

From the remarkably constant relation between the dip of the Silurian strata and the inclination of their reversed faults, no matter into what various positions the two structures may have been thrown, it is tolerably clear that these dislocations took place before the strata had been seriously disturbed. The persistent parallelism of the faults and of the prevailing north-easterly strike of the rocks indicates that the faulting and tilting were parts of one continuous process. The same dominant north-easterly strike extends across the whole Highlands, and also over the Silurian tracts of Southern Scotland and the North of England. There is reason to regard it in all these regions as probably due to one great series of terrestrial movements. These must have occurred some time between an early part of the Silurian period and that portion of the Old Red Sandstone period represented by the breccias and conglomerates of the Highlands. In the Central and Eastern Highlands the slates, phyllites, grits, quartzites, and limestones which, along the southern border, are scarcely more altered than their probable equivalents among the Silurian rocks of the Southern Uplands, have been greatly plicated, and have assumed a more or less crystalline structure. But when these changes were brought about, there lay to the north-west a solid ridge of Archæan gneiss and Cambrian sandstone which offered strong resistance to the plication. The thrust from the eastward against this ridge must have been of the most gigantic kind, for huge slices, hundreds of feet in thickness, were shorn off from the quartzites, limestones, red sandstones, and gneiss, and were pushed for miles to the westward. During this process, all the rocks driven forward by it had their original structure more or less completely effaced. New planes, generally parallel with the surfaces of movement, were developed in them, and along these new planes a rearrangement and recrystallisation of mineral constituents took place, resulting in the production of crystalline schists. This metamorphism certainly occurred after early Silurian times, for Cambrian and Lower Silurian strata, as well as Archæan rocks, have been involved in it.

It is obvious that into the problems of Highland geology, always admittedly obscure, a fresh element of difficulty is introduced. At the same time the aid furnished by a minute study of the Sutherland sections is so great that we may hope to attack these problems with more success than has hitherto seemed probable. The work, too, is not of a kind to be attempted in a few hasty scampers over the ground. It will require patient detailed mapping. But when the great base-lines have once been accurately traced, the difficulties will doubtless begin to diminish, and, like the pieces of a puzzle, the various segments of the Highlands will then be found to range themselves in their proper places. ARCH. GEIKIE

Report on the Geology of the North-West of Sutherland

IN the north-west of Sutherland the most ancient rocks belong to the Archæan series, and present a great uniformity in lithological characters. They consist mainly of coarse hornblendic gneiss, with distinct zones of gray and pink granitoid gneiss, in which the mica is more abundant than the hornblende. Lenticular veins and bosses of hornblende-rock and hornblende-schist, some at least of which are evidently intrusive, occur in the gneiss, while the presence of small kernels of cleavable hornblende and actinolite forms another characteristic feature of the series. Veins of pink or white pegmatite abound, sometimes parallel with the foliation of the gneiss and sometimes traversing it in all directions. These, however, are distinct from dykes of pink granite, which also intersect the gneiss and coarse pegmatites, and are themselves crossed by later pegmatite-veins. Here and there, indeed, the branches of a pegmatite-vein can be seen to return upon themselves and traverse the main trunk from which they start. Where the Archæan rocks have been recently stripped of their former cover of Silurian quartzite, bands of green epidotic gneiss appear among them, and a soft green mineral with a greasy lustre (agalmatolite?) is there characteristic of the superficial parts of the pegmatite-veins.

The highly crystalline Archæan rocks are overlain unconformably by a succession of conglomerates, grits, and sandstones, regarded by Murchison as the equivalents of the Cambrian system of Wales. In the course of the work of the Geological Survey in the present region they have been divided into certain zones, which, though they need not be stated here, as they have no bearing on the main question to which this paper is devoted, may prove to be of considerable importance in unravelling the geological structure of the districts further south.

Between the Cambrian sandstones and the overlying quartzites at the base of the Silurian series there is a complete discordance. To the west of the Kyle of Durness, for example, the Cambrian sandstones dip to the north-west, while the overlying quartzites dip to the south of east. Moreover, as the observer passes eastwards to the shores of the Kyle, the Cambrian sandstones are bed after bed transgressed by the quartzites, which eventually rest directly on the Archæan gneiss. The Silurian strata in the Durness area (A in Section) consist of a calcareous series at the top; a middle series, composed partly of calcareous and partly of arenaceous strata; and an arenaceous series at the base. The various sub divisions of the strata are given in descending order in the subjoined tabular statement.

C. Calcareous Series ...	VII. Durine Group ...	Fine-grained, light gray limestones, with an occasional dark fossiliferous band.
	VI. Croisaphuill Group	*c*. Fine-grained, cleaved, lilac-coloured limestones, full of flattened worm-casts; fossils distorted by cleavage. *b*. Alternations of black, dark gray, and white limestone, with an occasional fossiliferous band, like zone (*a*) of this group. *a*. Massive, dark gray limestone, chiefly composed of worm-casts which project above the matrix on weathered surfaces. Near the base are several lines of small chert nodules. This is one of the most highly fossiliferous zones in the Durness Basin.
	V. Balnakeil Group ...	Alternations of dark and light gray limestone, highly fossiliferous, with occasional impure, argillaceous, unfossiliferous bands. Most of the beds are distinctly cleaved, and contain few worm-casts.
	IV. Sangomore Group...	Fine granular dolomites, alternating near the top with cream-coloured or pink limestone. Near the base are two or more bands of white chert, one of which is about 5 feet thick.
	III. Sailmhor Group ...	Massive, crystalline-granular, dolomitic limestones, occasionally fossiliferous, charged with dark worm-castings set in a gray matrix; large spheroidal masses of chert near the base. This limestone is locally known as "the Leopard Stone."
	II. Eilean Dubh Group	Fine-grained, white, flaggy, argillaceous limestones and calcareous shales. As yet no fossils have been found in this division.
	I. Ghrudaidh Group ...	Dark leaden-coloured limestones, occasionally mottled, alternating near the top with white limestone. About 30 feet from the base there is a thin band of limestone charged with *Serpulites Maccullochii*, and a similar band occurs at the base.
B. Middle Series (partly calcareous and partly arenaceous)...	Upper Zone	At the base lies a massive band of quartzite and grit, passing upwards into carious dolomitic grit, crowded in patches with *Serpulites Maccullochii*, more especially in the decomposed portions (Serpulite-Grit).
	Middle Zone	Alternations of brown, flaggy, calcareous, false-bedded grits and quartzites with cleaved shales.
	Lower Zone	Calcareous mudstones and dolomitic bands, weathering with a rusty brown colour, traversed by numerous worm-casts, usually flattened, and resembling fucoidal impressions. These beds are often highly cleaved. This and the overlying zone form the "Fucoid-beds" of previous authors.
A. Arenaceous Series...	Upper Zone	Fine-grained quartzites, perforated by vertical worm-casts and burrows becoming more numerous towards the top of the zone ("pipe-rock" of previous authors). These beds pass downwards into massive white quartzites.
	Lower Zone	False-bedded flaggy grits and quartzites, composed of grains of quartz and feldspar. At the base there is a thin brecciated conglomerate, varying from a few inches to a few feet in thickness, containing pebbles of the underlying rocks, chiefly of quartz and orthoclase, the largest measuring about 1 inch across.

The Silurian strata in the Durness area are arranged in the form of a basin, truncated on the east side by a fault that brings them against the Archæan gneiss, and thus disconnects them from the Eriboll area, with which they were certainly at one time united. Of the identity of these strata in the two areas there cannot be the smallest doubt. We have recognised them zone by zone, completing the proofs of this identity by detecting in the south and central parts of the Durness Basin the representatives of the middle series, viz. the "Fucoid-beds" and "Serpulite-grit," which had not previously been noted in that area. Though subject to local variations in thickness, these zones are singularly persistent, and, from their marked lithological characters and fossil contents, constitute admirable horizons in unravelling the complicated geological structure of the region. A rich assemblage of fossils has been obtained by the Survey from the various fossiliferous bands indicated in the foregoing table, comprising Trilobites, Annelids, Cephalopods (*Nautilus*, *Litnites*, *Orthoceras*, *Piloceras*, &c.), Heteropods, Gasteropods, Lamellibranchs, Brachiopods, Corals, Sponges, and Foraminifera. As yet this collection has not been examined in detail, but from observations in the field it is probable that some of the limestone zones will be found to be characterised by particular fossils.

A striking feature of the Durness Basin is the amount of displacement of the strata by faults; indeed, this feature is so characteristic of the highest limestone zones that it is difficult satisfactorily to compute their thickness. But from the base of the quartzite to the top of the calcareous series the total thickness of Silurian strata cannot be less than 2000 feet. In Sangomore Bay, near the village of Durine, the highest limestone zone is overlain by shattery quartzite, striped fissile schist, frilled schists, and gneiss. Though unquestionably resting upon the limestone and sharing in the normal faulting of the district, these crystalline strata do not prove a conformable upward succession, as has been naturally enough supposed. The key to the reading of this and of the corresponding section at Farrid Head is to be sought in the Eriboll tract.

The Silurian rocks of the Durness Basin are separated from those of Loch Eriboll (B in the Section) by a prominent ridge of Archæan gneiss, the eastern slope of which is covered by a cake of quartzite. Along the crest of the chain the basal breccia is exposed, overlain by the lower zone of false-bedded grits (No. 3) and the upper zone of "pipe-rock" (No. 4 in Section). As the eastern declivity of the ridge is greater than the dip of the quartzites, the observer, on descending the slope, crosses the basset edges and dip-slopes of the latter strata, and eventu-

ally finds himself again on the old platform of Archæan gneiss exposed by denudation (see Section). Both the zones of quartzite are then once more met with in their normal order, the highest beds exposed on the western shore of Loch Eriboll belonging to the horizon of the "pipe-rock." On the eastern shore, at Ant Sron, on the crest of a low anticlinal arch of the "pipe-rock," there is an excellent section of the middle series between the quartzites and the limestones. The two subdivisions of the "Fucoid-beds" (No. 5) and the "Serpulite-grit" (No. 6 in Section), which are typically developed at that locality, pass underneath the Serpulite-limestone at the base of Group I., exactly as they do at Durness. The dark leaden-gray limestones of the lowest group (I.) are then rapidly succeeded by flaggy limestones (Ant Sron, Chorrie Island, Heilim) and dolomitic limestones which, probably the equivalents of the Eilean Dubh Group in Durness, are the highest members of the series here represented (No. 7 in Section). A careful search among the Eriboll limestones has failed to bring to light any organic remains save *Serpulites* and certain minute spherical bodies which may prove to be Foraminifera. A similar dearth of fossils characterises the two lowest zones in Durness, so that this feature is common to both areas. The non-occurrence of the higher fossiliferous limestones in Eriboll may be accounted for by the remarkable geological structure of that region which is now to be described.

As the observer passes eastwards along the magnificent quartzite sections on Crag Dionard and Conamheall, south of Loch Eriboll, he cannot fail to note the numerous flexures of the strata, and especially the peculiar type of their sharp anticlinal folds. As a rule, the eastern limb of each of these folds dips at a gentle angle to the south-east, while the west limb is highly inclined, vertical, even inverted, or sometimes broken by a reversed fault the effect of which is to bring lower over higher beds. These reversed faults (*ttt* in Section) become more numerous eastwards. They are admirably displayed both in ground-plan and dip-section on the shore north of Heilim, where they repeat the various zones ranging from the "pipe-rock" to the Eilan Dubh limestone (Group II.). The strike of the reversed faults ranges on the whole with that of the strata traversed, and their hade is inclined at a higher angle than the dip of the latter, the difference generally amounting to about 10°. Inland from the coast-section, north of Heilim, to the base of Ben Arnaboll, the zones just mentioned are constantly repeated by a complicated system of reversed faults and folds, the general inclination of the strata being towards the south-east. As that hill is approached, the displacement produced by these faults increases in amount; hence the observer meets with beds occupying a lower geological horizon the further east he travels. At length this intricate system of faults and folds culminates in a great dislocation which, for convenience

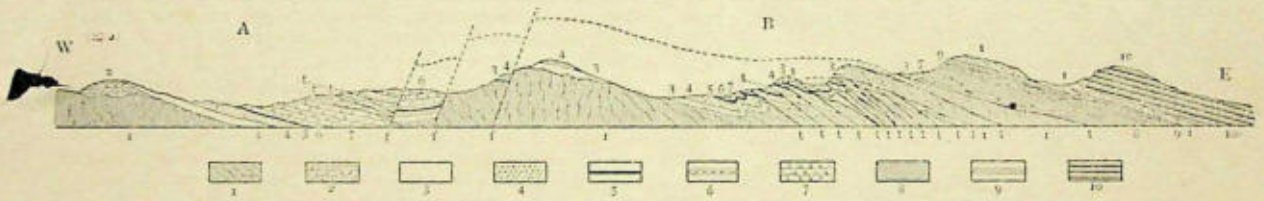


DIAGRAM-SECTION OF DURNESS-ERIBOLL REGION.

10. Gneissose Flagstones, &c.
9. Siliceous Schist ... ... } Newer Gneiss
8. Frilled Schist ... ... } Newer Gneiss
Green Schist ... ... } Newer Gneiss
7. Durness-Eriboll Limestone—Upper Series
6. Serpulite-Grit ... ... } Middle ,, } Lower Silurian Series
5. Fucoid-Beds ... ... } Middle ,, } Lower Silurian Series
4. Piped Quartzite ... ... } Lower ,, } Lower Silurian Series
3. False-bedded Quartzite ... } Lower ,, } Lower Silurian Series
Basal Breccia ... ... } Lower ,, } Lower Silurian Series
2. Sandstones and Conglomerates—"Cambrian"
1. Gneiss, Granite, Pegmatite, &c. } Archæan Gneiss

A = Durness Area; B = Eriboll Area; ff = Normal Faults; ttt = Reversed Faults and "Thrust-planes"; Dotted lines = continuation of normal faults and thrust-planes.

of description, and to distinguish it from the ordinary reversed faults, may be termed a *Thrust-plane*. By means of it a great mass of coarsely crystalline gneiss with pegmatite-veins, in places upwards of 400 feet thick, is placed above the Silurian rocks (see Section). A careful examination of the mass which caps Ben Arnaboll clearly proves that *it rests transgressively on all the zones of the Silurian rocks, from the lower zone of the quartzites (false-bedded grits) up to the limestone which overlies the Serpulite-grit.* Owing partly to its low hade and partly to subsequent folding, the outcrop of this thrust-plane resembles that of an ordinary overlying formation cut into a sinuous line by denudation. It is admirably seen in dip-section on the east and north slopes of Ben Arnaboll, whence it can be followed round the west face of the hill, descending into the valley on the west, then bending back on itself, winding round the north slope of Druim Tungi, and entering Loch Eriboll in Heilim Bay. It reappears at the base of Crag-na-Faolinn, and has been traced still farther to the south, while northwards it can be followed to the Whitten Head, at the mouth of Loch Eriboll.

That the gneiss thus brought up on Ben Arnaboll and elsewhere is in reality the Archæan gneiss is evident, for two reasons. First, its lithological characters agree with those of the typical Archæan area to the west, save in certain cases where the original features have been effaced by the crushing to be afterwards described. Near the thrust-plane, this effacement is complete, but in the heart of the mass the normal characters of the Archæan rocks, including in some instances their characteristic north-west strike, are retained. The rocks consist of coarsely crystalline hornblendic gneiss and pink granitoid gneiss, with lenticular veins of hornblende-rock and kernels of cleavable hornblende, while massive veins of pink pegmatite are well developed. The soft greenish mineral (agalmatolite?) already mentioned as characteristic of the gneiss, where now or lately covered with quartzite, occurs here in the pegmatites, and veins of epidosite are abundant. Second, at various localities the brecciated conglomerate and false-bedded quartzite at the base of the Silurian strata are found resting on these crystalline rocks. Further, the unconformable junction can on one line be traced continuously for more than a mile. There can be no doubt, therefore, that this mass is really a fragment of the old platform of Archæan rocks on which the Silurian strata were deposited.

The occurrence of this Archæan gneiss in its present position above much younger rocks is doubtless to be ascribed to the same cause which elsewhere has resulted in foldings of the strata. In the present instance we see an attempt, as it were, to establish an anticlinal fold of the type already described as occurring to the west, with a steep westward and gentle eastward slope. The west limb however has here given way along a great dislocation or reversed fault, while the eastern limb has been driven forwards until the Archæan rocks have been carried over the truncated edges of the Silurian strata. The vertical beds of the basal quartzites are still

to be seen on the west limb of the anticline on Ben Arnaboll, Crag-na-Faolinn, and on Whitten Head (see Section). The quartzites on Druim Tungi, and indeed all the Silurian strata on the east side of Loch Eriboll, between Heilim and Crag-na-Faolinn, form part of a syncline which has been pushed westwards in front of the anticline along this thrust-plane. This structure explains the origin of the inversion of the Silurian rocks along the junction line east of Camas-an-Duin, and the occurrence of the lower limestone groups in a shallow trough at Eriboll. Of special interest is the occurrence of a small outlier of Archæan gneiss on the crest of a hill (Sithean-na-Cuag) north-west of Ben Arnaboll. This mass rests on the Fucoid-shales, Serpulite-grit, and limestone. Though now isolated by denudation, it was obviously originally continuous with the mass on Ben Arnaboll, and it thus furnishes striking proof of the westward extension of displaced gneiss, and of the thrust-plane on which it travelled.

The effects of this great movement on the Silurian strata which have been over-ridden by the gneiss are somewhat remarkable. The pipes or vertical worm-tubes in the quartzites have been flattened, drawn out, and bent over in a direction perpendicular to the strike of the thrust-plane. The false-bedded grits and quartzites present a streaky appearance resembling fluxion-structure, due to the elongation of the fragments of orthoclase-feldspar and the quartz grains. The fine-grained rocks, especially the compact quartzites and the Fucoid-beds, are highly cleaved, the strike of the cleavage-planes being parallel with that of the thrust-plane, and this parallelism being maintained quite irrespective of any variation in the direction of dip of the strata next the gneiss. On the surface of the cleavage-planes also there is a series of parallel lines like slickensides which will be described presently; and lastly, there is a slight development of sericitic mica along many of the cleaved surfaces. No less important is the alteration produced on the overlying Archæan gneiss. In the heart of the mass, as already stated, there is little apparent change, but near the thrust-plane the beds are drawn in towards it till their strike roughly coincides with that of the thrust-plane. The inclosed hornblende merges into a green chloritoid product, the hornblendic gneiss has been converted into a fine green schistose rock, while the quartz and feldspar of the pegmatites have been drawn out into streaky or wavy lines, so as to assume somewhat the appearance of rhyolites. Finally a new set of divisional planes has been superinduced on the mass, the strike of which is parallel with that of the plane of thrust.

Again, there is clear evidence to show that the thrust-plane just described was followed by minor movements of a similar nature in the gneiss itself, whereby different portions of the mass were made to slip over each other. Occasionally a thin lenticular mass of the bottom-quartzite has been caught in these planes of disruption.

But all these evidences of displacement are merely the precursors of a still more powerful thrust-plane, which has been traced continuously from the shore east of Whitten Head to the crest of Crag-na Faolinn, and at intervals for many miles to the southward into the Assynt country. The strike of the strata overlying this plane is, on the whole, north-north-east and south-south-west, with a general east-south-easterly dip, usually at comparatively low angles. Though roughly parallel with it, this greater thrust-plane here and there overrides the lower or more westerly one, for the rocks on its upper side may be seen to pass across all the zones of the Silurian series up to the limestones. A recognisable and tolerably persistent order of succession has been observed in the rocks on the upper side of this thrust-plane. At the base, and resting on different platforms, there usually lies a belt of striped fissile schist, followed by green schist with alternations of gneiss, which, though it has lost nearly all trace of its original foliation, is probably a portion of the Archæan gneiss. A number of lenticular masses of Silurian quartzite occur on this horizon between the Whitten Head coast and Crag-na-Faolinn. In some cases, the basal breccia and portions of the overlying false-bedded grits are clearly seen resting on the Archæan rock, the planes of foliation of the gneiss being roughly parallel with the bedding of the quartzites. On closer examination, however, it is observable that successive folia of the gneiss impinge against the basal breccia. In other cases, wedges of the false-bedded grits, without the basal breccia, are caught between two thrust-planes. Perhaps the most remarkable example of these isolated masses of Silurian rocks, is the limestone intercalated among the green schists, on the hill-slope above Eriboll House. This mass appears to belong to one of the higher limestones of the Durness Basin which have not elsewhere been noticed in the Eriboll area. It lies not far above the great thrust-plane, and though its relations to the schists are not as well shown as could be desired, its presence here is evidently due to the same series of movements that brought in the intercalations of quartzite. Passing eastwards we find, next in order, a belt of frilled green schists (No. 8 in Section) with a well-marked calcareous zone near the top, which has been traced from the shore east of Whitten Head for a distance of ten miles in a south-west direction, and which extends still further to the south. To these succeed a thin band of compact siliceous schists (No. 9 in Section) overlain by hornblendic and micaceous gneiss, which is succeeded by a great development of gneissoid flagstones (No. 10) with occasional bands of hornblendic and micaceous garnetiferous schists.

This order of succession in the rocks above the upper thrust-plane is also recognisable far to the west in Sangomore Bay and on Farrid Head in the Durness area. It is evident that there has been an extraordinary amount of movement of these rocks along the upper thrust-plane, since they override all the other rocks pushed forward by the lower thrust-planes in the Eriboll area, and rest directly on the limestones of the Durness Basin. The thin band of shattery quartzite between the striped fissile schist and the limestone in Sangomore Bay is a fragment of the false-bedded quartzite zone which has been pushed forward along the surface of the thrust-plane,—a characteristic feature of the thrust-planes in Eriboll.

The microscopic characters of the rocks from the different zones above the upper thrust-plane have yet to be studied. Much fresh light may thence be expected on the *modus operandi* of the processes involved in the extraordinary lithological changes which the rocks have undergone. Meanwhile a careful examination of the various masses in the field points very clearly to the nature of these processes. The striped green fissile schist which occurs along the thrust-plane presents an exceedingly compact texture with a remarkable streaked structure which at once recalls the fluxion-lines of an eruptive rock. Still more conspicuously is this structure displayed by the masses of pegmatite in the gneiss; they lose their ordinary character and assume more that of rhyolite. The intercalations of quartzite are marked likewise by the same streaked appearance, their component particles of quartz and feldspar being all elongated in one common direction. The gneiss associated with the schists above the thrust-plane, though its original foliation can still in places be detected, has had a new set of schistose planes superinduced in it which are on the whole parallel with the thrust-plane. Bands of hornblendic gneiss merge into hornblende-schist and chlorite-schist, and these again into finely-frilled schists. All these new structures, which are quite independent of the original bedding or foliation of the rocks, were obviously connected with the production of the great thrust-plane, with which they lie more or less parallel. They point to

enormous mechanical movements under which, as the rocks sheared, the individual particles were forced over each other in one common direction, viz. from east-south-east to west-north-west. Further evidence of this mechanical movement is supplied by certain abundant fine parallel lines, like those of slickensides, which occur almost everywhere on the foliation-surfaces or other parallel divisional planes. They are especially well developed among the striped fissile schists and the gneissose flagstones. These lines run in the same general direction already mentioned (E.S.E. to W.N.W.). In many cases it may be observed that the component particles of the rocks are oriented in this same direction, while original quartz-veins are drawn out into parallel rods. Another important feature connected with these rocks is the development of minerals along the new planes of schistosity. In particular, the abundance of sericite mica is noteworthy, the longer axes of the crystals of which lie in a direction parallel with the slickenside-lines. Other micas, hornblende, actinolite, and garnets have also made their appearance along the same planes. This re-crystallisation becomes more pronounced the further east one advances from the outcrop, or passes upwards from the great thrust-plane.

This accumulated evidence points to the conclusion that in the north-west of Sutherland the rocks have been powerfully affected by one grand series of terrestrial movements whereby new structures have been super-induced upon them. Among these changes the original characters of the rocks have been more or less completely effaced, and new crystalline structures have been produced. Although a normal upward succession from the Silurian strata into an overlying series of schists cannot be maintained in the north of Sutherland, it is nevertheless certain that the displacements and metamorphism here described are later than Lower Silurian time. It is also evident that these great changes had been completed before the time of the Lower Old Red Sandstone, the conglomerates and breccias of which rest upon and are made up of fragments of the crystalline schists.

One final feature of the Durness and Eriboll area remains to be noticed. The geological structure of this region has been further complicated by the subsequent folding of the strata, and by a double system of normal faults (*ff* in Section) which affect the strata and thrust-planes alike. One set of normal faults trends north-north-east and south-south-west, while another, which appears to be newer, trends more or less at right angles to these. By these two systems of later dislocations, the thrust-planes with their low hade have been intersected and shifted precisely as if they had been ordinary boundary-planes between two geological formations. Much of the difficulty, indeed, which has been from the first experienced in unravelling the complicated structure of this region may be traced to the effect of the intricate network of reversed and normal faulting. The very preservation of the Durness Basin is due to two normal step-faults, one of which lets down the quartzites more than 1200 feet, while the other brings the whole Silurian Basin down to the sea-level.

B. N. PEACH
JOHN HORNE

THE GENESIS OF AN IDEA, OR STORY OF A DISCOVERY RELATING TO EQUATIONS IN MULTIPLE QUANTITY

I VENTURE, even at the risk of appearing egoistical, to call the attention of a wider circle of English mathematical readers than are likely to notice it in the pages of the *Comptes Rendus*, to what appears to me a remarkable discovery in the theory of matrices, or, in other words, of multiple quantity which has lately presented itself to me. It seems to me the more necessary to do so because the nature of the theorem which constitutes the discovery would hardly be suspected from the leading title of the note in the *Comptes Rendus* in which it is contained, being indeed an after-thought, so that the sting of the paper has to be sought for in its tail.

Hamilton, of immortal memory, has given, in his "Lectures on Quaternions," a solution of a certain quadratic equation in *quaternions*, those algebraical entities which (building upon a suggestion in Prof. Cayley's ever-memorable paper[1] on matrices, in the *Philosophical Transactions* for 1858 or thereabouts) I have, with the general concurrence of all who have given attention to the subject, found means of identifying with binary matrices or algebraical quantities of the second order, and thus succeeded in determining the True Place of Quaternions in Nature. Now, what Hamilton has done for an equation of the second degree of quantities of the second order, the theorem in question effects in a much more simple and complete manner for a similar sort of equation of any degree and relating to quantities of any order.

The history of the discovery in question constitutes in itself, it seems to me, an interesting chapter in Heuristic. This is how it came about. Hamilton's equation admits of six solutions or roots, which arrange themselves naturally in three pairs, and stand in immediate, and what we algebraists call rational relation to the three roots of a cubic equation, or rather to the six square roots of those three roots. From this it follows immediately that one single condition must be sufficient to reduce the number of distinct roots of the equation in quaternions or binary matrices from six to four, inasmuch as, when two roots of the cubic referred to become equal, two *pairs* of roots of the original equation must coincide. It naturally therefore became an object of interest to obtain the quantity which, equated to zero, expresses the condition of equality of two roots of this cubic, which of course may be effected by means of a well-known formula for finding the discriminant of a cubic equation; but the quantity so obtained directly from the cubic is of an exceedingly complex form, and leaves the mind entirely unsatisfied as to its true internal composition, just as from a handful of diamond dust it would be impossible to infer the crystalline form which constitutes the true idea, the *raison* or *façon d'être* of the glittering gem.

Again and again my mind reverted fruitlessly to the subject until, on September 28 last, pacing the deck of the splendid Dover and Calais boat, the *Invicta*, under the vivifying and genial rays of a bright and benignant sun, the idea occurred to me that the form to be determined must be subject to satisfy a certain partial differential equation, and without the aid of pen or pencil I succeeded, ere the voyage was half over, in identifying the discriminant of the cubic with that of a biquadratic of the simplest imaginable constitution possible: in technical language, supposing $px^2 + qx + r = 0$ to be the equation in question, I discovered virtually that the desired discriminant is identical with that of the biquadratic form which is the determinant of the binary matrix (or the tensor squared of the quaternion) $px^2 + qx + r$ treated as if x were an ordinary quantity. Starting from this point it was easy to infer all the possible cases of equality which could occur between the six roots; and, more than that, to classify under thirteen classes all the principal cases that could present themselves in the solution of the equation, not merely for the general case when there are six actual and determinate roots, but even for those cases when some of the roots pass off into infinity and become conceptual instead of actual, or else, without passing to infinity, remain actual but contain arbitrary constants.

This more-than-anticipated complete solution of the problem before me was in part suggested by the opening

[1] This paper constitutes a second birth of Algebra, its *avatar* in a new and glorified form. See introduction to "Lectures on Universal Algebra" in the sixth volume of the *American Mathematical Journal*.

lines of a memoir by M. Darboux on the solution of a biquadratic equation in Liouville's journal, with which its eminent author, my colleague in the Institute of France, providentially presented me shortly after my arrival in Paris, and which led me to see that the three pairs of solutions of the Hamiltonian equation must stand in immediate conceptual relation to the three pairs of sides of the complete quadrangle formed by a certain conic related to the form $px^2 + qx + r$ (in fact the determinant of the matrix $pu + qv + rw$) with the fixed conic $v^2 - uw$.

Now comes the turning point, the *ἀναγνώρισις* of this strange eventful history.

"There's a Divinity that shapes our ends,
Rough-hew them how we will."[1]

Seized with a sudden and fortunate attack of bronchitis, which confined me to my bed, and in the access of nocturnal fever which that state induces, my thoughts reverted with increased activity to this geometrical figure. It became clear to my inner sense that there ought to be an immediate relation between the biquadratic determinant of the form $px^2 + qx + r$, spoken of above, and the three pairs of its roots, and seizing my courage with both hands, I made bold to declare to myself that the functional parts of the six *identical equations* to the six roots ought to be the three pairs of conjugate quadratic factors of the biquadratic in question.

But if this should turn out to be true, it became impossible not to suspect, or even more than half believe, that an analogous statement must admit of being made for a unilateral equation (*i.e.* one in which, as in Hamilton's, the multipliers of each power of the unknown matrix x lie all on the same side (whether to the right or left) of it) whatever might be the degree of the equation, and whatever the order of the matrices concerned. In other words, supposing $fx = 0$ to be such equation, and $\phi x = 0$ to be the identical equation to any one of its roots, ϕx ought to be contained as an algebraical factor in the determinant of the matrix fx when, for the moment, x therein is regarded as an ordinary quantity. If this were so, then the reciprocal theorem would necessarily be true (on account of the determinant referred to being in general irreducible), viz. that, supposing ω to be the order of the matrices concerned, every algebraical divisor of it, say ϕx, of the degree ω, must be the identically-zero function to one or the other of the matrices x which satisfy the equation $fx = 0$, and consequently it would be only necessary to combine, according to a well-known method of elimination, the given form fx with each in succession of the derived forms, which constitute a brood or litter as it were, issuing "de son propre sein," to obtain all the roots of fx by solving the ordinary algebraical equation $\det.(fx) = 0$, and that thus the solution of the unilateral equation would depend on the solution of an ordinary equation of the degree $n\omega$, n being the degree of f in x, and ω the order of the matrices concerned: the number of the roots of fx would therefore be the number of ways of combining $n\omega$ things ω and ω together, *i.e.* $\frac{\Pi(n\omega)}{\Pi\omega\,\Pi(n-1)\omega}$. But herein arose a self-created difficulty, a phantasmal projection of my own brain, to block up the way, and throw doubt and discredit on all that precedes. Supposing $\omega = 2$, the number of roots thus ascertained would be $\frac{2n(2n-1)}{2}$, or $2n^2 - n$, and for $n = 3$ would be 15. Now, in the *London and Edinburgh Philosophical Magazine* for May last, whilst I had shown that $2n^2 - n$ is the number of roots of a unilateral equation in quaternions of the degree n, and of the trinomial or Jerrardian form, I thought I had proved the number of solutions of a *complete* cubic equation in quaternions to be 21 (upon which I based the formula $n(n^2 - n + 1)$ for a unilateral equation of quaternions of the degree n. There was then the choice to be made—to abandon the conjectural theorem, or to admit an error in the supposed determination of the number 21. I felt no hesitation in making my election, especially as there was a loop-hole for error in such numerical determination, inasmuch as no actual arithmetical calculations had been made, but the order of a certain system of equations which ought to be equal to the number of roots of fx was inferred from calculations in which all numerical quantities were left in blank; it was therefore quite possible (however unexpected the fact) that some of the leading coefficients of the resolving equation of the degree 21 might become zero,[1] and consequently that the order might fall below (although it could not rise above) that number. To my gratified surprise my faith met with its reward, for I soon found an easy proof of the remarkable theorem which I have ventured, in emulation of a phrase of Cauchy, to call a "*pulcherrima regula*," which will appear in the number of the *Comptes Rendus* next forthcoming after this date, and which may be summed up approximately in the following words:—*Every latent root of every root of a given unilateral function in matrices of any order, is an algebraical root of the determinant of that function taken as if the unknown were an ordinary quantity, and conversely every algebraical root of the determinant so taken is a latent root of one of the roots of the given function.*[2] This constitutes a marvellous extension (to a matrix implicitly given by a unilateral equation) of the already no-little-marvellous Hamilton-Cayley theorem of the identical equation to a matrix given explicitly.

My good genius met me on the deck of the *Invicta*, and only left me three weeks later on board the returning steamer from Boulogne. There my pleasing algebraical dream came to an end.[3]

J. J. SYLVESTER

New College, Oxford, October 26

[1] It is one of Descartes' "self-evident primary truths" that nothing which has happened could not have happened otherwise.

[1] Or else that its functional part might be composite and throw off an irrelevant factor.

[2] In terms more precise as regards the *converse* the theorem runs as follows:—*The identically-zero function to a root of fx is a factor of the determinant to fx, and conversely every factor of that determinant of degree equal to the order of x is identically zero.*

[3] A letter just received from M. Hermite informs me that M. Poincarré, in a paper presented by him to the Institute on Monday last, takes up the wondrous tale of multiple quantity so largely treated of by me in recent articles in the *Comptes Rendus*. The subject could not be in better hands. The ball is served, and the most skilful and practised players—the Cayleys, the Lipschitzes, the Poincarrés, the Weyrs, the Buckheims (and who knows how many more?)—stand round ready to receive it, and keep it flying in the air.—November 8.

OUR FUTURE WATCHES AND CLOCKS

HOWEVER long the use of the letters "a.m." and "p.m." for distinguishing the two halves of the civil day may survive, it seems probable that the more rational method of counting the hours of the day continuously from midnight through twenty-four hours to the midnight following may before long come into use for a variety of purposes for which it is well adapted, even if it should not yet be generally employed. It seems proper, therefore, to consider in what way ordinary watches and clocks could be best accommodated to such a change in the mode of reckoning. To place twenty-four hours on one circle round the dial instead of twelve hours as at present seems the most natural change to make; but, in addition to a new dial, it would involve also some alteration in construction, since the hour-hand would have to make one revolution only in the twenty-four hours instead of two. And there would be this further disadvantage, that the hours being more crowded together, the angular motion of the hand in moving through the space corresponding to one hour would be less—in fact, one-half of its present amount. It is to be remembered that, in taking time from a clock, persons probably pay small attention to the figures, either those for hours

or minutes, the relative position of the hands on the dial probably at once sufficiently indicating the time to most persons without any need of reference thereto, but it would be by no means so easy to pick up the hour from a circle containing twenty-four, and especially in the case of public and turret clocks. There is also the question of change of the motion-work to which allusion has been already made—necessary if the hour-hand is to make one revolution only in twenty-four hours—a practical question in regard to which the watch- or clock-maker could probably best speak.

There is another way of adapting ordinary watches and clocks to the twenty-four hour system, which, if the watch is intended only for the reckoning of local time, seems deserving of consideration. It consists in making the hour figures shorter, not necessarily at all less distinct, and placing two circles of figures round the dial, an inner circle with hours from 0 to 11, and an outer circle with hours from 12 to 23. The hour-hand would thus point to 1 and 13 and to 2 and 14, &c., at the same time, it being understood that the hours 0, 1, 2, &c., would be reckoned in the morning, and the hours 12, 13, 14, &c., in the afternoon, a convention to which people would probably soon accommodate themselves. On such a plan a watch would only require a new dial, no change of wheelwork being necessary, so that it could be very readily applied to existing watches, and so sooner promote the use of the twenty-four hour system. Persons might perhaps object to the introduction of two hour-circles from an artistic point of view. But, after all is said, the question whether one circle containing twenty-four hours, or two circles having twelve hours in each, be preferable, is one to be settled only by a consideration of the relative advantages and disadvantages of the two proposals, in regard to which it would be interesting to learn what business men and others on the one hand, and practical watchmakers on the other, may have to say. There are conditions under which the one circle of twenty-four hours would certainly be the more advantageous, and clearly it would be well that one system only should if possible be used.

As regards clocks, there is the further question of striking the hours. For public clocks we could not go on to twenty-four. It may be a question whether in large towns one stroke only at each hour might not be a sufficient indication, though even this rule probably could hardly be universally applied.

THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

AT a meeting of the General Committee of the British Association held at the Royal Institution on the 11th instant, Sir Lyon Playfair was elected President for the meeting at Aberdeen next year. It was resolved to request the following to accept the office of Vice-President for that meeting:—The Duke of Argyll, the Duke of Richmond and Gordon, the Earl of Aberdeen, the Earl of Crawford and Balcarres, Sir William Thomson, James Matthews, Lord Provost of Aberdeen, Dr. Alexander Bain, Lord Rector of the University of Aberdeen, the Very Rev. Principal Pirie, and Prof. W. H. Flower. The following were elected Local Secretaries: Prof. G. Pirie, Dr. Angus Fraser, and Mr. J. W. Crombie; Local Treasurers: Messrs. Robert Lumsden and John Findlater. The following appointments were also made:—General Treasurer: Prof. A. W. Williamson, Ph.D., F.R.S.; General Secretaries: Capt. Douglas Galton, C.B., F.R.S., and A. G. Vernon Harcourt, F.R.S.; Secretary: Prof. Bonney, D.Sc., F.R.S.; Ordinary Members of the Council: Capt. W. de W. Abney, Prof. W. G. Adams, Prof. R. S. Ball, J. F. La Trobe Bateman, Sir F. J. Bramwell, Prof. W. Boyd Dawkins, Dr. Warren De La Rue, Prof. J. Dewar, Capt. Sir F. J. Evans, Prof. W. H. Flower, Dr. J. H. Gladstone, J. W. L. Glaisher, Lieut.-Col. H. H. Godwin-Austen, J. Clarke Hawkshaw, Prof. O. Henrici, Prof. T McK. Hughes, Dr. J. Gwyn Jeffreys, Prof. H. N. Moseley, Admiral Sir E. Ommanney, W. Pengelly, Dr. W. H. Perkin, Prof. Prestwich, the Right Hon. George Sclater-Booth, Dr. H. C. Sorby, Sir R. Temple; Auditors: John Evans, D.C.L., Treas.R.S., Dr. Huggins, F.R.S., and George Griffith, M.A.

Invitations for the year 1886 were received from Birmingham, Bournemouth, and Manchester, and after a discussion (in which the representatives of Manchester expressed their willingness to withdraw in favour of Birmingham for the year 1886, but their earnest hope that the Association would not fail to visit them in 1887), it was agreed, *nem con.*, to accept the invitation from the town of Birmingham for the year 1886.

The report of the Council relating to the rules concerning the representation of local scientific societies at the meetings of the Association and the establishment of a Permanent Committee as a means of union between them and the Association were sanctioned, and it was resolved in accordance with a recommendation from the Council to present the die for the medal which is about to be founded at McGill University, Montreal, in commemoration of the visit of the Association to Montreal.

THE NEW VOLCANIC ISLAND OFF ICELAND

AT the end of July this year the light-keeper at Cape Reykjanes, the south-west point of Iceland, reported that a volcanic island had risen in the sea a few miles off the cape. Reykjanes has long been noted as a centre of volcanic activity, and from time to time islands have arisen and submarine eruptions have occurred in its neighbourhood. In the year of the great Skaptárfell eruption, which proved so fatal to Iceland, 1783, an island appeared off Reykjanes, only to disappear again after a very brief existence. Only a year or two ago an eruption of considerable violence occurred in the sea, not far from the spot where the new island appeared. Columns of steam and clouds of dust, mingled with occasional glowing masses of fused rock, were seen to rise out of the sea, and large quantities of pumice were thrown up and drifted ashore on the neighbouring coast.

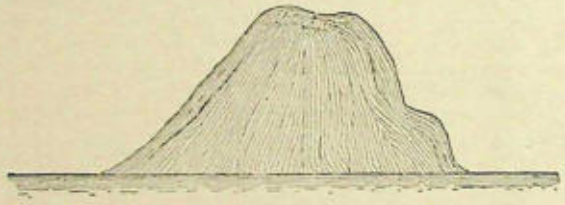
Being desirous to learn as much as possible about the new island, I visited Reykjanes on September 9. The cape, like the greater part of the surrounding district, is entirely covered with lava; not far from the sea lie a number of boiling pools of considerable size, from whose agitated muddy waters arise the columns of steam that give the cape its name, Reykjanes (Smoking Cape); over a large area surrounding the pools the earth is perforated by steam jets and small mud boilers, and the traveller must pass warily over its treacherous surface, for under the thin and yielding upper crust lie beds of soft many-coloured clays, boiling hot, permeated by steam and mixed with sulphur. On a projecting cliff about 150 feet high stands the lighthouse, a low octagonal stone house, and from the point a line of islands, four in number, runs out to the south-west, the nearest being about seven miles, and the farthest about sixteen miles, from the cape. Of these only the nearest two, Eldey or Melsækken (the Meal-sack, so called from the guano deposits that whiten the top of its bleak cylindrical mass), and Eldeyjard-rangur, are usually visible from the lighthouse. The farther two, Geirfuglasker and Geirfugladrangur, are chiefly interesting as having been formerly frequented by the Great Auk or Gare-fowl (*Alca impennis*), now apparently extinct.

When I reached Reykjanes, rain and mist obscured the sea, Eldey could only with difficulty be seen, and the new island was quite invisible. I waited patiently for better weather, employing the time in examining the boiling springs and hot clay-beds, which are similar to

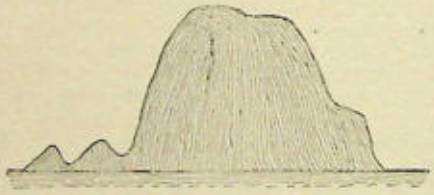
those of the Krísuvík sulphur mines, and the so-called "porcelain rock," a bed of very pure, white, and compact siliceous sinter or geyserite, deposited by some long extinct boiling spring. It was not till the afternoon of the next day that the weather cleared up a little, and a long and patient watch from the top of a hill behind the light-house was at length rewarded by the discovery of a dim spot on the horizon, which close observation through a good telescope showed to be the new island. It was quite invisible to the naked eye, but the light-keeper assured me that he had often seen it in clear weather, without a glass. When first seen, on July 29, its shape was that of a truncated cone with a slight depression on the top, and a considerable hollow half way down the slope on the north side.

On August 5 and 6 a series of violent earthquake shocks occurred, which shook and split the masonry of the lighthouse and damaged the lamps. For several days the new island was obscured by mist and rain, and when it again became visible its shape was considerably altered; a large part of the slope on the south side had slipped down into the sea, where it now lies, forming two little hillocks close to the foot of the main mass, and leaving a steep face nearly perpendicular towards the bottom. On the north side there is shoal water extending some distance from the island. The length of the island is about one-

The New Volcanic Island off Reykjanes, Iceland.



The island as when first seen.



The island as it now appears.

third greater than its height. It lies nearly west-south-west of Reykjanes, and considerably to the north-west of Eldey. Two French naval officers who visited Reykjanes and made observations of the island about a fortnight before I arrived there, estimate its distance from the coast at nine or ten miles, but I believe it to be considerably greater. When first seen the island was perfectly black, but now the light-keeper tells me he can in clear weather distinguish by the aid of his glass a perceptible whitening of the upper part, due no doubt to the droppings of the myriads of sea-fowl which frequent the neighbouring islands and coast, and have apparently at once taken possession of the new island.

It is a singular fact that none of the usual volcanic manifestations seem to have announced or accompanied the rise of the new island; no earthquakes were felt, no smoke or fire seen, and no pumice found floating on the sea. The island seems to have risen calmly and silently, without a soul being aware of its appearance, till, on July 29, the light-keeper happening to look out to seaward, discovered it. For aught that any one knows to the contrary, it may have been there for many days before he happened to see it. No one has yet visited the island itself; the sea off Rekjanes is almost always rough, and the currents are very strong round the cape; the islands are surrounded by shoals and reefs; landing is at all times difficult and dangerous, even in the best weather, and quite impossible if the sea is at all disturbed; and as, since the discovery of the island, the weather has been for the most part stormy, intending explorers have been deterred by the dangers of the passage. Singularly enough, a French war-vessel and a Danish gun-boat which passed Reykjanes shortly before my visit failed to see the new island. From the direction in which the new island lies, and its apparent distance from the coast, I am inclined to think that it must lie near to the Geirfuglasker (Gare-fowl Skerry), one of the four islands above mentioned, which lies somewhat to the north-west of the line formed by the other three, and which, being low and flat, cannot be seen from Reykjanes. It is not impossible that the new island is merely an addition to or upheaval of the old Geirfuglasker, which, by heightening it so as to make it visible from the shore, would produce the impression that a new island had risen. This view is held by some of the fishermen on the coast who are familiar with the islands, but the point cannot be definitely settled till the island is visited.

W. G. SPENCE PATERSON,
H.B.M. Consul for Iceland

British Consulate, Reykjavík, September 27

TELESCOPES FOR ASTRONOMICAL PHOTOGRAPHY

I.

BEFORE giving any suggestions as to the best kind of telescope to use, and the best methods to follow in the application of photography to astronomical observation and record, it may be more convenient to mention briefly what can be done in this way, particularly as the subject will be new to many who have not followed closely what has been recently done.

I wish to mention (1) That photography has now shown itself to be capable of giving us pictures of nebulæ that are superior to those made by eye and hand. (2) That anything that can be seen by the eye with a telescope of a certain size can be photographed, and, further than this, stars that are too faint to be seen in this telescope can yet be photographed by it with sufficient exposure. (3) That portions of the heavens of several degrees extent each way can be photographed, and stars therein of a magnitude smaller than that shown on the best existing charts or maps, pictured in their proper relative positions and magnitudes in a quicker, better, and more accurate manner than by the plan hitherto used. (4) That it is possible thus to make a complete series of such pictures embracing the whole heavens, that will be practically free from human error. (5) That each individual nebula, cluster, or group of stars, can also be taken on as large a scale as possible, and form a supplement to the picture-maps on the smaller scale. (6) That though such pictures may differ slightly from the eye observations, owing to the different colours of light not affecting the eye and the sensitive plate in the same manner, they would have the enormous advantage that they could be compared directly with other pictures, taken, after the lapse of any number of years, under conditions that there would be no difficulty in making almost identical. (7) That there are other applications of this new power, as in direct enlargements of the surface of the moon piece by piece, of the planets, of double stars, and close clusters, and indirectly in the discovery of planets, either major or minor, by the simple process of direct comparison of star pictures taken at intervals, when the actual position of a planet will be recorded at each date. If there be a planet beyond Neptune, such a plan as this is perhaps the only way to detect it, especially if it is now near the Milky Way, where stars of its probable magnitude cluster so thickly that no process other than this could be used to chart the stars and detect movement. If these things can be done, and I most

confidently say they can, then it must be admitted that nothing short of a revolution in observational astronomy must result, to the enormous gain of astronomy.

I speak relying entirely on my own work and experiments, which I shall refer to in detail further on, and I am strengthened in my opinions by what I hear has been done in a similar direction elsewhere, though I have not, except in one case, seen any of the actual work done.

The possibilities that are thus opened out really border on the marvellous. As has been already said by some one else, a library may now be made, not of books full of descriptions and figures, the accumulated work of many men working many years, each on his own system, but of pictures written on leaves of glass by the stars themselves.

Such a work will mark an epoch in astronomy, and its value increase as long as astronomers exist. No one can doubt for one moment the importance of such a work, nor the fact that, now it is possible, any delay in doing it will be a direct loss to astronomy. How it is to be done—whether by the slow process of letting it be done by the disjointed efforts of many amateurs of astronomy, or by being properly taken in hand and finished by united effort and proper means in the course of a few years—remains to be seen.

I propose to make some suggestions as to the practical part of this work in the selection of the best kind of telescope and mounting, the methods of working, the work to be done, and some other matters in connection. The most important matter is no doubt the selection of the best instrument to work with: of the two kinds of telescopes now in use, the reflector seems to be the most suitable for this work, though a reservation may be made in favour of the refracting principle where large fields on a small scale are required. Both kinds of telescopes when of moderate dimensions, that is, not more than 18 inches aperture, are so nearly alike as optical instruments that the chief distinction worth noting, neglecting for the present one or two points where they differ, and altogether such points as are rather matters of individual prejudice on the part of the observer than qualities or defects in the instruments, is that of cost, the reflector being very much less expensive to make. It is true that the refractor has been hitherto generally considered the most satisfactory in use, and has been preferred when expense has not been a consideration of importance. I think this may be rather due to the greater care that is bestowed upon the more expensive instrument, both in the making of the object-glass and the mounting, than to any real difference that there is between them. The first cost of the raw material alone differs immensely. For the reflector one disk of glass alone is required, and if it is only properly annealed it need not be optically pure. There is only one surface to work, though it is of importance that this should be properly figured, this is not a difficult matter, yet there is little doubt it has often been very imperfectly done in many so-called reflecting telescopes.

For the refractor two disks of glass are required; they must be optically pure, and their first cost alone is more than is often spent on the reflector, including the mounting. These disks must be wrought on four surfaces to proper curves, and time often spent afterwards in perfecting the object-glass; when this is done, the cost is found to be so great that it is felt to be worth a costly mounting. We cannot then be surprised that the better made and mounted telescope should be chosen, but that does not decide the question, Which is the best optical instrument? Nor can this question be decided definitively, because the images formed by each differ. If we look with a reflector at a bright star, the image is seen as an intensely bright point of light, dazzling to the eye if the telescope is large, and we see rays or coruscations round it of an irregular shape that are never steady. I think this effect is not due to the telescope, but is entirely subjective, and caused by this extremely small point of light exciting only a very small portion of the retina; for by proper precautions the light can be reduced, and these rays and the dazzling effect got rid of. With stars less bright it is not so pronounced, and on planets or objects of sensible magnitude it ceases entirely. The image of such a bright star in the refractor is quite of another kind: it is seen as a small disk of light of *sensible diameter* surrounded by the well-known system of diffraction rings and outstanding colour. This disk of light though small, has a different effect on the retina: it can be seen as a shape, pretty steady and free from too much dazzling glare. It is here that the refractor has such an advantage for micrometrical work, permitting bisections to be made with such precision.

The adjustments of the object-glass are considered more constant than those of the speculum, and though the troubles attending the reflector are much exaggerated, they have existed in the arrangements usually adopted. For certain instruments such as the transit-circle, where the connection between the optical axis and some part of the instrument has to be maintained, the object-glass is superior to the speculum; a tilt of the former that would not have an appreciable effect on the position of the image of a star would in the other displace this image twice the amount of tilt.

Both kinds have certain advantages, according to the use they are put to, and it is really not of much consequence which is the best instrument of this size. It is when we begin to consider the effect of increased size and all its attendant difficulties that the question of the suitability of either for the purpose of photography has to be answered.

With the reflector increase of size means proportionate increase in other qualities, in light-grasping power, in defining, and in separating power. With the refractor the greater absorption of light due to increased thickness reduces the light-grasping power, and definition becomes a matter depending not upon the optician but upon the glass-maker; the correction for colour, which even in theory is approximate only, becomes more difficult, and the defects due to the necessarily imperfect correction become more apparent—and these two facts alone show that as the refracting telescope gains in size it becomes more and more unsuitable for photography.

Moreover, when the aperture of the two kinds of telescopes under consideration is the same, the focal length of one must be something like twice that of the other, and that means that the image is four times less bright, and there does not seem to be any indication that the focal length of refractors can be very much reduced. This is only one part of the question, the next and most important one is that of actual cost or difficulty of construction. In the case of the refractor the preliminary difficulty in getting the lumps of glass out of which the lenses have to be made is so great that the increase of the size beyond 30 inches seems at the present moment very doubtful—they may reach 3-foot, or even 4-foot aperture, but it is most unlikely: the cost alone, good or bad, would be simply enormous, and such a size may be for the present left out of consideration. With the reflector the case is entirely different: from what has been said, it is easy to see that the gain by increase of size is proportionate here, and that only mechanical difficulties have to be met. Mirrors of glass covered or coated with silver for the reflecting surface are now in existence of 3- and 4-foot aperture; larger are in hand, and can be made at a cost absurdly below the cost of even a possible refractor: the only limit that I can see here is that of glass, and the limit in this case stops not at 30 inches, as with the refractor, but at something like 70 inches, and that and nothing else of a constructive character prevents the reflector being made much larger, and size is a great

thing in photography. It is, in the case of eye-observation, a fact that you could positively have a telescope too big for the eye to use, but any increase that is at present possible in the reflector would only add to its photographic power.

The optical arrangements of the reflector are so varied that I propose to treat of them in detail for the purpose of indicating the most suitable. A. AINSLIE COMMON

NOTES

THE following is the list of officers, &c., to be proposed at the anniversary meeting of the Royal Society, December 1, 1884 :—President, Prof. Thomas Henry Huxley, LL.D. Treasurer, John Evans, D.C.L., LL.D. Secretaries: Prof. George Gabriel Stokes, M.A., D.C.L., LL.D., Prof. Michael Foster, M.A., M.D. Foreign Secretary, Prof. Alexander William Williamson, LL.D. Other Members of the Council: Capt. W. de Wiveleslie Abney, R.E., William Henry M. Christie, Astronomer-Royal, Prof. George H. Darwin, M.A., F.R.A.S., Warren De La Rue, M.A., D.C.L., Robert Etheridge, F.R.S.E., F.G.S., Sir Frederick J. O. Evans, K.C.B., Prof. William Henry Flower, LL.D., Prof. George Carey Foster, B.A., Sir Joseph D. Hooker, K.C.S.I., Prof. Henry N. Moseley, M.A., F.L.S., Hugo Müller, Ph.D., Capt. Andrew Noble, R.A., C.B., Lord Rayleigh, D.C.L., Prof. J. S. Burdon Sanderson, LL.D., Lieut.-Gen. R. Strachey, R.E., C.S.I., Prof. J. J. Sylvester, M.A., D.C.L., LL.D.

PROF. LIVERSIDGE, of the Sydney University, sends to the local press a suggestive communication in connection with the recent meeting of the British Association in Montreal, and the invitation forwarded by the Victorian Premier to visit Melbourne next year. Feeling how insurmountable for the present are the obstacles to such a visit, the writer proposes what appears to be a very wise alternative. Instead of looking forward to a near visit from the Association, he suggests, as a preliminary step, a federation of the various scientific societies in Australia, Tasmania, and New Zealand into an Australasian Association for the Advancement of Science on the lines of the British Association. A first meeting of the new Association might be held in Sydney on the hundredth anniversary of the colony, which with the combined attractions of an International Exhibition might induce a fair number of scientific visitors from England to take part in the proceedings. After the first meeting gatherings could take place annually, or every two or three years, as might be agreed upon by the members, in various parts of Australasia. The writer concludes with the remark, which few will gainsay, that such an Association would tend greatly to advance the sciences in the colonies, and in many ways materially favour their progress elsewhere.

ACCORDING to *Science*, Prof. E. S. Holden, Director of the Washburn Observatory of the University of Wisconsin, has lately collected all the data available for the discussion of the law of distribution of the fixed stars, so far as this is determinable from the method of star-gauging. The data were collected from a comparison with the results of a series of star-gauges in progress with the 15-inch equatorial of the Washburn Observatory; and they included (1) the 683 previously published gauges of Sir W. Herschel, with the places brought down from 1690 to 1860; (2) the 405 unpublished gauges of Sir W. Herschel, extracted from his observing-books, and generously placed at Prof. Holden's disposal by Lieut.-Col. John Herschel (these also reduced to 1860); (3) 500 counts of stars from the published charts of Dr. C. H. F. Peters; (4) 983 counts of stars from the unpublished charts of Dr. Peters, from the Paris charts as revised by him, and from the unpublished ecliptic charts of Prof. Watson; (5) 856 counts of stars from the unpublished and published charts of Dr. J. Palisa. These, with the data from Sir J. Herschel's 605 southern gauges, and Celoria's *Durchmusterung* of the stars between 0° and + 6°, complete the very valuable collection of data which Prof. Holden has brought together in convenient tabular form, and from which one of his most important conclusions is, that the method of star-gauging must be applied to the study of comparatively small regions, and that the results from these are then to be combined into larger groups. Prof. Holden hopes that these tables may serve the valuable end of finally disposing of the fundamental assumption that the stars are equally scattered in space, and may bring about the study of their distribution on a more general basis.

THE Boston Society of Natural History have adopted a policy with regard to their library which, if generally followed, would make scientific libraries more generally useful. The Society send such books as can be replaced to students in any part of the country. The receivers of course pay the cost of carriage, and, in addition, strangers are required to deposit a sum equal to twice the market-value of the books so lent, as a guarantee against loss.

A BUREAU of scientific information has been formed in Philadelphia, composed of officers and members of the Academy of Science, whose duty shall be the imparting, through correspondence, of precise and definite information upon the different departments of science. The organisation is purely voluntary. The Secretary is Prof. Angelo Heilprin, of the Academy of Science.

THE new buildings of the Central School at Paris were opened last week by M. Rouvier, the new Minister of Commerce and Agriculture. A number of speeches were delivered on the occasion, from which we learn that as many as 5000 French engineers owe their training to this institution since its foundation fifty years ago by the late M. Dumas and others. The object contemplated by the erection of this institution was to check the predominatingly theoretical character of the instruction imparted by the Government schools and to remodel the engineering education in France according to the English standard. About ten years ago the establishment was purchased by the Government, but the teachers have held as closely as possible to the lines on which its teaching was originally laid down.

MR. STANFORD, of Charing Cross, has issued a reprint of the paper on the Ethnology of Egyptian Sudán, contributed by Prof. A. H. Keane to the November number of the *Journal* of the Anthropological Institute. This monograph, which will be welcome to all interested in the eventful drama now in progress in the Nile Valley, contains a summary but comprehensive survey of all the races between Egypt and the Equator, which are grouped in five main divisions: Bantu, Negro, Nubian, Semitic, and Hamitic. Much light is thrown on the obscure relations of these peoples to each other, and a clear picture presented to the reader of the manifold ethnical conditions in those regions. The tabulated schemes of all the Sudánese races with their numerous subdivisions, seem to be very complete, and will help to a better understanding of the reports daily received from the scene of the operations undertaken for the relief of Gen. Gordon and the Egyptian garrisons in the Sudán.

THE first annual meeting of the New England Meteorological Society was held in Boston on the 21st ult. The papers read were :—On rain-gauges, by Mr. Fitzgerald; rainfall maps, by Mr. Davis; weather observers in New England, by Prof. Upton; the establishment of a meteorological station on Blue Hill, Mass., by Mr. Rotch.

WITH reference to our recent note to the effect that Prof. Hugo Gyldén, Director of the Stockholm Observatory, had

accepted a professorship at the Göttingen University, we are informed that the celebrated astronomer will, in consequence of the generous offer made to him by the King of Sweden, remain in his native country.

PROF. F. E. NIPHER finds, according to *Science*, from data taken from Dr. Engelmann's observations at St. Louis, Mo., lasting over a period of forty-seven years, that the duration of maximum rains is inversely proportional to the violence, or that the product of violence into duration is constant. This constant is the amount of water which may fall in a continuous rain, and is, for Dr. Engelmann's series of half a century, about 5 inches. A rain of 5 inches per hour may last one hour. A rain of 4 inches per hour may last an hour and a quarter; and such a rain Dr. Engelmann observed. A rain of 2½ inches per hour may last two hours, and several such rains were observed. A rain of 1 inch per hour may last 5 hours. Each of these cases would be a 5-inch rain. For a longer period of time than fifty years it is likely that greater rains than 5 inches may be observed. The same is to be said if observations are to be taken over a wider area of country. In fact, a rain of 6 inches in three hours occurred near Cuba, Mo., some years since. This would increase the value of the constant from five to six, but otherwise the relation will probably remain unchanged. The importance of this law, *Science* points out, is very great in engineering, where the capacity of sewers, culverts, and bridges must be such as to carry the water. A more general investigation which Prof. Nipher is now making will determine the relation between the violence, duration, and frequency not only of maximum but of all rains. This work, when completed, will enable an engineer to construct the water-ways of bridges of such a capacity that they will probably stand a definite number of years before they are washed away. This number of years will be so determined that the interest on the invested capital during the probable life of the bridge will equal the possible damage when the destructive flood comes which the engineer determines shall destroy his work. The running expense of maintaining the bridge is then the least possible.

IN the October number of the *American Journal of Science* Mr. Lewis discusses the validity of observations on supposed glacial action at eleven points in Pennsylvania south of the terminal moraine, all of which he has visited. He concludes that they are all non-glacial, some being simple water-worn gravels, others being ice-rafted boulders, while the scratches reported in two localities are pronounced to be plant-fossils. The glacial action reported in Virginia needs, it is said, similar re-examination.

THE Meudon balloon made its third trial trip last Saturday. Starting at 12.15 noon, when a slight south-west breeze was blowing, it drifted in the direction of the Boulogne racecourse, and after arriving in the vicinity of that place, a distance of about a mile from its starting-point, obeying the motive power controlling its movement, it retraced its journey and alighted at the place from which it had ascended at one o'clock, having thus taken three-quarters of an hour to finish its trip of two miles altogether, going and coming. It is said, however, that the motive power of the voltaic elements was not quite so efficient as had been anticipated.

AT the last meeting of the Geographical Society of Hamburg, Dr. Sievers gave a short sketch of a journey of a year's duration which he intends making in the Cordilleras of Merida in Venezuela. Geographical investigation has, so far, not touched this region. Humboldt travelled through the eastern part from Cumaná to Caracas, the llanos of Caracas and Calabozo, and the districts in the Upper Orinoco, but he did not visit the Cordillera region of Merida. Later travellers also, including Godazzi, whose work was otherwise thorough, did not reach the place. Dr. Sievers will examine the region geologically, and obtain as many measurements of heights as possible.

THE report of a journey from Seul, the capital of Corea, to Songdo, by Mr. Aston, a consular official in Corea, has been published. The difficulties of travel in the country appear to have been much exaggerated; the people are friendly to strangers, and the discomforts are not greater than in China.

ACCORDING to a telegram from Calcutta, Mr. Griesbach, the geologist with the Afghan Boundary Commission, describes the route between Quetta and the Helmund as presenting features very similar to those in the Pishin valley and Candahar, namely, a system of precipitous, deeply eroded ridges, extending from north and south to north-east and south-west. Extensive post-Tertiary deposits fill the intervening valleys. The south-west extremity of the Ghazarband range is composed of sandstone shales and grits of the Flysch facies of Eocene rocks. A series of low hills and valleys stretch between Canjpai and Nushki, which from their composition appear to be merely continuations of the Kojah Amran range, but near Galiahah the formation is distinctly younger, the epoch being mostly trap-rock, which in places bursts through the Cretaceous limestone overlying it, and locally converts it into white marble.

NOT the least valuable of the many excellent reports published in the course of the year by the Chinese Customs department is that of the medical officers on the health of the various ports at which they are stationed. These gentlemen deal frequently with subjects of wider interest than the sanitary condition and health of certain limited portions of the Chinese Empire. Thus in the last reports, Dr. Macgowan, of Wenchow, gives an account of the cholera epidemic which visited China last year. He states, on the authority of a native author, that Indian or Asiatic cholera first made its appearance in China in 1821, medical tradition attributing its origin to the Straits of Malacca, whence it was brought to Fokhien in a junk. It subsequently spread southward to Canton, and from thence to other provinces. In 1825 a great outbreak occurred at Ch'un-Ching, on the Yangtsze, and thence the disease travelled slowly northward, visiting Corea and Japan, where it became extremely virulent. It has since been endemic in China, sometimes becoming epidemic, occasionally extending over the whole of Eastern Asia, and at other times confining itself to a province or part of a province. Dr. Macgowan states that the native doctors treated the disease as common cholera, and did not cure one in a hundred; and he concludes that Indian cholera in China differs from the common cholera of the country only in its epidemic character, the former being migratory, the latter stationary.

IN the *Archives des Sciences physiques et naturelles*, Prof. Forel of Morges has a paper on the solar corona of the spring of 1884, of which the following is a summary. In Switzerland, in the course of the present year, has been observed an extraordinary optical phenomenon consisting of a reddish corona of large diameter surrounding the disk of the sun, as well as of a reddish tint on the white clouds. This corona has been visible since the beginning of the year, and during the months of July and August it was constantly seen. Visible from high altitudes whenever the sky was clear, it was generally lost lower down, hidden probably by the light from lower layers of dust in the atmosphere. The corona is probably occasioned by dust settling in the higher layers of the atmosphere where they are protected from meteorological variations of the lower layers. This dust would be of uniform dimensions, and of a mean diameter of about 0·003 mm. In the absence of any other explanation, M. Forel refers this phenomenon to the brilliant crepuscular illuminations of last winter, and attributes these

luminous objects to the volcanic dust of the eruption of Krakatoa of August 27, 1883. In *La Nature* M. Tissandier describes the corona as observed in two balloon ascents on October 23 and 24.

M. HENRI MAGET is about to publish in Paris an atlas of the French colonies and foreign possessions. The work, which will consist of twenty-five maps, will be brought out with the assistance of eminent French colonial geographers. The maps will be of large size, in three or four colours, and some of them have obtained a silver medal and a diploma of honour, at the recent Geographical Exhibition at Bar-le-Duc. It will be completed in five parts, the first of which has already appeared. This contains maps of (1) New Caledonia, (2) Central Africa (the Congo and the Gaboon), (3) Tonquin, (4) Madagascar, (5) the Grand Duchy of Luxemburg. The second part will contain maps of Réunion, Tahiti, Guadaloupe, Senegal, and the New Hebrides.

WE have again to welcome the appearance of a new edition (the tenth) of Prof. Morren's most useful "Correspondance botanique." Since the appearance of the ninth edition (in 1881) the list of "gardens, chairs, museums, and botanical reviews and societies throughout the world," including also the addresses of all private working botanists known to the editor, has again undergone considerable enlargement—we hope an indication of a gradual spreading of interest in botanical science.

DR. BRUDENELL CARTER has issued in a separate form his now celebrated letter to the *Times* on "Eyesight and Civilisation" (Macmillan and Co.). He has taken the opportunity to introduce a few explanatory diagrams.

PROF. F. W. PUTMAN has sent to the *Leader* a full account of his recent explorations amongst the so-called Liberty Group of Mounds on the Harness estate, Ohio, first surveyed and described by Squier and Davis in 1840. In their great work on "The Ancient Monuments of the Mississippi Valley" these archæologists describe five small mounds within the great square of twenty-seven acres. Most of these, as well as three others represented on their plan just outside a "gateway" on the east side of the larger forty-acre square have been much reduced by cultivation. All have now been carefully examined, two—evidently burial-places—yielding objects of considerable interest. The human bones were much decayed; but amongst the other finds were copper plates, ear-rings, and celts, slate and stone ornaments, some large beads covered with copper, and in one instance with silver over the copper, and many other objects, all of which have been deposited in the Museum of Cambridge University. In another large mound north of the same spot an extensive bed of ashes and charcoal yielded much pottery, pieces of cut mica, some grass matting with charred seeds, nuts, acorns, and bones. Near the eastern corner of the great square stands the largest mound of the whole group, which in future Reports of the Peabody Museum will be referred to as the "Big Mound of the Liberty Group." It is 160 feet long by 80 to 90 wide, and 13 to 18 high, and appears from the portion so far examined to be a burial-place of a remarkable character. Some 40 feet from the centre, at the northern end, twelve chambers were opened, and yielded charred mats and cloth in which the bodies had evidently been wrapped, besides various burnt objects, such as copper plates, ear-rings, shell beads, and long flint knives. In two of the chambers skeletons were found stretched at full length, with a copper plate on one of them, the action of which had preserved the structure of a finely-woven piece of cloth. In the other chambers the bodies had been burnt on the spot, as shown by the relative position of the bones and by the fact that in two instances portions of the bodies had fallen beyond the fire, and so escaped burning. Other discoveries made early in the present year in two of the pits by some boys, under the guidance of Mr. Wilson, yielded a great variety of objects which have also been secured for the Peabody Museum. Important links have thus been obtained between the builders of this great mound and neighbouring earth-works in the Scioto Valley and the constructors of the remarkable group on the Turner estate in the Little Miami Valley.

MR. ELLIS, of 90, New Bond Street, has now on exhibition a number of garments, fur-lined and fur-covered, which were used by the German Polar Expeditions of 1882. In both cases the furs were hardly worn at all. The first expedition, which wintered from August 21, 1882, to September 12, 1883, in Kingawa Fjord, Cumberland Gulf, 60° 15′ W. longitude and 60° 36′ N. latitude, and as there was a perfect calm through the winter, the furs were not necessary; similarly the second expedition, which wintered in the island of South Georgia (36° 5′ W. longitude and 54° 32′ S. latitude) from August 21, 1882, until September 5, 1883, found the temperature equally mild. The furs were lent for exhibition by the Imperial German Polar Commission.

THE last census of Roumania gives a total population of 4,424,961, of which 2,276,558 are males, and 2,148,403 are females. According to religious sects there are 4,198,664 orthodox Greeks, 134,168 Jews, 45,152 Roman Catholics, 28,903 Protestants, 8734 Gregorians, 8108 Armenians, and 1323 Mohammedans. The foreign element in the population is composed as follows:—28,128 Austrians, 9525 Greeks, 3658 Germans, 2822 English, 2706 Russians, 2631 Turks, 1142 French, 167 Italians, and 539 of various nationalities—in all 51,138 persons. The urban population numbers only 781,170, while the rural population is 3,643,783.

ON October 16 a mirage was seen at Lindesberg, in Central Sweden. It represented a large town with four-storied houses, a castle, and a lake. The phenomenon was observed for about fifteen minutes.

THE red sun-glows have recently been observed in the far north of Sweden.

THE additions to the Zoological Society's Gardens during the past week include a Barbary Ape (*Macacus innuus*) from North Africa, an Anubis Baboon (*Cynocephalus anubis*) from West Africa, a Siamese Blue Pie (*Urocissa magnirostris*) from Siam, presented by Mr. R. B. Colom; a Ring-tailed Coati (*Nasua rufa*) from South America, presented by Mr. C. M. Courage; six Alexandrine Parrakeets (*Palæornis alexandri*), a Blossom-headed Parrakeet (*Palæornis cynocephalus*), a Banded Parrakeet (*Palæornis fasciatus*), from British Burmah, presented by Mr. Eugene W. Oates, F.Z.S.; two Ring-necked Parrakeets (*Palæornis torquatus*) from India, presented respectively by Mr. W. G. Burrows and Miss Perry; a Weka Rail (*Ocydromus australis*, white var.) from New Zealand, presented by Mr. J. Satchell Studley; a Brown Capuchin (*Cebus fatuellus*) from Guiana, two Pronghorn Antelopes (*Antilo apra americana* ♂ ♀) from North America, deposited; a Great Grey Shrike (*Lanius excubitor*), six Curlews (*Numenius arquata*), British, purchased; a Blue-winged Teal (*Querquedula cyanoptera* ♂) from South America, received in exchange.

VARIATION OF THE ATOMIC WEIGHTS

THE annexed list contains all the elements except a few very little investigated. If the whole numbers in columns are taken to be each the weight of nine atoms in the gaseous state, and a comparison is made with the best determinations of vapour-densities on record, the result is as follows. The first nineteen determinations are Deville and Troost's, and are to be found in *Comptes Rendus*, xlv. (1857) p. 823; lvi. (1863) p. 893; lx. (1865) p. 1222; lxiii. (1866) p. 20.

		Vols.	Observed at	Calc. sp. gr.	
$3P_4$	=	1		4·433	
			500 & 1040	4·425	
$3As_6$	=	1		10·529	
			564	10·6	
$3Se_2$	=	1		5·5416	
			1420	5·68	
$3Te_2$	=	1		9·0513	
			1390 & 1439	9·04	
$3Cd$	=	1		3·9253	
			1040	3·94	
$3Al_2Cl_6$	=	1		9·3514	
			350 & 440	9·348	
$3Al_2Br_6$	=	1		18·772	
			440	18·62	
$3Fe_2Cl_6$	=	1		11·3834	
			440	11·395	
$3Ta_4Cl_4$	=	2		9·836	
			350	9·6	
$3Nb_2Cl_5$	=	2		9·5208	
			350	9·6	
$3Nb_2Cl_3O_2$	=	2		7·654	
			440 & 860	7·88	
$3Zr_4Cl_4$	=	2		8·0815	
			440	8·15	
$3Hg_2Cl$	=	2		8·3085	
				8·21	
				8·35 Mitscherlich	
$3H_4N_3Cl$	=	4		0·9294	
			350 & 1040	1·005	
$3H_4N_3Br$	=	4		1·7144	
			860	1·71	
$3H_4N_3I$	=	4		2·5457	
			440	2·59	
$3H_4N_3C_4H_5Cl$	=	4		1·4143	
			350	1·44	
$3H_4N_3ClHgCl$	=	4		3·3134	
			440	3·5	
$3H_4N_3IHgI$	=	4		6·546	
			350	6·49	
$3Cl$	=	1		2·47	
				2·47 Berzelius	
$3Br$	=	1		5·611	
				5·54 Mitscherlich	
$3I$	=	1		8·9358	
				8·89 V. Meyer	
$3Hg$	=	1		7·0655	
				7·03 Mitscherlich	
$3HgCl$	=	1		9·536	
				9·8 Mitscherlich	
$3As_6O_6$	=	1		13·854	
				13·85 Mitscherlich	
$3P_2S_5$	=	1		7·758	
				7·67 V. & C. Meyer	
$3P_2Cl_3$	=	2		4·814	
				4·85 Mitscherlich	
				4·875 Dumas	
$3As_2Cl_3$	=	2		6·3383	
				6·3 Dumas	
$3Bi_2Cl_3$	=	2		11·1871	
				11·16 Jacquelain	
$3PbCl$	=	1		9·536	
			At 1046°–1089°	mean of 4 exp. = 9·5 Roscoe[1]	
$3Ti_4Cl_4$	=	2		6·8808	
				6·836 Dumas	
$3Sn_4Cl_4$	=	2		9·1898	
				9·199 Dumas	
$3Si_4F_4$	=	2		3·6944	
				3·6 Dumas	
$3Si_4Cl_4$	=	2		5·9572	
				5·939 Dumas	
$3Sb_2Cl_3$	=	2		8·07	
				8·1 Roscoe & Schorlemmer ("Chemistry")	
$3Sb_2(C_4H_3)_3$	=	2		7·3773	
				7·438 Löwig & Schweitzer[2]	
$3In_2Cl_3$	=	2		7·7698	
				7·87 V. & C. Meyer	

[1] *Proc. Roy. Soc.* xxvii. p. 427. [2] *Journ. Chem. Soc.* v. p. 69.

The agreement in all cases is such that, considering the difficulties with which the determination of vapour-densities is attended, it is not likely that other atomic weights could be chosen to obtain like good results. If now the weights in column *t* are taken to be the weights of a single atom for each element in a certain solid or liquid state, the percentages of oxygen in the following chlorates agree closely with the values found by experiment,[1] to wit :—

$100AgClO_6$	contain	25·0525	O	
	found	25·0795	O	Stas
	,,	25·088	O	Marignac
$100AgBrO_6$	contain	20·34	O	
		20·349	O	Stas
$100AgIO_6$	,,	16·9619	O	
		16·9747	O	Stas
		17·047	O	Millon
$100KBrO_6$	,,	28·7307	O	
		28·6755	O	Marignac
$100KIO_6$	,,	22·4227	O	
		22·473	O	Millon
$100NaClO_6$	,,	45·0672	O	
		45·0705	O	Penny

The agreement in these instances is as good as with the adopted weights ; but it is complete also in the following cases, in which there are great discrepancies with the prevailing atomic weights :—

$100PtCl_2KCl$ contain	69·362	$PtCl_2$ and	30·638	KCl		
	69·417	,,	30·583	,,	Berzelius	
	69·318	,,	30·682	,,	Seubert	
Mean	69·3675	,,	30·6325	,,		
,, ,, yield			117·825	AgCl		
			117·9606	,,	Seubert	

The agreement of the mean of the percentages of Berzelius and Seubert with the calculated values is complete ; the discrepancy between the amounts of silver chloride is small and within the limits of errors of observation. But the percentages of platinum and chlorine in $PtCl_2$ arrived at by the two experimenters are widely different, viz. :—

40·424 Pt ; 28·993 Cl Berzelius
40·107 ,, ; 29·211 ,, Seubert

The true weight of the chlorine follows from Seubert's analysis of the ammonium salt—

$100H_4N_3PtCl_3$ yield 194·954 $(AgCl)_3$
Seubert obtained 192·846 ,,

His rate between the silver chloride and the potassium salt gives ... } Pt = 195·002 Clarke
His rate between the silver chloride and the ammonium salt gives ... } ,, = 196·871 ,, ;

the latter rate is therefore at fault, and 100 parts of the ammonium salt correspond to 194·694 AgCl, if the rate is the same as with the potassium salt ; the difference between this number and 194·954 is within the limits of errors of observation. The rate $\frac{100}{194·954} \times (AgCl_3)_3$ gives $H_4N_3ClPtCl_2 = 70·84883$, and the rate $\frac{69·362}{30·538} \times KCl$ gives $PtCl_2 = 53·95833$; H_4N_3Cl is therefore 16·8905, and as the weight of H_4N_3 is not in doubt and = 5·74468, Cl is = 11·14583, as in column *t*. With this weight of chlorine all discrepancies disappear, while the weights recalculated from the same data vary between Pt = 194·314 and 196·871. It is moreover minutely confirmed by the results obtained from all the other elements of the same group.

$100OsCl_2KCl$ contain } 41·0226 Os ; 28·5027 Cl ; 30·4747 KCl
40·638 ,, 28·9024 ,, 30·4596 ,, Berzeliu

Berzelius's percentage of chlorine is again too large, very nearly to the same extent as the chlorine found by him in the potassio-platinum chloride, while the percentage of the potassium chloride is very exact.

[1] The experimental values are those recalculated by Prof. F. W. Clarke ("Smithsonian Miscell. Coll.," vol. xxvii.).

100$IrCl_2N_3H_4Cl$ contain	44·3691 Pt			
100$IrCl_3KCl$ contain	43·732 ,, Seubert			
	40·3874 ,, ; 28·8097 Cl ; 30·803 KCl			
	39·88 ,,	29·291 ,,	30·82 ,,	Seubert
		29 ,,		Berzelius

The same discrepancies as in the case of the platinum salts present themselves: as the percentage of the potassium chloride is exact, that of $IrCl_3$ follows; and, as to the weight of the chlorine, the difference of the percentages found by the two experimenters shows that there is the same cause of error as in the corresponding platinum salt.

100$PdCl_2.2KCl$ contain	32·678 Pd ; 21·4512 Cl ; 45·8708 KCl			
	32·69 ,,	21·416 ,,	45·892 ,,	Berzelius

The agreement is here as good as complete; but the values actually derived from these data vary from Pd = 104·674 to 110·796, owing to the value of the weight assumed for chlorine.

100$Rh.Na_3Cl_6.Cl_3$ contain—

27·1468 Rh ; 45·6215 NaCl ; 27·2317 Cl
27·094 ,, 45·577 ,, 27·329 ,, Berzelius

100$Rh.2KCl.Cl_3$ contain—

29·1276 Rh } 41·6537 KCl ; 29·2187 Cl
28·989 ,, 41·45 ,, 29·561 ,, Berzelius

The agreement is almost complete in the case of the sodium salt, and not doubtful in the other, because the weight of KCl is certain. The values for rhodium derived from the sodium salt are very discordant, varying from 102·98 to 105·696.

100$Ru.2KCl.Cl_3$ contain	28·9984 Ru ; 41·7297 KCl ; 29·2719 Cl				
Numbers actually found	28·96 ,,	41·39 ,,			Claus
Mean of the 3 experiments	28·78 ,,	41·09 ,,	30·17 ,,		

The calculated amount of ruthenium is undoubtedly the actual percentage, because 28·91 Ru were found in the second experiment as 28·96 in the first; and the weight of KCl not being doubtful, that of chlorine can only be as calculated. The results which have been derived from these data are most discordant, viz. Ru 96·854—107·19.

The weights of column *s* give $O_6 = 16$ and $S_3 = 16$; those of column *t*, $O_6 = 15{\cdot}31914$, $S_3 = 15$. . . . There is consequently a difference of the chemical proportions in the two states which explains many anomalies encountered in analytical work, and among others the following:—Berzelius observes (*Pogg. Ann.* viii. p. 16) that, from causes which he has been unable to discover, the atomic weight of sulphur cannot be derived from the specific gravities of the gaseous compounds H_2S and SO_2, the numbers obtained being so high that the discrepancies exceed the limits of possible errors of observation. He had obtained S = 201·165 from the analysis of $PbSO_4$; Thénard and Gay-Lussac's weighing of H_2S gave S = 203·9; his own weighing of SO_2, 207·58. His weight for O being 100, these 207·58 S represent 407·58 SO_2, which with $S_2 = O_6$ give S = 203·79, practically the same as the value derived from the other gaseous compound. The two numbers 203·9 and 203·79 reduced to the value of the weights of column *t* give respectively 191·056 and 191·053. Berzelius's number 201·165 corresponds to the value of column *t*, H being = 1; with H = 0·95745, the actual weight, it becomes 192·605. The three numbers in hydrogen units—15·292, 15·284, and 15·408—though from different causes all too large, agree with each other as well as can be expected under the circumstances, and the difficulty disappears therefore with the adoption of the weights of columns *s* and *t* for the two different states.

This being so, it is to be expected that for other states the weights will also be still further different, and this conclusion is fully confirmed by the facts. Let the weights of column *t* be = 1, then the weights of the states *a*, *b*, and *c* are as follows:—

$$a = 0{\cdot}999104\ ;\ b = 0{\cdot}997338\ ;\ c = 0{\cdot}99468.$$

Instead of such loss of weight there may be a gain to the same extent, as, for instance, in the state $\frac{1}{b} = 1{\cdot}002662$. There are still other variations which are multiples of *a*, *b*, *c*, as—

$$a^2 = 0{\cdot}99866\ ;\ \frac{c^2a}{2} = 0{\cdot}99424\ ;\ cb = 0{\cdot}99203.$$

The evidence of the reality of these weights appears from the following comparison with some of the very best experiments on record. The numbers marked with an asterisk are derived by the volumetric method, which, in consequence of variation of the atomic weights, yields in all cases more or less faulty results.

100$KClO_6$ contain ...	60·87379 KCl = 1		
	60·81927 ,, = *a*		
Mean	60·84653		
Mean of all experiments on record	60·846 ,,	Berzelius, Penny, Pelouze, Marignac, Gerhardt, Maumené, Stas	
100Ag = *c* yield ...	132·8426 AgCl		
Mean of all experiments on record	132·8418 ,,	Berzelius, Turner, Penny, Marignac, Maumené, Dumas, Stas	
100Ag correspond to	69·0244 KCl = *a*		
	* 69·062 ,,	Marignac	
	* 69·10345 ,,	Stas	
100Ag yield	114·8733 $AgS = a^2$		
	114·8581 ,,	Dumas, Stas, Cooke	
100AgCl yield ...	86·4733 ,, = a^2		
	86·4733 ,,	Berzelius, Svanberg, and Struve	
100Ag correspond to	54·1258 NaCl		
	*54·2076 ,,	Pelouze, Dumas, Stas	
100Ag yield	157·4707 $AgN_3O_6 = b$		
Mean of 7 experiments	157·472 ,,	Stas	
Mean of all experiments on record	157·479 ,,	Penny, Marignac, Stas	
100AgN_3O_6 corresponds to	84·35994 AgCl		
	84·3743 ,,	Turner, Penny	
100AgN_3O_6 correspond to	43·8331 KCl = *a*		
	*43·8715 ,,	Marignac, Stas	
100KCl = *a* yield ...	135·6532 $KN_3O_6 = c$		
	135·6423 ,,	Stas	
	135·6345 ,,	Penny	
100$KClO_6$,, ...	82·5033 ,,		
	82·500 ,,	Penny	
100$NaClO_6$,, ...	79·8917 $NaN_3O_6 = \frac{c^2a}{2}$		
	79·8823 ,,	Penny	
100NaCl ,, ...	145·435 ,,	$= \frac{c^2a}{2}$	
	145·4164 ,,	Penny	
	145·4526 ,,	Stas	
100$AgC_4H_3O_4 = c$ contain	64·6608 Ag		
	64·664 ,,	Marignac	
	64·6065 ,,	Liebig and Redtenbach	
100$AgC_4H_2O_6 = c$ contain	59·3367 ,,		
	59·2806 ,,	,,	,,
100$AgC_4H_2O_5 = c$ contain	62·0621 ,,		
	62·0016 ,,	,,	,,
100BaCl yield ...	138·0494 AgCl		
	138·07 ,,	Berzelius	
,, ,, ...	112·251 $BaSO_4$		
	112·19 ,,	Turner	
	112·175 ,,	Berzelius	
100$CaCO_3 = c$ yield	56·0312 CaO = 1		
General mean ...	56·0198 ,,	Dumas, Erdman, and Marchand	
100$CaCO_3 = c$ yield	136·0037 $CaSO_4 = 1$		
	136·0525 ,,	Erdman and Marchand	
100Pb ,,	146·4418 $PbSO_4$		
	146·4262 ,,	Berzelius, Turner, Stas	
100PbO ,,	135·853 ,,		
	135·804 ,,	Turner	

100$PbSO_4$ yield	109·2444	$PbN_3O_6 = b$
	109·307	,, Turner
100Pb ,,	159·98	,,
	159·9743	,, Stas
100$PbN_3O_6 = b$,,	67·3790	$PbO = 1$
	67·4016	,, Svanberg
100AgCl correspond to	29·5607	$LiCl = \frac{1}{b}$
	29·584	,, Mallet, Troost
100Ag correspond to	39·2692	,, $= \frac{1}{b}$
	39·358	,, Stas
$100LiCl = \frac{1}{b}$ yield	162·6508	$LiN_3O_6 = c$
	162·5953	,, Stas
100Tl yield	130·38969	$TlN_3O_6 = b$
Experiment 8 ..	130·3897	,, Crookes
Mean of 10 experiments	130·391	,, ,,
$100G_2O_3(SO_3)_3.12HO = c$ contain—		
	14·1694	GO
	14·169	,, Nilson and Pettersson
$100MgC_2O_4H_2O_2 = c$ contain—		
	27·338	$MgO = 1$
	27·3665	,, Svanberg & Nordenfeldt
$100MgCO_3 = c$ contain	47·6	,,
Mean of 19 experiments	47·627	,, Marchand and Scheere
$100H_4N_3.SO_4.3AlOSO_3.24HO = cb$ contain—		
	11·2814	AlO
Mean of 10 experiments	11·2793	,, Mallet
$100H_4N_3SO_4.3GaOSO_3.24HO = cb$ contain—		
	18·9325	GaO
	18·9596	,, Lecoq de Boisbaudran

These determinations include the most classical labours on record, and the general agreement with the calculated numbers is surprising, and the more conspicuous in the cases in which the efforts of the experimenters to exclude error have been pushed to the utmost limits, as in Stas's syntheses and in Prof. Crookes's synthesis of thallium nitrate. Notwithstanding the difficulty in this case, because the element is the heaviest of all so far discovered, one experiment has yielded the identical calculated number, and the mean of all deviates from it only by 0·00131. Moreover the same weights recur in similar compounds; all nitrates, for instance, have a lower value than the corresponding chlorides and sulphates, and the value is the lower the greater the composition, as in the alums. The evidence is such that no doubt seems to be admissible as to the reality of a variation of the atomic weights. This conclusion is independent of any value of the atomic weights; for the discrepancies exhibited in the results of Prof. Clarke's recalculations from the same experimental data above quoted are inevitable if the variation of the atomic weights is not taken into account. In c units Ag is 108·09679 if H = 1, calculated from the weights of column t; Cl in the gaseous state is = 35·66; the calculated weights correspond therefore, within the limits of experimental errors, to the atomic, but the weights are those of different states.

The difference between the weights of the gaseous and the other states is very considerable; the weight of 3 molecules of $H_4N_3I.HgI$, for instance, is = 378 in the state of gas, 354·734 in A units, 352·847 in units = c; the discrepancies are so great that they exceed by far the limits of possible errors, and as from the comparisons made it appears certain that the different values are realities, the only explanation is that the atomic weights vary. If in new experiments, in which the possibility of variation is kept in view, all discrepancies which actually exist should disappear, variation will be established beyond all doubt. It will then be in order to inquire into its cause. How the weights of the table have been obtained is, for the present, unessential; it is only necessary to add that column v contains Prof. Clarke's recalculated weights, and column u the same values calculated from the weights of column t, column x giving the number of atoms represented in each instance. Column w shows the corresponding weights of the gaseous state. These columns have been added for the sake of comparison.

	A	t	u	v	w	x
Li	22	2·30559	7·412	7·0235	7·333	3
Ca	58	6·23656	39·0824	40·082	38·666	6
Na	70	7·52688	23·5842	23·051	23·333	3
K	118	12·68817	39·7564	39·109	39·333	3
Rb	256	27·5269	86·2424	85·529	85·333	3
Mg	36	3·8537	24·15	24·014	24	6
Sr	132	14·1303	88·5498	87·575	88	6
Ba	206	20·05183	138·1915	137·007	137·333	6
Pb	306	32·7566	205·2748	206·946	204	6
Ag	324	34·683467	108·6748	107·923	108	3
Cs	398	42·605	133·496	132·918	132·666	3
H	3	0·31915	1	1·0023	1	3
N	14	1·48936	14	14·029	14	9
O	24	2·55319	16	16	16	6
F	58	6·04166	18·93	19·027	19·333	3
Cl	107	11·14583	34·9236	35·451	35·666	3
Br	243	25·3125	79·3125	79·951	81	3
I	387	40·3125	126·313	126·848	129	3
B	11	1·14583	10·771	10·966	11	9
G	14	1·45833	9·072	9·106	9·333	6
C	18	1·875	11·75	12·0011	12	6
Si	22	2·29166	28·722	28·26	29·333	12
Al	28	2·9166	27·416	27·075	28	9
P	32	3·3333	31·33	31·029	32	9
Ti	42	4·375	54·833	49·961	56	12
La	44	4·5833	143·61	138·844	146·666	30
S	48	5	31·33	32·058	32	6
Di	50	5·20833	146·875	144·906	150	27
Yt	60	6·25	88·125	90·023	90	13·5
Yb	62	6·45833	182·125	173·158	186	27
Ce	64	6·6666	139·26	140·747	142·222	20
Sc	66	6·875	43·0833	44·081	44	6
Zr	68	7·0833	88·7777	89·573	90·666	12
Ga	72	7·5	70·5	68·963	72	9
As	76	7·9166	74·417	75·09	76	9
V	78	8·125	50·9166	51·373	52	6
Cr	80	8·3333	52·222	52·129	53·333	6
Mn	84	8·75	54·833	54·029	56	6
Fe	86	8·9583	56·139	56·042	57·333	6
Ni	90	9·375	58·75	58·062	60	6
Co	91	9·4792	59·403	59·023	60·666	6
Sn	92	9·5833	120·11	117·968	122·666	12
Cu	96	10	62·666	63·318	64	6
Nb	98	10·20833	95·95833	94·027	98	9
Zn	100	10·4166	65·278	65·054	66·666	6
Ta	106	11·04166	184·5186	182·562	188·444	16
Se	120	12·5	78·333	78·978	80	6
Sb	126	13·125	123·375	120·231	126	9
W	142	14·79166	185·3888	184·032	189·333	12
Mo	150	15·625	97·9166	95·747	100	6
Cd	170	17·7083	110·972	112·092	113·333	6
In	176	18·3333	114·888	113·659	117·333	6
Th	178	18·54166	232·389	233·951	237·333	12
U	184	19·1666	240·222	239·03	245·333	12
Te	196	20·4166	127·945	128·254	130·666	6
Au	204	21·25	199·75	196·606	204	9
Bi	216	22·5	211·5	208·001	216	9
Ir	300	31·25	195·833	193·094	200	6
Pt	304	31·6666	198·444	194·867	202·666	6
Hg	306	31·875	199·75	200·171	204	6
Os	308	32·0833	201·056	198·951	205·333	6
Ru	318	33·125	103·7916	104·457	106	3
Rh	320	33·3333	104·444	104·285	106·666	3
Pd	326	33·95833	106·403	105·981	108·666	3
Tl	618	64·375	201·708	204·183	206	3

San Francisco, California, July 24 E. VOGEL

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—The following gentlemen were on Monday, November 3, elected to Fellowships at St. John's College:—C. M. Stewart, M.A., First Class in Natural Sciences Tripos of 1879, author of several papers on chemical subjects, and Master

at the Newcastle School, Staffordshire; J. Brill, B.A., Fourth Wranger in 1882, Assistant Professor of Mathematics in University College, Aberystwith; W. F. R. Weldon, B.A., First Class in the Natural Sciences Tripos of 1881, author of a number of papers in Zoology and Comparative Anatomy, formerly Demonstrator to the Professor of Zoology and in the Morphological Laboratory; A. R. Johnson, B.A., Sixth Wrangler and First Division in the Mathematical Tripos of 1882-83 (new regulations), author of papers in the *Messenger of Mathematics*, &c.; G. F. Stout, B.A., First Class in the Chemical Tripos of 1881-82 (new regulations), and First Class (with distinction in Metaphysics) in the Moral Sciences Tripos of 1883; G. B. Mathews, B.A., Senior Wrangler in 1884, Professor of Mathematics in the University College of North Wales, Bangor. It is worth noting that Pure and Applied Mathematics, Chemistry, and Biology have been markedly recognised by this election.

Dr. Donald MacAlister has been appointed University Lecturer in Medicine, and Dr. Bushell Annington University Lecturer in Medical Jurisprudence.

Mr. Walter Heape has been approved by the Board for Biology and Geology as Demonstrator in Animal Morphology, on the nomination of the Lecturer in that subject, Mr. Sedgwick.

Prof. Sidgwick, Prof. Adamson (Owens College), and Messrs. James Ward and J. S. Nicholson are appointed Examiners for the Moral Sciences Tripos.

Mr. A. R. Forsyth of Trinity College is appointed Examiner in the Mathematical Tripos (Third Part) in January next, in the place of the late Mr. R. C. Rowe.

In reference to our note a fortnight ago (vol. xxx. p. 649), we should state that, at Trinity College, Major Scholarships of the value of 80*l.* a year, which may be raised to 100*l.* subsequently, are open for competition in Natural Sciences as well as in Classics and Mathematics to persons not yet in residence, with the usual restriction as to age.

SHEFFIELD.—Another step has been taken in the formation of the new Engineering School at Firth College, Sheffield, in the appointment of Mr. W. H. Greenwood to be Professor of Metallurgy and Mechanical Engineering, and Mr. Ripper to be Assistant Professor of Engineering. It may be in the memory of our readers that the City and Guilds of London Institute made a grant about eighteen months ago of 300*l.* a year to the Firth College in aid of the establishment of a Chair of Engineering. Since then additional subscriptions have been promised for five years to the amount of 550*l.*, together with a capital sum of over 10,000*l.* A site for laboratories and shops has been obtained, and these will be proceeded with as soon as possible. It is hoped that the special advantages of Sheffield will make it the central school of metallurgy, especially for iron and steel, in the kingdom, and the Committee intend to spare no efforts in rendering it a complete and effective one.

SCIENTIFIC SERIALS

The American Journal of Science, September.—On the amount of the atmospheric absorption, by S. P. Langley. From numerous observations taken at sea-level or at an altitude of nearly 15,000 feet, the author is led to infer that the mean absorption of light as well as of heat by our atmosphere is probably at least double the usual estimate of about 20 per cent. He also believes that fine dust particles, both near the surface and at a great altitude, play a more important part in this absorption, both general and selective, than has been hitherto supposed.—A study of tornadoes, by Henry A. Hazen. In this paper the author examines some of the ordinary theories that are advanced for explaining the origin and development of these destructive phenomena. After showing some of the seeming difficulties involved in these theories, he proceeds to point out a few of the characteristics of the outbursts, with a view to opening up fresh lines of investigation, upon which a further advance may be made towards a true knowledge of the forces underlying them. He is inclined to think that J. Allan Broun's theory, attributing tornadoes to the direct influence of the sun's electricity upon the moisture of the air, or possibly to the indirect effect from the sun's heat, is more satisfactory than the numerous theories of friction, evaporation, condensation, sudden changes of temperature, and the like.—On the absorption of radiant heat by carbon dioxide, by J. E. Keeler. The author considers it probable that to the action of CO_2 in the atmosphere is due one or more of the great gaps in the invisible part of the solar spectrum which the discoveries of Prof. Langley show to be much more extensive than had hitherto been supposed. He further regards it as certain that some other agent than this gas contributes essentially to the total absorptive power of the atmosphere, so that a method of analysis based on this power, in which the effect of the second agent is neglected, cannot lead to correct results.—Note on the Triassic insects from Fairplay, Colorado, by Samuel N. Scudder. These fossil remains present an assemblage of forms altogether different from anything hitherto found in the Palæozoic series on the one hand, or in the Jurassic beds on the other. They seem to show a commingling of strict Jurassic forms with a larger proportion of types which may be called Upper Carboniferous or Permian, with a distinct Jurassic leaning. Hence the probability that the beds in which they occur belong to the Triassic or intermediate formation.—On the flexibility of Itacolumite, by Orville A. Derby. From observations made on this extensive series of quartzose rocks occurring in the gold and diamond regions of Minas Geraes, Brazil, the author infers that the peculiar property of flexibility attributed to them is not an original characteristic, but only a surface character, a phase of weathering or decay brought about by percolating waters.—On the age of the glazed and contorted slaty rocks in the vicinity of Schodack Landing, Rensselaer County, New York, by S. W. Ford.—On the relations of the mineral belts of the Pacific slope to the great upheavals, by Geo. F. Becker. The views of H. P. Blake and Clarence King regarding the parallelism of the series of mineral belts on the Pacific slope to the great mountain ranges, and attributing the deposits themselves to the solfateric action accompanying the ejection of igneous rocks, have since been mainly confirmed. But, independently of any theory, a conclusion of economical importance evidently follows from the fresh facts recently brought to light. A great majority of all the rich ores west of the Wahsatch Range occur in belts following the western edges of distinct geological areas—the Cretaceous in Utah, the Palæozoic and Carboniferous in New Mexico and Arizona, the Jura-Trias in East California, &c. Hence analogy points to the neighbourhood of the still unexplored portions of these contacts as the most promising for future discoveries of the precious metals.—Notice of the remarkable marine fauna occupying the outer banks off the southern coast of New England, No. 9, by A. E. Verrill.—Brief contributions to zoology from the Museum of Yale College, No. lv.—Work of the steamer *Albatross* in 1883.—Geology of the Blue Ridge, near Balcony Falls, Virginia, by John L. Campbell.

October.—On the duration of colour-impressions upon the retina, by Edward L. Nichols. Taking up the subject where it was left fifty years ago by Plateau's researches, the author concludes, from a protracted series of experiments: (1) that the study of the duration of colour-impressions produced by different portions of the spectrum tends to confirm Plateau's results; (2) that the persistence of the image is a function of the wave-length producing it, being greatest at the ends of the spectrum, and least in the yellow; (3) that it decreases with the intensity of the ray producing it; (4) that it is not the same for all eyes; (5) that the duration is in inverse order to the luminosity of the colours producing it; (6) that each wave-length of the visible spectrum produces three primary impressions, red, green, and violet, of which the green is the most evanescent, violet the most persistent; (7) that the duration of the retinal image depends upon the length of time during which the eye has been exposed, decreasing as the exposure increases.—Description of a fulgurite from Mount Thielson, Oregon (one illustration), by J. S. Diller.—On the paramorphosis of pyroxene to hornblende in rocks (two illustrations), by Geo. H. Williams.—On the southward ending of a great synclinal in the Taconic Range (with a map and several illustrations), by James D. Dana. The section of the Taconic Range here dealt with extends about 150 miles along the western border of New England, mainly between Middlebury, in Central Vermont, and Salisbury, in North-Western Connecticut. The conclusions arrived at regarding the synclinal character of the system and the Lower Silurian age of the rocks agree with those of Sir William Logan, except that he made the limestone to precede instead of to include the Trenton group.—On supposed glaciation in Pennsylvania, south of the terminal moraine (with a map), by Prof. H. Carville Lewis. The author considers that all the existing surface phenomena may be explained by the action of running waters and other causes independent of glaciation.—History and chemical analysis of a mass of meteoric iron

found in a head-stream of the Red River, Wichita County, Texas, by J. W. Mallet. The analysis yielded iron over 90 per cent., nickel over 8, a little cobalt, tin, phosphorus, copper, sulphur, graphitic carbon, silica, and a trace of manganese.—The life and work of Jean-Baptiste-André Dumas, by J. P. Cooke.—Account of a new meteorite discovered in Grand Rapids, Michigan, on May 15, 1883, by J. R. Eastman. The analysis of the fragment now in the Smithsonian Institute yielded: iron 94·543, nickel 3·815, cobalt 0·369, insoluble residue 0·118.

Rivista Scientifico-Industriale, September 15-30.—Origin of atmospheric electricity, of thunder-clouds and volcanic eruptions, by Giovanni Luvini.—Description of an automatic and continuous registrator of electric energy transmitted at a given part of a circuit, by Prof. Rinaldo Ferrini.—On the electric conductivity of greatly diluted saline solutions, by Dr. Giuseppe Vicentini.—On a system of electro-chronometric bells adapted to private residences, by Giuseppe Bianchedi.—Note on the Walker railway-carriage break, by Angiolo Villa.—On a new system of simultaneous telegraphy and telephony, by M. Van Rysselberghe.—Descriptive notes on the fauna of Sardinia, by Prof. A. Costa.

SOCIETIES AND ACADEMIES

LONDON

Chemical Society, November 6.—Dr. Perkin, F.R.S., President, in the chair.—It was announced that a ballot for the election of Fellows would take place at the next meeting of the Society (November 20).—The following papers were read:—On the action of aldehydes and ammonia upon benzil (continued), by F. R. Japp and S. C. Hooker. In previous papers two general reactions have been studied relating to the joint action of aldehydes and ammonia upon similar bodies; in addition, a third totally distinct reaction occurs, which is investigated in the present paper. The authors have studied the action of salicylaldehyde and ammonia upon benzil. A condensation-product, $C_{28}H_{24}N_2O_4$, was obtained, which proved to be dibenzoyldihydroxystilbenediamine. By the action of dilute hydrochloric acid, the hydrochloride of a new base, $C_{14}H_{16}N_2O_2$, was formed; its platinum salt, picrate, sulphate, diacetyl derivative, &c., were prepared and examined. The authors have also studied the action of furfuraldehyde and ammonia upon benzil.—Isomeric modifications of sodium sulphate, by S. U. Pickering. The author has determined the heat of dissolution of efflouresced sodium sulphate heated to various temperatures. He concludes that there are two modifications: one formed by not heating above 150°, the other being produced at temperatures from 150° to the fusing-point of the salt.—On some vanadates of the amines, by G. H. Bailey. The author has prepared and studied a considerable number of these bodies, and has compared them with the corresponding vanadates of the alkalies.—Contributions to our knowledge of acetoacetic ether, part I, by J. W. James.—On magnesium hydrosulphide solution and its use in chemico-legal cases as a source of hydrogen sulphide, by E. Divers and T. Shimidzu. The authors prepare this solution by passing ordinary hydrogen sulphide into a flask containing magnesia suspended in water. By heating the solution to 60°, a steady stream of hydrogen sulphide free from hydrogen and from hydrogen arsenide is obtained.—On the origin of calcium thiosulphate: an emendatory note to a paper on calcium hydrosulphide, by E. Divers. The author concludes that there is essentially only one method of forming the thiosulphate, *i.e.* by the union of sulphur with calcium sulphite.

Physical Society, November 8.—Prof. Ayrton in the chair.—Mr. Kavagee was elected a member of the Society.—Prof. F. Guthrie read a paper on certain phenomena attending mixture. In a previous paper Dr. Guthrie had noticed the increase of volume attending the separation of triethylamine and water effected by heat. The present paper is an account of a more thorough examination of this and allied phenomena. Experiments conducted with a number of different liquids showed that mixtures can be arranged in two distinct classes. Of the first a mixture of water and ether is an example: when shaken up together they mix, heat is *evolved*, and a *diminution* of bulk takes place. If any excess of ether present is poured off, and the lower clear liquid *heated* in a sealed tube, it becomes turbid owing to the separation of the ether. This is accompanied by an *increase* of bulk and *absorption* of heat. Triethylamine and water and diethylamine and water are mixtures belonging to this class; the temperature of separation is a function of the ratio in which the two liquids are present. A typical case of the second class is a mixture of alcohol and bisulphide of carbon. These mix with one another in all proportions above 0° C. with *increase* of bulk and *absorption* of heat. Upon being *cooled* to about − 17° C. they separate. The separation of a mixture of ether and water and of a mixture of alcohol and the bisulphide was shown. In these cases the action is regarded as a chemical one, and generally an excess of one liquid or the other is present. To determine the combining proportions two methods were used. In the first a number of mixtures of the same two liquids in different proprtions were taken, and the rise or fall of temperature produced by their mixture measured. When this was a maximum, there might be assumed to be no "dead matter" present. In the second method, which is more delicate, but more laborious, and which was used when the approximate combining proportion had been found by the first, the change of volume produced by mixture was noted; when this increment is a maximum, the liquids are present in their combining proportion. These experiments gave very concordant and definite results: for example, the molecular compound of ether and carbonic sulphide is represented by the formula $C_4H_{10}O,2CS_2$, and that of chloroform and carbonic sulphide by $CHCl_3,CS_2$. A striking confirmation of this view is afforded by the behaviour of the vapour-tension of a mixture. The temperature being constant, if the vapour-tension is plotted with the percentages of the more volatile liquid as abscissæ, the curve is, for a mixture of two liquids which have no chemical action upon one another, as the iodide and bromide of ethyl, a straight line. For ordinary mixtures, however, this is not the case. A curve is obtained in which there is observable at a certain point an irregularity. The corresponding abscissa indicates the molecular combination found by the previous experiments.—Dr. C. R. Alder Wright read a paper by himself and Mr. C. Thompson, on voltaic and thermo-voltaic constants. In a former paper the authors had stated that in a cell set up with two metals immersed in pure solutions of their corresponding salts, a given increment in the strength of the solution surrounding the metal acquiring the higher potential causes an increment (a) in the E.M.F. set up (e), while an increment in the strength of the other solution causes a decrement (b) in the E.M.F. This law is now substantiated; it is, however, found that for dilute acids, instead of metallic salts, (b) may be negative. The authors also find that it is possible to represent the E.M.F. of a cell by the difference of two quantities which they term the voltaic constants. These are quantities, one relating to each plate and its surrounding liquid. The voltaic constant of a metal and a liquid is a function of the nature of the metal surface, the strength of the solution, and the temperature, but is independent of the opposed plate and its liquid; it is practically defined as the E.M.F. set up when opposed to a zinc plate in a solution of the corresponding salt of the same molecular strength. The authors further conclude that the E.M.F. of a given combination usually *stands in no simple relationship to the chemical action taking place in the cell*, but that it may be expressed by the sum of the mechanical equivalent of the chemical action per electro-chemical equivalent, and the difference of two quantities, one being related to each metal and its surrounding liquid, and being constant for that metal and liquid termed *thermo-voltaic constants*. This thermo-voltaic action may act with or against the chemical action in producing E.M.F. In some cases, as in that of a cell composed of iron in ferrous sulphate and cadmium in cadmic sulphate solutions, the E.M.F. is against and greater than that produced by chemical action; consequently the cell works backwards with absorption of heat. At the close of the paper Prof. Ayrton and Dr. Guthrie remarked upon the apparent exception here shown to the second law of thermodynamics.

PARIS

Academy of Sciences, November 3.—M. Rolland, President, in the chair.—Observations of the new planet 244 made on October 22 to 24 with the equatorial *coudé*, with remarks on the efficiency of this instrument, by M. Lœwy. The author gives a full account of the performance of this equatorial, which has now been installed in the Paris Observatory for the last two years. His opinion of its excellent qualities is supported by the testimony of Dr. Gill and Mr. Norman Lockyer, the latter of whom pronounces it one of the instruments of the future.—A first study on the parallax of the sun, by M. Bouquet de la

Grye. This paper is based on the calculations made in Mexico by the author and M. F. Arago during the late transit of Venus. From the measurements then taken there results a mean parallax of 8·76 with an apparent approximation of 1/100 of a second.—Studies made at the Physiological Station on the locomotion of men by means of the odograph, by M. Marey. These studies have been undertaken mainly with a view to practical results. One of the objects has been to determine the most favourable conditions under which military forced marches can be accomplished most rapidly and with the least expenditure of muscular energy. The paper is accompanied by two illustrations, showing the readings of the odograph for a man walking at the rate of sixty paces per minute, and the curves of velocity and of the length of stride under various conditions.—A fresh contribution to the study of the Permian reptiles, by M. A. Gaudry.—Note on complex numbers, analogous to the quaternions of Hamilton, by M. H. Poincaré. The various problems connected with this subject are reduced to the following: to find all the continuous groups of linear substitutions variable to n, whose coefficients are linear functions of n arbitrary parameters. This problem is here dealt with.—On the involution of higher dimensions, by M. N. Vanecek.—On some general properties of algebraic surfaces of any degree, by M. Maurice d'Ocagne.—Note on algebraic equations, by M. Berloty.—On the conditions of equilibrium of a liquid mass subjected to electro-magnetic action, by M. G. Lippmann.—Conditions of a helicoidal element for the maximum of efficiency in a screw propeller, by M. Ch. Hauvel.—A comparison of the weighted thermometer with the tubular thermometer, by M. Em. Barbier. The author presents a fresh proof of the proposition already demonstrated by M. Regnault, that if the two instruments agree at the two fixed points, they remain in agreement at all fixed temperatures.—Description of two portable electric lamps, invented by M. G. Trouvé. The author, who gives two illustrations, describes two types of electric lamp, one suited for domestic purposes, the other for workshops, factories, mines, &c. Superiority over all others is claimed for both, on the ground of lightness, portability, convenience, and absolute security even in the most explosive atmospheres.—On the decomposition of the oxide of copper by heat, by M. E. J. Maumené.—Experimental researches on the temporary preservation of various virulent agents in animal organisms, where they remain in a quiescent state, by M. G. Colin. From these experiments it appears that the virus, in passing to animals where it is harmless, may preserve its properties intact for one or two weeks even under unfavourable conditions. It is also shown that in certain refractory cases the virus may give rise to serious and even fatal disorders without any apparent analogy to those caused by it in normal subjects; and further that the same animals may serve several times at varying intervals for the transmission of the poison, although a first inoculation may not have produced in them the attenuating effects of vaccination.—On the employment of the sulphate of copper for the destruction of mildew, by M. P. de Lafitte.

BERLIN

Physiological Society, October 31.—Herr Aronsohn presented a report of experiments which he had instituted in conjunction with Herr Sachs, and which had led to the discovery of a thermal centre in the cerebrum. Starting with the idea that in consequence of a diabetic prick of the medulla oblongata an increase of temperature would manifest itself in the liver, and finding by experiment no confirmation of this conjecture, Herr Aronsohn pushed his investigations for other thermal centres in the brain, and in the course of these researches came upon a spot where, on wounding it with a needle, a very considerable rise of temperature quickly set in. The speaker was not able to specify more exactly the spot at which it was necessary to make the prick in order to produce this effect. It was at all events certain that it was rather limited, and should be determined by more minute anatomical examinations of a number of brains of animals preserved in chromic acid after being operated on. Equally deep pricks made at every other spot of the cerebrum had either produced no effect on the temperature of the body, or had lowered it somewhat. In all the successful cases the corpus striatum was pierced by the needle; in all the unsuccessful cases the corpus striatum remained untouched. There was yet, however, no warrant from this circumstance to conclude where the exact seat of the thermal centre was situated.—Dr. Rawitz described some observations he had made with reference to the copulation of snails, a subject which had hitherto not been investigated. He further communicated from his own experience that snails (*Helix pomatia* and *hortensis*) could, in a state of captivity, be fed on paper. Dr. Kossel confirmed this statement from his own observations, and related that, on feeding snails with highly calcareous paper, abnormal calcareous deposits were observed in their monstrously developed shells.

VIENNA

Imperial Academy of Sciences, October 9.—Preliminary communication on monocyclic systems, by L. Boltzmann.—On the anatomical process of tabes dorsalis, by A. Adamkiewicz.—On double refraction of light in liquids, by E. von Fleischl.—On the comets recently discovered by Barnard (Nashville) on July 16, and by Wolf (Heidelberg) on September 17, and on their ephemerides and elements as computed by K. Zelbr at the Vienna Observatory, by E. Weiss.—On the development of the walls of arteries, by B. Morpurgo.—On the perception of sound, by E. Bruecke.—On the action of benzoyl-hyperoxide on amylene, by E. Lippmann.

STOCKHOLM

Society of Natural Sciences, October 18.—Prof. Sandahl, President, in the chair.—On foreign physiological institutions, by Dr. Tigerstedt. Referring to the development of physiology during recent years, the speaker described some of the principal institutions abroad, having visited forty of this kind. A similar one, on a smaller scale, was being established at the Carolina Institute in Stockholm.—The President, announcing the death of Dr. Regnell, the Brazilian Mæcenas, referred to the valuable botanical collections he had presented to the Upsala University.—Prof. Aurivillius exhibited a collection of butterflies, preserved by Herr E. Holmgren by removing the intestines and inflating the specimens. They were in splendid condition, the colours being particularly bright.—On the habits of the eider-duck and the dottrell, by Dr. Sundström. The speaker stated that careful study had proved that the eider-hen does not, as is so generally supposed, take her young during the summer into the ocean, but remains among the islands on the coast. The bird had greatly increased in the south of Sweden during the last few years.—On thunderbolts, by the same.—Herr Neves reported the receipt from Finland of eggs of the eagle, *Aquila clanga*, and the snipe, *Terekia cinerea*.

CONTENTS

PAGE

World-Life. By Prof. G. H. Darwin, F.R.S. . . . 25
Letters to the Editor:—
The Pentacrinoid Stage of *Antedon rosaceus*.—Dr. William B. Carpenter, F.R.S. 27
Natural Science for Schools.—Science Master . . 28
The Recent Lunar Eclipse.—Wentworth Erck. (*Illustrated*) 28
The Sky-Glows.—T. W. Backhouse; G. W. Lamplugh 28
Peculiar Ice Forms.—W. 29
Seismographs—An Apology.—Dr. H. J. Johnston-Lavis; Charles A. Stevenson 29
Fly-Maggots Feeding on Caterpillars.—Dr. E. Bonavia 29
The Crystalline Rocks of the Scottish Highlands. By Arch. Geikie, F.R.S., Director-General of the Geological Surveys of the United Kingdom.—Report on the Geology of the North-West of Sutherland, by B. N. Peach and John Horne. (*Illustrated*) 29
The Genesis of an Idea, or Story of a Discovery Relating to Equations in Multiple Quantity. By Prof. J. J. Sylvester, F.R.S. 35
Our Future Watches and Clocks 36
The British Association for the Advancement of Science 37
The New Volcanic Island off Iceland. By Consul W. G. Spence Paterson. (*Illustrated*) 37
Telescopes for Astronomical Photography, I. By A. Ainslie Common 38
Notes 40
Variation of the Atomic Weights. By E. Vogel . . 42
University and Educational Intelligence 45
Scientific Serials 46
Societies and Academies 47

THURSDAY, NOVEMBER 20, 1884

BACTERIOLOGY

AMONG the most striking of the recent rapid advances of science is the development of what we may term bacteriology. For more than one hundred years a debate had been going on as to the origin of the minute forms of life which were present in decomposing organic materials, but till the publications of Cagniard-Latour and Schwann no part was assigned to them in the production of the chemical changes which these materials undergo. It was not, however, till the publication of Pasteur's papers on the alcoholic fermentation and on spontaneous generation little more than twenty years ago that any sound basis was obtained for the idea that a micro-organism was able to cause fermentation. The science of bacteriology really dates its commencement from the first publication of Pasteur's papers. Following rapidly on this work, researches have been carried on which have now demonstrated that all the fermentations belonging to the same class as the alcoholic fermentation are due to the development of micro-organisms, and that bacteria are most important factors in Nature, being the chief agents by which the complex organic constituents of plants and animals are brought back to simple forms capable of serving again as food for plants.

But the researches have not been confined to the study of fermentations. In 1851, Rayer and Daraine observed in the blood of animals suffering from splenic fever the presence of numerous small rods which were supposed to be crystals. On the publication of Pasteur's papers, Daraine again took up the subject, and came to the conclusion that these rods were bacteria and the cause of the disease. For some years little was done in this direction, though microscopical observations on the occurrence of bacteria in various diseases were described. With the publication of the investigations of Koch and Pasteur on anthrax, and more especially of Koch's modes of cultivation, a new start was made, and these researches have since been carried on with a certainty and a precision that could not have been anticipated, and have led to the accumulation of a large amount of knowledge with regard to the causation of infective diseases. A causal relation has been established between bacteria and splenic fever, various septicæmic affections, and infective diseases in the lower animals, tuberculosis, glanders, erysipelas, and other diseases in man; while in a number of other cases, in which the causal relation has not been completely demonstrated, facts have been made out which render it extremely probable. In spite, however, of this large addition to our knowledge, the subject is as yet little more than in its infancy, numerous questions of the greatest importance and likely to lead to the most important results still requiring investigation.

Apart from its purely scientific interest there is perhaps no department of science which so nearly concerns the health and well-being of the community, and already important practical results have been obtained, affecting medicine, industry, and public health. Following closely on Pasteur's early publications, and as a direct result of them, we have the great revolution in surgery brought about by Sir Joseph Lister, resulting in such improvements in the management of wounds as have been the means of saving numerous lives and of greatly enlarging the scope of surgical interference. Our knowledge of the value of disinfectants, of the mode of spread of infective disease, and of the precautions necessary to prevent its spread has also been very largely increased, and must lead to great improvements in hygiene. Nor must we omit to mention the valuable experiments begun by Toussaint and Pasteur, and now being carried on to a large extent by Pasteur, on the attenuation of virus and the conversion of virulent micro-organisms into useful vaccines. This has been demonstrated to be possible in the cases of chicken cholera, anthrax, pig typhoid, and possibly hydrophobia, and has been put practically into force in France in the case of the first three affections. Useful facts affecting various industries have also been made out. The deplorable condition of the silkworm industry some years ago and Pasteur's investigations thereon are well known, and have led to the restoration of the silk manufacture; while his work on diseases of beer and wine, and the work of others on various fermentations, have proved of the greatest benefit.

While some of this work has been done in this country, by far the greater part has been done abroad, more especially in Germany and France, where its importance is recognised, and where special facilities are afforded by the Governments and various public bodies. In Germany especially, besides the laboratory, supported by the Government, in which Dr. Koch works, a number of similar institutions are being established throughout the country; and in France the laboratories of Pasteur and others are established and supported by the Government and by various municipal authorities, every facility for carrying on these researches, and the necessary funds, being provided. In this country, on the other hand, there is no laboratory of the kind, and what work has been done has been by individual investigators working at their own expense, and often without suitable accommodation. To carry on this work a considerable amount of apparatus is necessary, an assistant is required, and the use of a laboratory where animals can be kept is essential. Without the help of a trained assistant, the investigator's time must be largely taken up in the sterilisation and preparation of his cultivating media and in other manual work, leaving but little time for actual investigation, more especially if, as is often the case, teaching or medical practice must be carried on as well in order to earn a livelihood. How different are the conditions where a well-equipped laboratory is provided, where trained assistants are present, and where a salary is given sufficient to enable the investigator to devote his whole time to the work. Surely it would be possible to establish a proper laboratory in this country.

That the matter is felt to be of importance was shown last summer by the fact that the Executive Council of the Health Exhibition devoted a considerable sum to the establishment of a model laboratory under the direction of Mr. Watson Cheyne, in which many of the results and the most recent methods of investigation were shown. This laboratory was visited by large numbers of scientific men and others, and the hope was universally expressed that the model would become the basis of a permanent institution. We

are glad to hear that the Executive Council of the Exhibition are taking into consideration the advisability of devoting their surplus funds to this object, and we hope that they may ultimately resolve to do so. They could not better advance the cause of hygiene, and more fittingly carry on and perpetuate the work begun by the Exhibition. The sum required to build and adequately endow such a laboratory would of course be considerable, but there can be little doubt that, once the matter is started, various public bodies will aid in the work, while a suitable site at South Kensington might be obtained from the Commissioners, as there the laboratory would be in the vicinity of those belonging to the Science and Art Department and the City and Guilds Institute.

HEROES OF SCIENCE

Heroes of Science: Mechanicians. By T. C. Lewis, M.A. (London: Published under the direction of the Society for Promoting Christian Knowledge, 1884.)

IN this volume short histories are given of the following inventors:—Watt, George Stephenson, Richard Arkwright, Crompton, Maudsley, Joseph Clement, James Nasmyth, Whitworth, and Babbage. The facts told of the lives of these men have been gathered from reliable sources and are accurate. It is unfortunate that Prof. Lewis did not introduce more of these facts in his book instead of using up its very limited space by inserting an inordinate amount of moralising, which is extremely tantalising, and makes it often difficult to proceed owing to the impatience which it causes. No words that could be used by way of reflection, even by a great writer, could add much to the moral stimulus afforded by the simple narrative of the lives of men like Watt and Stephenson, and the style which we encounter here, although often very ambitious, signally fails in attaining its mark and, instead of increasing our admiration for the men described, adds an unwelcome tinge of the ridiculous to the account. Thus in describing the early life of Arkwright we meet with these sentences amongst others:—"Before this he was probably as well off as most itinerant dealers in hair of his rank, but this first decisive step of his" [that from a village barber to a dealer in hair] "was enough to show that he could be dominated by an idea even to the length of relinquishing some certainties of advantage." "Whilst he was doing his unexciting work of preparing orderly cover for the outside of other men's heads" [this means making wigs] "he was—apparently too without much mental excitement—introducing order and exercising thought in the interior of his own; in consequence of which it appears that, whatever he did in those days to cover the heads of thinking and thoughtless men and women with a fair show of hair, he has done more for us in providing for the inside of ours some furniture of profitable thought," &c.

Amongst many curious pieces of information which we come across we may draw attention to the following piece of social history probably hitherto unknown. "When Adam delved and Eve span, or when their descendants first adopted this division of labour, the work of digging was carried on in the sweat of the brow, it required strength, and was relegated to the man; the process of spinning, which required less strength than dexterity, was assigned to the woman." Neither in Genesis nor in the *Transactions* of the Anthropological Society do we remember having seen any account of this early example of the division of labour. Valuable practice in English construction after the manner of the old so-called orthographical exercises, might be set on this book, by asking boys studying English to criticise and explain (if possible) the meaning of the phrases in italics in the following sentences:—(Page 155) "In him we look in vain for *the disinterestedness that endears self-sacrifice to us.*" (P. 253) "The revolution that was being effected by the introduction of machine tools, was, like all revolutions, sure to meet with resistance. It is not too much to say that by its means *a little one became a thousand.*" As a piece of grandiloquent writing, of which we here find many samples, we may instance this (p. 211):—"Modern inventions succeed one another like the links of a golden chain forged by men of god-like skill for our support, and indeed for our elevation. The cloak of an Elijah often falls upon the shoulders of an Elisha."

We are curious to know if the assailers of classical education have ever used stronger language than is here employed in describing Nasmyth's studies (p. 212):—"The classical education they had attempted with little success to give to him there was not at all suited to his bent. He asked for food, and they gave him a nauseous poison." In these days when the working man is so courted and admired, we should have thought it, to say the least, unnecessary to inform the readers of this book that (p. 202) "in all his (Clement's) work . . . there was an interest in his art which in his case raised it above the labour of a calling," or (p. 232), "in labour such as his (Nasmyth's) there was no degradation." This too after he had become an employer of labour himself!

Besides committing great errors of style, the author occasionally errs as to matters of fact. Thus (p. xiv.), he says, "The world has had to be content with using from two and a half to four pounds of coal for" one horse-power. The limit would have been put much lower had he studied the records of the engines of the best American liners. On p. 57 a description is given of "the double-acting steam-engine, in which steam is admitted to press the piston both upwards and downwards, the piston being also aided in its motion by a vacuum produced by condensation on the side towards which the steam is pressing it." To say that the piston motion is "*aided*" by the vacuum on the opposite side to that on which steam is acting is a curious way of representing the fact that without such a vacuum no motion of the piston would be *possible*. The definition of parallel motion given is new. On p. 58 we read, "The specification included . . . the contrivance for parallel motion or for making the piston-rod move perpendicularly up and down without chains or perpendicular guides, or untowardly friction, arch heads, or other pieces of clumsiness."

The book, which we are informed (p. vi.) is intended for boys, does not give enough explanation. The descriptions of inventions given are of the briefest, and will be quite unintelligible to any one who has not already spent a considerable amount of time in studying them elsewhere. If Prof. Lewis had been content to omit the wearisome reflections which he has placed in the book, and had,

instead, inserted a few engravings, he would have made the book more entertaining and less trying to readers of only average patience. If he had spent more time on the solid parts, and less on its affected adornments, he would have produced a valuable and interesting book.

OUR BOOK SHELF

The Student's Guide to Systematic Botany. By Robert Bentley, F.L.S., M.R.C.S. Engl., &c. (London: J. and A. Churchill, 1884.)

THIS little book, which aims chiefly at supplying the wants of medical and pharmaceutical students, represents fairly what was the state of systematic botany in England twenty years ago. The bulk of the book is occupied with a detailed description of the natural orders of Phanerogams, while the Cryptogams are dismissed in fourteen pages. But it is not only by the very cursory way in which these plants are treated that the student is led to underrate the importance of the morphological differences by which the various groups of Cryptogams are distinguished; the heterogeneous series of Algæ and Fungi are described as "orders" comparable, as regards the terms used in the classification, with the orders of the Angiosperms. Again, in the text, signs of antiquity are numerous: for instance, in distinguishing the Cryptogamia from the Phanerogamia (p. 14) we find that the former "are reproduced by spores, and are therefore acotyledonous," a sentence which implies that the spore is the homologue of the seed! In describing the ferns no mention is made of the prothallus, antheridia, or archegonia, though the latter are described as occurring in the mosses, and resulting in the formation of a "sporangium." These examples are sufficient to show that this book does not meet the present requirements even of medical students, who now have access to other text-books, treating of the principles of systematic botany in a manner more in accordance with the present state of the science than the "Student's Guide" of Prof. Bentley.

The Electrician's Pocket-Book. The English Edition of Hospitalier's "Formulaire Pratique de l'Électricien." Translated, with additions, by Gordon Wigan, M.A., Barrister-at-Law. (London, Paris, and New York: Cassell and Co., Limited, 1884.)

M. HOSPITALIER'S "Formulaire Pratique de l'Électricien," of which the work before us is a translation, has become well known in this country as a useful compendium of data and rules for electrical work, and Mr. Wigan has done good service in putting an English version within the reach of the numerous class of practical men whose knowledge of French is, to say the least, limited. He has executed his task very creditably, as the book, so far as we can tell without a minute examination of the numerical and other data, seems fairly accurate and trustworthy. The least satisfactory part of this work, as of all others of the same kind which we have seen, is, we think, the synopsis of theory which is given along with the data and other practical information. In these days of excellent elementary and advanced text-books of theoretical and to some extent also of applied electricity, the necessarily detached and somewhat scrappy statements of theory which partly fill the "pocket-books," are little called for, and the space occupied by them could be used to better advantage for other matter, or the book lightened by their omission.

In looking over the book we have found some slight faults in descriptions of instruments, &c., which might be mended in a new edition. For instance, in p. 75, the author (? translator) has entirely misapprehended the use of the V-groove in Sir W. Thomson's "hole, slot, and plane" arrangement for insuring that an electrometer or other instrument is replaced, after being moved, in exactly the same position. The "hole" is not simply a hole, but a conical hollow, and the primary object of having a V-groove is to obviate the infinitely perfect fitting which a second hollow would render necessary. Again, the description of the quadrant electrometer (p. 107) does not seem likely to convey any clear idea of the construction of the instrument.

The subject of the testing and laying of submarine and land telegraphs is not very fully treated, and the data in this department is also comparatively meagre. On the other hand, descriptions of a large number of dynamo-machines and statements of experimental results regarding their behaviour in electric lighting and transmission of power form a marked feature of the book, and we need not say that even roughly approximate information of this kind in a collected form is very valuable.

On the whole, we feel sure that the work will form a valuable pocket companion to the electrical engineer.

A. GRAY

Science Note-Book. By C. H. Hinton. (London: John Haddon and Co., 1884.)

THE constitutive elements of Euclidean geometry are the straight line and the circle—two continuous curves, which stand to one another in a certain relation of reciprocity, and the actual production of which, as Newton has already remarked, demands certain mechanical appliances—the ruler and the compass. If we add to the above that Euclid's method is the synthetical, then his system of geometry is defined without ambiguity. The principal lack of this geometry, which was not clearly brought to light until the second half of this century, consists in this, that it is limited to considerations of quantity, and only treats secondarily of the relations of position.

Poncelet has recognised this defect, and has laid the foundations of the so-called modern geometry, which, during the last few decades has so greatly enriched the science of space as well in positive results as in new methods.

Euclid's system, however, has not been uprooted, but only completed on a side on which it was wanting. In schools the "Elements" of the Alexandrian geometer are generally taught, while descriptive geometry and the theory of higher curves (as taught in the University course) are chiefly based on modern methods.

In a handy introductory publication Mr. C. H. Hinton, Science Master at Uppingham School, has brought forward points of view which form a third method of geometrical investigation, fundamentally different from both those mentioned above. It is not opposed to either, but appears as a welcome complement of both. The author does not presuppose continuous elements as has been generally done, but only sets of points equally distributed in two dimensions, which, merely for the sake of convenience, are connected by straight lines. As in Euclid's geometry an infinite pencil of rays can be drawn from every point, so the conic sections may be determined by a method of counting discrete points. The problem of division of a given line into parts, and of the construction of parallels can be generally solved.

The practical advantages of this new method in the form in which it is now published are purely educational, though it is wholly based on the principles just mentioned. The author has succeeded in bringing new ideas into simple and attractive form, which enables the youthful and inexperienced mind in a very short time to acquire a mathematical knowledge of space which is of much value in facilitating a subsequent thorough understanding of Euclid and of modern geometry. The work has an encouraging appearance, inasmuch as it does not contain any hypercritical transformation of the system of our old Euclid (in which respect so many authors have recently

erred), but makes us acquainted with new thoughts which in themselves are worthy of pursuit, and which in their present form are of general educational service.

KARL HEUN

The Dynamo: How Made and How Used. A Book for Amateurs. By S. R. Bottone. (London: W. Swan Sonnenschein and Co., 1884.)

THIS little book of 75 pages is designed to give to amateurs practical information as to the construction of a small working dynamo-machine. What is aimed at is the building up of a machine capable of being worked by hand and suitable for experimental purposes. The dynamo-electric machine is one which an amateur mechanician may very well undertake with every prospect of success and satisfaction; and the book before us is thoroughly practical and is pleasantly written, and will, we feel sure, be acceptable to many. We are acquainted with books on the steam-engine for amateur constructors; but a dynamo of simple form is easier to make than a steam-engine, and will, we think, when made, prove a far more useful and pleasure-giving toy than a steam-engine such as an amateur can put together. When all is done, a steam-engine of amateur construction can do little more than go round and round; but a host of experiments in electric lighting and in electro-chemistry may be made to follow on the successful completion of a small hand-dynamo.

The author describes the making of a very simple dynamo with a kind of shuttle-wound armature. All his instructions are clear and, as we have already said, thoroughly practical. The only question on which we have any doubt whatever is whether, at any moderate speed of turning, the dynamo will yield so much current as the reader is told he may expect.

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.*]

Natural Science in Schools

As one who has been engaged in teaching science in schools for the last ten years, I should like to make some remarks on Prof. H. E. Armstrong's interesting lecture, published in NATURE of November 6 (p. 19).

(1) In the first place I would like to express my agreement with his weighty opening words. The main body of schoolmasters are so completely without any science-training that it is very difficult for many of them to see its necessity or even its advantage. The younger generation of masters in the large public schools, moreover, having come to the work in recent years have not, like their predecessors at Rugby, Clifton, Taunton, and elsewhere, had an opportunity of observing the gain of life and general intelligence which followed the introduction of science into the regular school work, in those schools where it was taken in hand seriously and with enthusiasm. Others, again, have more or less forgotten. Consequently it is still necessary to point out that, excellent as is the training given by the mathematical and classical teaching of our schools, yet that by itself it is not enough. No excellence in the *method* of teaching classics and mathematics will compensate for this, to adopt Dr. Armstrong's words, that they fail to develop "the faculty of observing, and reasoning from observation and experiment," that they fail to give any idea in the concrete of the nature of evidence. No doubt many able men educated on a classical or mathematical basis, can observe and reason from observation; this is, however, in spite of, and not in consequence of, their training. To the majority the deficiency is a serious matter, and probably it goes far to account for the peculiar opinions of scholars one sometimes hears expressed by practically successful men, and produces the unfortunately too prevalent idea among them that, if their sons are to go into business and to succeed, they must not stay at school too long—they must not learn too much book-learning. It should, then, in addition to its other services, be the function of science in education to keep awake and develop the natural practical intelligence of our lads, and so to make up for the deficiencies in this respect which accompany the otherwise vast advantages of a literary and mathematical culture.

(2) I suppose that no science-teacher will fail to agree with Prof. Armstrong that we have by no means exhausted the possibilities even of our present opportunities. As my object is to advocate advances, however, I will not dwell upon that part of his remarks except to say that I am sure a closer acquaintance with the methods of a good many of our science schoolmasters—with the time at their disposal, the laboratories they work in, and their boys, in short with the conditions under which they work—would satisfy him of the considerable value educationally, when it is properly done, of much that he condemns, and also that something of what he advises is already being attempted.

The lectures in schools are already, I should say, usually more or less of the nature of the tutorial classes which he recommends, and, whilst we recognise a great educational value in analytical work, if properly taught, we shall, I feel sure, be ready to abandon that for something better as soon as it is ready for us.

Having said this much, I hasten to add that I quite recognise, on the other hand, the value of Prof. Armstrong's suggestions, and that I am at present conducting a class on a system which in principle is very like that which he suggests. Indeed it is in several important points the result of suggestions made to me by Prof. Armstrong some two years since. More particularly I am trying a form of what I may call the problem method of practical teaching, which Prof. Armstrong so strongly recommends.

As it is only lately that we have had the necessary accommodation for this attempt, my experience is not very great. But I have learnt a good deal, and, as Dr. Armstrong's lecture brings the question into prominence just now, I may say what my experience is so far. Remembering that economy of time is of the first importance, and that our object in teaching science in schools is to promote a certain attitude of mind towards Nature rather than to produce skilful manipulators, I am not yet certain whether courses of work in which each pupil, with assistance, suggests and carries out the experiments himself, or tutorial classes, in which the suggestions are as far as possible elicited by the teacher from the class, and then the work is carried out by the teacher before the class, will give the best results. I tried the latter plan some years ago with beginners at Taunton with the most encouraging results. I believe, however, that a combination of the two methods will finally prove best. There is no doubt that greater interest is created when the pupils do the work themselves; on the other hand, much time is lost, at first, through difficulties of manipulation. Accordingly I am trying to arrange things so that the simpler experiments shall come together and be done by the boys; and when anything more difficult has to be done we fall back upon the tutorial method. I have no doubt of the advantage of practical work combined with some form of lecturing, *if there is time enough*. But in schools there rarely is time enough given for both. As an introduction to a course of lessons on the present system a practical course or a tutorial class on the lines proposed by Dr. Armstrong will certainly be of great value, and one or the other must, I think, be possible in almost every school.

(3) I will now pass to some points not discussed by Dr. Armstrong in which it appears to me that chemical teaching at present is open to improvement. I always aim, myself, not at informing my classes of chemical facts or principles, but, as far as possible, at leading them to discover them for themselves. In this I am more or less hampered by the absence of sufficient appreciation of the bearing of the simpler physical facts of Nature upon chemical processes. This I supply as far as I can. But I believe, and I am trying the experiment, that a real advance in the value of chemistry as an education will be made if, as an introduction, the beginners are put through a course of practical problem work which brings out in every possible way the dependence of chemical operations upon the simpler physical properties of matter; such as volatility, solubility, &c.

(4) I was told the other day, by a great authority on educational matters, that science has had a distinct and good effect on grammar-teaching. I think, on the other hand, that science-teachers have been rather slow to recognise and imitate one

particular excellence in the method of language-teachers. I refer to the practice of making the students acquainted with the works of great writers at the earliest possible period. I should like to see fairly advanced classes of chemical and other students, in schools and elsewhere, reading, with assistance, some of the more suitable memoirs of such men as Davy, Graham, and Faraday. I do not advocate the complete abandonment of text-books, but I should rejoice greatly if their use could be considerably restricted and something better substituted. Has not this neglect of the original writings of great workers by our teachers something to do with the subsequent neglect of research by so many of their pupils? There is of course this practical difficulty in the way of what I propose—that original memoirs are not at present obtainable in a form in which they can be put in the hands of whole classes of students. If my suggestion should prove acceptable to even a few teachers however, that is a difficulty which could be very easily surmounted.

(5) When any one proposes to himself a change in his mode of teaching, unless his position is quite exceptional, he always finds himself confronted by one solid difficulty, viz. public examinations of one kind or another. Teachers at first inspired the examiners. Now they find themselves too often helpless before them. In the face of our various examining Boards individuals are nearly powerless. The time seems to have come when an association of science-teachers for the improvement of science-teaching is a real necessity—something more or less resembling the Association for the Improvement of Geometrical Teaching. Such a body would often be invaluable. It could, by the appointment of committees, and perhaps by pecuniary help, promote such experiments as I have suggested in Paragraph (4). In cases such as the recent unfortunate action of the War Office, it might be expected to do good work by replacing individual by organised action. And it could hardly fail, by bringing teachers and examiners into contact, to do much to make advances in teaching more possible than at present.

My various remarks on so many points have necessarily been brief and incomplete. I could not, in the form of a letter, go *fully* into questions of advantage, disadvantage, and difficulty. I shall have amply attained the object I have had in view if I have helped to draw attention to these important matters.

W. A. SHENSTONE

Do Flying-Fish Fly or Not?

I HAVE crossed the Atlantic and Indian Oceans many times and at different seasons of the year, but until my last voyage to Calcutta I was unable to answer this question positively. For days together, aided at times by a powerful field-glass, I have endeavoured to establish satisfactorily whether these nimble little fish used their membranous wings after rising above the surface of the sea or not. An old and valued friend, the late Charles Kingsley, on his voyage to the West Indies, so graphically painted in the pages of "At Last," records his opinion in favour of the wings being employed as a means of propulsion through the air after the fish quit their more natural element, and I certainly inclined to the same belief, although, owing to the "ever-vexed" condition of the Atlantic, I found accurate observation impossible. In the Indian seas the fish appear at rarer intervals, and limit correspondingly the chances of watching their movements.

On a blazing afternoon in May last, on board the steamer *India*, some hundred miles off the African coast on the way to Ceylon, I had the first and only opportunity I ever enjoyed of establishing beyond dispute this vexed question, which I am not aware has hitherto been settled. The sea was perfectly calm, covered here and there with a yellow scum which exhaled a fresh unpleasant smell like a beach covered with sea-weed at low water. From the spar-deck above the cabins, which were fitted up in the fore-part of the ship, I could descry at frequent intervals shoals of flying-fish rising and apparently fluttering from 50 to 100 yards before dipping again into the mirror-like surface of the ocean. Along with several of the passengers—some of them provided with field-glasses—I vainly endeavoured to make certain whether the fish did or did not make use of their wings after leaving the water. Opinions were divided, for, owing to the rapid motion of the fish, it was impossible to keep any one of them long enough in the field of vision. It occurred to some of us at length to look over the bows of the steamer, and there we saw a sight not soon to be forgotten. The flying-fish appeared frequently shooting upwards in large numbers from the blue glassy depths directly beneath us, as the shoals were disturbed by the vessel's cutwater, and their every movement plainly discernible while under water and from the moment they rose "winnowing the waving element" with expanded wings a d tail, bent on escaping the pursuing craft, until they dipped again into the sea for shelter or to obtain fresh impetus for continued flight. I satisfied myself, and so did my fellow-watchers, that after a certain number of strokes with wings and tail—from twenty to thirty, varying with the dimensions of the fish—which we repeatedly counted, as they left corresponding impressions on the oily surface of the water, these appendages were not employed to accelerate, but merely to sustain, the flight while the fish remained in the air. The curved impressions left by the wings on the water appeared, as nearly as I could judge, from twelve to eighteen inches apart on either side of the fishes' course until clear of the water. The tail left no perceptible imprint, but could be clearly seen waving from side to side, adding doubtless considerably to the impulse. After rising out of the water the wings and tail remained ridged, but in some instances were slightly twisted to preserve the equilibrium. Occasionally a fish appeared to lose its balance in the hurry of escape, and toppled over in a ridiculous fashion.

The yellow scum also attracted attention, tinging the ripple at the bows a deep orange. I had some of it brought on board, and a fellow-passenger of an entomological turn placed some under a powerful microscope, but failed to determine the species to which it belonged. Ten years ago, near the same place, I observed the water assume a dirty yellow tinge, as though it had suddenly shoaled, while the same unpleasant smell was perceptible. The discoloration and smell I found to be due to the presence of vast quantities of animalcula, about a quarter of an inch long, semi-transparent, jointed like a cane, and about the thickness of a small needle.

ROBERT W. S. MITCHELL

8, Garden Reach, Calcutta

Earthquake Measurements

I REGRET that Prof. Ewing should take so much to heart my criticisms of his results of earthquake registration. I think that if we can get a single movement instead of a double one we gain much by halving the errors of double registration, extra friction, complexity of calculation, &c., all causes that tend to increase the imperfection of the results.

Neither did I intend to disparage seismological investigations on the plain of Yedo, but it does seem to me that the first thorough study, such as Prof. Ewing and others have initiated, should be in a locality where the minimum of disturbing influences would be able to complicate the results. In fact, we should expect much more progress in arithmetic in a child which commences by learning to count than in another that is immediately put to study fractions. I should never suggest that one earth-shaken locality should be continuously studied more than another when once we have decided upon the most serviceable and accurate registering apparatus.

Now as a resident in a country continuously shaken by earthquakes, many of which are disastrous, and where investigators are few and far between, we want instruments that give the least complicated tracings possible if we are to find observers amongst inhabitants of the Italian provincial towns. The same thing holds good to a variable extent in other countries.

Again, hardly any one would accuse me of claiming entire originality for the principle in the apparatus described. For example, every one knows that the pendulum has been used as a seismograph for centuries even. All that I claim is a combination of different forms of actuating and registering apparatus, with a few novel introductions, for it is practically impossible to *invent*, in the true sense of the word, a new seismograph any more than a new locomotive.

Perhaps, in my critic's opinion, we have reached perfection in seismographic instruments, which it appears is not shared by many workers, as the continual new suggestions and modifications indicate, as does also the fact that throughout all the observing-stations so far instituted it is rare to find two provided with similar instruments.

In regard to Prof. Ewing's last paragraph, perhaps experience will determine whether my suggestions do really lie outside the sphere of practical seismology.

In conclusion I shall be happy to hear suggestions for any improvements from others, for in my own humble opinion we do not yet possess a single seismograph that reaches near to perfec-

tion (my own of course included), so that we may still consider the instrumental investigation of earthquakes far from a settled matter, and one to be more fully worked out.

Naples, November 10 H. J. JOHNSTON-LAVIS

Autumn Flowering

REFERRING to your article on autumn flowering (p. 13), I may mention that my garden primroses are now flowering again, and a laburnum is in flower in the garden of one of the houses on this road. I was in Paris in September 1861, and saw many horse-chestnuts in flower. The summer of 1861 was unusually warm and dry on the Continent, though I believe not in the British Islands. JOSEPH JOHN MURPHY

2, Osborne Park, Belfast, November 14

The Northernmost Extremity of Europe

"A NORWEGIAN" (NATURE, p. 17) says that my description of Knivskjærodden as a low glaciated tongue of rock is hardly correct. As Norwegians ought to, and generally do, know more about their own land than do foreigners, I will quote Tönsberg, whose "Norge" is admitted as a high authority by all. Describing the scene displayed from the edge of the precipice of the North Cape, he says: "Beneath you at a distance of one-eighth of a mile, you see the *long low* Knivskjælodde, *which is undeniably the most northern part of Norway.*" The picture in his book (from a photograph) shows the northward extremity of this projection as washed over by the waves and its *western side* precipitous, as I saw it.

I sailed round it twice, more than ten years ago, halting in front of the North Cape for half an hour, and can only smile at the attempt to claim the northward supremacy of Knivskjærodden as a new discovery or one demanding further verification. In my copy of Munch's map (1852) it is shown as projecting a little further north than the North Cape.

Tönsberg further confirms my statement concerning the elevation of the neighbouring Arctic headlands, which "A Norwegian" also contradicts. Sverholtklubben, according to Tönsberg, is twenty-four Norsk feet higher than the North Cape. I should have added that the measurement I gave was in Norsk feet. Measured in English feet, the height of the North Cape is 1004 feet; that of Sverholtklubben 1029 feet at the edge of the cliff. There are about a dozen other headlands of similar magnitude between North Cape and the Varangerfjord.

W. MATTIEU WILLIAMS

Breeding of the Quadrumana

HAVE any of your readers any experience of the production in captivity, of a *second* generation of any of the quadrumana? At least twelve out of about eighty species kept in the Zoological Gardens have bred during the past thirty years—the lemurs forming a large proportion—and the Rhesus more frequently than any other monkey. I presume that even a *first* generation of any of the anthropoids is unknown—except possibly of the gibbon (?). The disposition and moral character (in the widest sense) of no species of monkey whatever approaches that of the dog. May not this be due to the absence of inheritance (to which the dog owes so much) of the gradually accumulated cultivation of these qualities through association with man? The dog has enjoyed all these advantages. The monkey cannot, owing to the impossibility of rearing a succession of generations in captivity. Does the experience of your readers, who may have studied a first generation of monkeys, point to any improvement on the parent stock in disposition and character? So far as I have been able to judge from individuals in public collections, the mere mental power of these animals conspicuously exceeds that of any others. I should be glad to know whether this opinion is shared by those who have had more extended opportunities of observation. ARTHUR NICOLS

Fly-Maggots Feeding on Caterpillars

YOUR correspondent, Dr. E. Bonavia (p. 29), is mistaken in supposing the flies bred from his butterfly-chrysalis were "house-flies." They belong to the sub-family *Tachinina*, which is of very large extent, comprising several hundreds of species in Europe alone, and all probably parasitic in other insects. The "house-fly" belongs to the sub-family *Muscinæ*. The mistake is very pardonable, for there is often great external similarity in form, colour, and size, and it is one frequently made in this country. R. MCLACHLAN

Clarendon Road, Lewisham, S.E., November 14

IT might interest Dr. E. Bonavia (November 13, p. 29) to know that it is not an unusual circumstance to find the larvæ of the house-fly in the nests of *Vespa vulgaris* and *V. germanica* feeding upon the live bodies of the larvæ and pupæ of the wasps. Occasionally I have found nests in the summer-time quite deserted by the wasps, all the pupæ in the cells having been eaten by the maggots of house-flies and other *Diptera*. F. W. ELLIOTT

Buckhurst Hill, Essex, November 18

The Sunday Question

THE announcement that, "after opening the Free Library on Sundays for two months, the Town Council have resolved to close it again *in consequence of the small number of visitors*," seems to indicate that the Town Council of Chester were as wise in deciding to close the Library as they had previously been in giving the people of Chester an opportunity of spending a portion of their day of rest in the Public Library, where those who do not possess libraries of their own can obtain access to the wisdom of the ages as stored in books.

If the facts are as stated, no one can complain of the action of the Chester Town Council, though some would have been glad to have seen a little more patience with people who for so long have been compelled to spend their Sundays when not at home either in the church, the public-house, or the streets, all of which may be attended with advantage and profit by free and intelligent men and women; but when men are driven to either of these places, what should be a blessing becomes in too many cases a curse.

However, as I have said, we have no right to complain of the Town Council of Chester closing the Public Library on Sunday if there is no considerable number of the people of the town desirous of using the institution on that day. In civilised communities representative authorities such as town councils and parliaments are only justified in spending public money on institutions when at least a considerable section of the community desires it.

The Sunday Society bases its claim for the Sunday opening of the British Museum, the South Kensington Museum, the Natural History Museum, the National Gallery, and the Bethnal Green Museum on the ascertained fact that very large sections of the community do desire to visit them on Sundays, and if it be replied that there are more people who have no such desire and therefore these institutions should be closed, I answer that that argument would close the whole of them on every day in the week, for no one will for a moment contend that a majority of the people of the United Kingdom have visited, or can possibly visit, these national exhibitions of the wonders of the universe and what we call its highest product—man.

But the benefit of these institutions is not confined to those who actually visit them. The sermon of the Puritan divine and the lecture at the mechanic's institute are alike indebted to the British Museum and the other institutions named.

Let the trustees of the British Museum follow the example of the Town Council of Chester and open the Museum on Sundays for two months, and the question, so far as the Sunday Society is concerned, will be settled for ever. I will venture to say that after such an experiment the British Museum would never again be closed on Sundays, and with such an example in the centre of the metropolis, no Sunday Society would be longer needed to advocate the opening of museums, art galleries, libraries, and gardens on Sundays.

The statement that at Keswick the "Sunday-opening experiment had been tried and abandoned" is true, but it should be explained that the Library at Keswick is not a public institution in the sense of being supported by rates and taxes, and is under the sole control of the vicar of the parish. It was the late vicar who closed the Library on Sundays, and I have the pleasure of announcing the fact that the Sunday-closing experiment has been tried and abandoned. The present vicar, the Rev. J. N. Hoare, did not decide to do this on his own authority, but he convened a special meeting of the Committee to consider the question,

when it was decided to again open the Library, during the winter season, on Sundays. MARK H. JUDGE,
Honorary Secretary of the Sunday Society
8, Park Place Villas, Paddington, W., November 17

A Pugnacious Frog

A SHORT time back, about 6 o'clock in the evening, just as it was getting dark, hearing a squeaking noise below my veranda, I got up to look, and saw a most amusing sight, viz. a fight between a frog and a bat. The latter was evidently getting the worst of it, but at last succeeded in getting away for a time from its opponent; the frog again attacked it, but this time *he* was glad to cry "quits," as the bat turned on him and beat him off, afterwards managing to hide somewhere so that we could not find it; the frog, however, was sorely bitten about the nose, and was in a sad plight. I do not know how the bat could have been on the ground, but it had probably fallen from its nest during the day, and was waiting for the evening, when the frog espied and attacked it with the bef re-mentioned result.

EDWIN H. EVANS

Margapala, Soemedang, Java, October 13

A DISEASE-GERM MYTH

WE are indebted to a correspondent for the following curious note from Fiji:—

You may have seen Wilfred Powell's "Wanderings in a Wild Country; or, Three Years among the Cannibals of New Britain." If you have not seen it, pray send for it, for, though falling far short of what it ought to be, it is not without interest. At p. 167 he tells a story of native magic which reminds me of something I have read before.

A native doctor being called in to a patient "looking wretchedly ill," performs a little "devil-devil" business, and then blows some burnt lime from the hollow of his hand against the patient's stomach; "then he began to scratch the man's navel with one finger," gradually approaching his mouth to the fellow's stomach, and drawing in his breath. Presently he places his mouth close to the man's navel, draws back suddenly, retches violently, and——throws up a worm. This the worthy doctor does twice.

Powell says, "I looked at the worms, they were *unlike anything I had seen before*, and appeared as if they certainly might have come from a man's body."

Now see Bates on the Amazons, cap. ix.:—"This (the illness) the Pagá pretends to extract, he blows on the seat of pain the smoke from a large cigar, . . and then sucks the place, drawing from his mouth, when he has finished, what he pretends to be a worm. . . . Senhor John contrived to get possession of the supposed worm after the trick was performed in our presence, and it turned out to be a *long white air root* of some plant"!!

Wilfred Powell should have got that worm or another specimen, even if he had been compelled, in the interests of science, to explore the patient's stomach with a pickaxe.

When Macdonald, of the old surveying-ship *Herald*, was in these waters, he was daily searching for a specimen of the pearly Nautilus (*N. pompilius*), which is pretty common here. One day upon the reef at Nasamusovu he met a Fijian coming out of his canoe in which he had been fishing. He showed him the picture of a Nautilus, which the man recognised at once, and, in reply to a question put through an interpreter, said he had just eaten one. Macdonald got into a great rage at the loss of such a treasure, but suddenly checking his excitement and glancing rapidly over the native, he said to the interpreter, "Quick, ask him how long it is since he ate it."

But there was something in the eye and the tone of the doctor's voice that so startled the gentle child of Nature that, before the interpreter could open his mouth, he had taken to his heels and put half a mile of reef between himself and the man of science.

What awful thought passed through Macdonald's mind has not been left on record.

THE BUDDHIST THEORY OF EVOLUTION

THE theory of evolution held by adepts in Buddhism is the outcome of the researches of an immense succession of investigators, believed to be qualified for their task by the possession of spiritual faculties and perceptions of a higher order than those belonging to ordinary humanity. In the course of ages the block of knowledge thus accumulated concerning the origin of the world and of man and the ultimate destinies of our race, checked and examined at every point, verified in all directions, and constantly under examination throughout, has come to be looked on as the absolute truth concerning the evolution, past and to come, of man and the planets he is destined to inhabit. The initiated members or "adepts" of the Buddhist cult claim to have attained, through intense self-absorption, a knowledge of physical laws of Nature not yet understood by Western science, investing them with extraordinary powers known as spiritualistic, such as clairvoyance and the disintegration and reconstruction of matter by a simple effort of will. They claim in fact to be in possession of potential faculties which will only be generally developed in future stages of evolution. This religion, which is wholly unaggressive and seeks no converts, attracts many on account of its claims to be in accord with all established scientific fact, and by its incorporation of so patent a truth as the doctrine of evolution as an integral part of its system.

A brief examination of these claims, and a glance at the past and future of man's evolution as thus elaborated, can hardly fail to be of interest, if it fails to carry conviction.

It is impossible, and unnecessary, to attempt to follow briefly the mystic subtleties of belief that have fascinated the Oriental mind, and been to it for ages what the pursuit of practical science has been to Western nations. Shortly stated, the Buddhist divides the human entity into seven principles, the higher of which have not yet reached their full development. The first three are of the earth, and done with at death. These are (1) the body; (2) vitality, or the life principle, an indestructible force which attaches itself to other objects after the decomposition of the body; (3) the astral body, "an ethereal duplicate of the physical body," which can under certain circumstances become disembodied and visible as a ghost; (4) the animal soul, or seat of all animal desires; (5) the human soul. The other two can be passed over, as they are still in embryo, and belong to a wholly superior and future condition of existence. The fifth and, later on, the sixth principles make up a man's continuous individuality through successive incarnations.

The solar system consists of seven planetary chains. The one with which man is concerned consists of seven planets, through each of which he has to pass seven times in order to accomplish his evolution. These are the Earth, Mars, which is in a state of entire obscuration or rest as regards the human life-wave, Mercury, just beginning to prepare for its next human period, and four other planets which are composed of an order of matter too ethereal for telescopes to take cognisance of. The system of worlds is compared to a system of towers standing on a plain, each of many stories, man's progress being a spiral round and round the series, passing through each tower as it again comes round to it, at a higher spiritual level than before. The impulse to the new evolution of higher forms is given by rushes, not a continual flow, of spiritual monads coming round the cycle in a state fit for the inhabitation of new forms, and those which for milleniums have gone on merel

repeating themselves then start afresh into growth, and rise rapidly, through intermediate, to the higher forms. The spiral character of the progress, and the fact that the tide of life passes from planet to planet in gushes, accounts for the gaps in the various kingdoms of Nature. Each time a spiritual monad arrives on a planet it has a complicated process of evolution to perform. It is many times incarnated before it passes onward, and man has many incarnations in each great race, the normal sum being not far short of 800, with an interval of at least 1500 years between each, spent in the "world of effects, or heaven of ordinary theology." In the first planetary round man inhabited an immense but loosely organised body, and could not be called intellectual. In the second he becomes of firmer body, whilst in the third he is rather in form of a giant ape than true man, yet of concrete body and advanced intelligence. In the fourth, the present round, his intellect becomes fully developed, and he achieves enormous progress. We now approach the transcendental mystery of mysteries, our future development. The fifth round will be occupied with a struggle between physical intellect and spirituality. In the sixth round a state of perfection of body and soul will be attained which can hardly even be imagined; while as to the seventh round the occult teachers themselves are solemnly silent, it being altogether too God-like for realisation. At the end of each planetary round an intercyclic period of extraordinary exaltation must be undergone. It is by processes of occult training that adepts project themselves precociously into the fifth round, or possess themselves of the attributes of fifth-round men, so as to be able to explore the mysteries of Nature and of other states of existence, and to assimilate knowledge by clairvoyance independently of observation.

We now exist in the fifth race of the fourth round. The first and second races developed no civilisation, but the third and fourth did do so several millions of years ago, though no traces of such now exist. The periods of the great root races are divided by vast convulsions or geological changes, which cut them off at the appointed time, leaving only a few survivors behind, who rapidly relapse into barbarism. The fourth race lived on "Atlantis," and reached its apogee in "the Eocene Age," when this great continent showed the first symptoms of sinking, a process that occupied it down to 11,446 years ago, when its last island, Poseidonis, went down with a crash. "Lemuria" was drowned with its high civilisation and gods about 700,000 years earlier than Atlantis, or just before the early part of the Eocene Age, the relics of its third-race inhabitants existing in some of the flat-headed aborigines of Australia. The true Chinaman is interesting as a relic of the fourth race. The civilisations of the ante-Glacial period were superior to those of Greece and Rome, or the Egyptian, which was in its decadence 12,000 years ago. The uninhabited Arctic regions will prove not only to have enjoyed a tropical climate, but were likewise the seat of one of the most ancient civilisations of the fourth race. Atlantis belonged to the Miocene times, and the cataclysm which destroyed it came at the appointed time, "otherwise it would be impossible for the best seer to calculate the exact hour and year when such cataclysms great and small have to occur." The relics of these former civilisations are hidden in strata which have never been geologically explored, deep in the unfathomed ocean beds.

An important part of the Buddhist creed is the belief in the alternation of periods of repose with periods of activity. As man sleeps every twenty-four hours, and vegetation subsides and revives with the seasons, so rest periods follow each incarnation. The tide-wave of humanity flows on to each of the seven planets seven times, and passes through its seven races and ebbs away again, but the great rest period of our planetary chain does not begin until the seventh round of humanity is perfected. At an incalculably remote period the whole of the seven planetary chains of our solar system will pass into a period of rest, and finally the whole universe itself will have its great cosmic night. After the long night of a planetary chain the animal and vegetable world resume their arrested activity, but when the time arrives for all the planetary chains of our system to pass into their night, each planet, as the seventh-round man quits it, is annihilated instead of merely becoming invisible, and there is an outflow from every kingdom of its entities. These will rest in lethargic sleep in space until brought into life again at the next solar period, and will then form the soul of the future globe. We have every indication that at this very moment such a solar night is taking place, while there are two minor ones ending somewhere. At the beginning of the next solar day period the hitherto subjective elements of the material worlds, now scattered in cosmic dust, will form into primordial ripples of life, and, separating into differentiating centres of activity, combine in a graduated scale of seven stages of evolution. Every orb will pass through seven stages of density, until its solidification and desiccation at last reach a point when it becomes a relaxed conglomerate, and its constituent masses cease to obey the laws of cohesion which hold them together.

Evolution takes its rise in the atomic polarity which motion engenders. In cosmogony the active and passive forces correspond to the male and female principles. The attribute of the universal spiritual principle is to expand and shed, of the material principle to gather and fecundate. These become consciousness and life when brought together. Our planet, like an iceberg, is merely a state of being for a given time, and its present appearance, geological and anthropological, is but transitory and will pass away.

Such are the beliefs and doctrines concerning evolution[1] held by the Oriental scholar, who holds in pity the benighted ignorance of Western so-called science. The book from which they are gathered is sober earnest, and I am asked whether the Buddhist ideas on evolution are in accord with the discoveries of science. The mere statement of the belief, shorn of its mysticism, is a sufficient answer. The importance attached to the numeral 7 seems puerile, and its reason is not easy to discover; it is claimed that the colours of the spectrum and the notes of the musical scale are seven, and that there are seven kingdoms in Nature. There is one seeming scientific fact, however, which, though it has escaped the "adepts," favours so far the belief in evolution by gushes, and is still unexplained. The first appearance of many forms of life on our planet, it is well known, is very sudden. All the groups of Mollusca, and especially in the case of Ammonites, appear at once fully developed and in great variety of species, and never develop into anything higher. So with the Echinodermata, the Crustacea, Insecta, the different orders of fishes, many orders of reptiles, marsupials, ferns, and dicotyledons. All these seem to have been evolutionised in a very sudden manner, and as yet afford no grounds for controverting the Buddhist belief that they are well developed arrivals from other planets.

J. STARKIE GARDNER

THE RAINFALL OF 1884

THE water famine with which the towns of Manchester and Bradford have recently been threatened has served to draw public attention to the fact that the rainfall of the present year has been strikingly deficient. As the extent of the deficiency is, however, little, or at the best imperfectly, realised, a few reliable statistics on the subject may be of more than ordinary interest.

The following table shows, for seventeen places situated

[1] Condensed from Mr. A. P. Sinnett's book, "Esoteric Buddhism" (Trübner and Co.), and as far as possible in his own words.

in various parts of the United Kingdom, the excess or deficit of rain which has occurred during the first, second, and third quarters of the present year, and also similar values for the month of October. In the last column we have the number of months in which the rainfall has been less than the average. It must, however, be explained that these numbers do not necessarily signify consecutive months. The values in the table have been compiled from the Monthly and Weekly Weather Reports issued by the Meteorological Office, and the averages employed have been those for the fifteen years 1866 to 1880.

Recording stations	Excess or deficit					No. of months with deficiency of rain
	January to March	April to June	July to September	October	The whole ten months	
ENGLAND AND WALES	per cent.	per cent.	per cent.	per cent.	per cent.	
York	+33	−54	−18	−70	−22	6
Stonyhurst	+31	−46	−21	−29	−13	7
Blackpool	+41	−32	−14	−45	− 2	6
Manchester (Prestwich)	+18	−44	− 8	−43	−14	8
Llandudno	+30	−32	−23	−66	−17	6
Leicester	−13	−27	−33	−39	−27	8
Hereford	+ 4	−19	−29	−70	−23	6
Cirencester	−11	−22	−29	−68	−26	6
Marlborough	+ 7	− 9	−37	−69	−21	6
Oxford	−20	−24	−41	−69	−34	10
London	−28	−37	−39	−62	−38	10
Cambridge	−30	−28	−10	−38	−23	9
SCOTLAND						
Aberdeen	+22	−36	−30	− 8	−11	7
Leith	+16	−30	+ 9	−40	− 5	6
Glasgow	+21	−34	+ 3	−17	− 2	6
IRELAND						
Londonderry	+37	−16	−11	+ 5	+ 4	5
Dublin	+20	−33	−46	−78	−29	8

An examination of the first column shows that during the first quarter of the year there was a deficiency of rain over the midland and south-eastern counties of England, but an excess in all other parts of the kingdom. The deficiency was most clearly marked in London and its immediate neighbourhood, where the total fall was from 28 to 30 per cent. less than the average. The excess was greatest in the north-west of England and north of Ireland; in most parts of these districts the aggregate was from 30 to 40 per cent. more than the average, but at Blackpool it was as much as 41 per cent. more.

The figures in the next column show that during the second quarter of the year the weather became much drier, and in fact a deficiency of rain was recorded over the entire kingdom. With the exception of Marlborough, where the falling off amounted to only 9 per cent., and Hereford and Londonderry, where it was respectively 19 and 16 per cent., the deficiency varied between 22 and 54 per cent., the lower value being recorded at Cirencester and the higher at York. Upon the whole it appears that the driest weather was experienced in Scotland, the north and north-west of England, and the neighbourhood of London.

From the figures in the third column it would appear that a very similar state of affairs prevailed in the July to September quarter. With the exception of Leith and Glasgow, where there was a trifling excess, every station in the table again had a deficiency of rain, the districts more seriously affected being the western and southern parts of England and the east of Ireland. In the catchment basin, from which the northern towns derive their water-supply, the deficit was not so strongly marked as in other parts of the kingdom, and the serious state of affairs which prevailed during October must therefore be set down to a long continued rather than an exceptionally severe spell of dry weather.

The figures for the month of October, given in the fourth column, show that the fall of rain was then abnormally small. At Londonderry, it is true, there was a slight excess, and at Aberdeen the deficit was not particularly striking, but in other parts of the country the falling off was very considerable. At many of the English stations the total for the month was only one-third of the average, while at Dublin it did not amount to as much as one-fourth. The places least affected were Stonyhurst, Leicester, and Cambridge, where the amount was from 29 to 39 per cent. less than the average.

The general result of all these facts, as given in the fifth column, shows that, with the exception of Londonderry, the rainfall of the past ten months has been less than the average in all parts of the kingdom. At Blackpool, Leith, and Glasgow the deficiency has not been particularly remarkable, but elsewhere, and especially in London and the home counties generally, it has been very great. At Oxford, and also in London, the aggregate fall for the period has been only about two-thirds of the average; and there is consequently no reason to doubt that, unless the weather of the remaining few weeks of 1884 undergoes a very sudden and decided change, the total for the year will be unusually small. Up to the present time (November 18) the rainfall for November has only amounted to one-third of the average for the whole month.

The last column in the table gives the number of months during which the amount of rain has been in defect of the average. At Manchester, Leicester, and Dublin there have been eight such periods, and at Cambridge nine; while at Oxford, and also in London, every month has shown a deficiency.

In endeavouring to compare the above figures with those for previous years, the meteorologist is met at the outset by a very familiar difficulty, namely that of finding reliable information for any very long period. As regards London, however, some valuable statistics are to hand in the rainfall diagram prepared some years ago by Mr. George Dines, F.R.Met.Soc. This diagram, which gives the monthly and annual fall of rain in the London district during the sixty years 1813 to 1872, was compiled with great care and precision partly from Luke Howard's observations, partly from the Cobham journals, and to a large extent from information published or supplied by Mr. Symons. By completing the statistics up to the present time, we get a long and very valuable series of returns, and are also able to obtain a really good and reliable average. In the following table are shown the total amounts of rain in London during some of the driest of the past seventy-one years, together with the percentage difference from an average based on the seventy years'

Years	For the whole year		January to October		No. of months in year with deficiency of rain
	Total fall	Percentage value below average	Total fall	Percentage value below average	
	inches		inches		
1832	19·8	20	16·4	24	9
1837	19·4	22	16·5	24	9
1840	19·4	22	15·5	28	8
1847	17·7	29	13·5	37	11
1850	19·2	23	15·8	27	9
1854	18·7	25	15·3	29	11
1858	17·3	30	15·2	30	8
1864	17·4	30	14·5	33	9
1884	—	—	13·4	38	?

observations 1813 to 1882. In selecting the years, those only have been chosen in which the aggregate fall of rain has been at least 20 per cent. less than the average. The table further gives the total fall and difference from the average for the first ten months in each of these years, and in the last column will be found the number of months during which the rainfall has been deficient.

From the first two columns it appears that the years 1858 and 1864 claim the distinction of being the driest of all, the total falls being only 17·3 inches and 17·4 inches respectively, or 30 per cent. less than the average. Next comes 1847, with a total fall of 17·7 inches and a deficit amounting to 29 per cent. As regards the period of ten months, the present year has been drier than any of the past seventy-one, but in the year 1847 the rainfall was nearly as deficient. In the case of the other dry years the aggregate fall for the ten months was at least an inch more than in either 1847 or 1884, and in the years 1832 and 1837 it was three inches more. On comparing the returns for the past seventy-one years, one more striking fact is brought to light. Out of the whole series there has been only one occasion on which the deficiency of rain has continued through a greater number of months than it has this year. This long period of drought commenced in November 1846 and continued until November 1847, and there were consequently no fewer than thirteen consecutive months during which the rainfall in London was below the average. FREDK. J. BRODIE

ANCIENT CHINESE GEOGRAPHY

NOT long since the Chinese Ambassador to England, in the course of a remarkable speech at Folkestone, twitted European scholars with the labours which they freely bestowed on the study of extinct nations and races, while the still existing civilisation of China, hardly inferior in antiquity to that of any other race, received but scant attention. Whether the charge is well founded or not we cannot pretend to decide here; but there is, we believe, no doubt that there is still in Chinese literature a vast mine, into which but few and trifling shafts have been sunk. The wealth of the geographical literature of China, for instance, is known to but a few scholars, and one of these, M. de Rosny of Paris, in a work recently published on the Oriental nations known to the ancient Chinese, says that, among all the literatures of the East, that of the Chinese probably contains the most valuable information for the study of Asiatic ethnography, for a crowd of nations which have disappeared, or which are unknown in Europe, have been the subject of substantial notices by the Chinese, outside which, probably, we know nothing of their political history or of the annals of their civilisation. M. de Rosny's work, which is published by the Ethnographical Society of Paris, is devoted to the translation and piecing together of extracts from old topographical works respecting various countries known to the Chinese in ancient times. Much of the labour in a work of this kind must necessarily be devoted to identifying the places mentioned. In many cases this has not even now been satisfactorily done. Thus, the origin of the name *Ta-tsin*, applied to the Roman Empire, is wrapped in obscurity. The latest theory is that it is the phonetical representation of Tarsus in Cilicia, whence Antoninus sent ambassadors to Bactria, so that the name of Tarsus was the first echo which China received of Rome. But although there is much in M. de Rosny's volume which can only interest the technical Sinologue, yet one can gather from the text, as well as from the maps, a fairly accurate idea of the knowledge of geography possessed by the Chinese in early times. Of the maps, which are nine in number, one contains the Indian Archipelago as known to the Chinese, and six others Indo-China and Malaysia, according to Chinese geographers, at various periods from the twelfth century before our era down to 906 after Christ.

The Chinese, then, according to M. de Rosny, have from the most remote times occupied themselves with the topography of the districts through which they migrated, and have studied the geography of the neighbouring countries. Yu the Great, who reigned in the basin of the Yellow River twenty-two centuries before our era, was a veritable geographer. The *Shu-king*, which contains an account of the public works executed under his direction, contains the first rudiments of Chinese ethnography, as Genesis does that of the Jews. A geographical work which is probably not less ancient is the *Shan-hai-king*. It is at least as old as the Choo dynasty—1134 B.C.—and some Chinese authors even carry its date back to the twenty-seventh century before Christ. In a book of rites of the Choo dynasty just referred to, it is stated that twenty-four officials were specially charged with the administration of a department for national geography. It is, however, to the historians that we have to look for accounts of the various peoples which early submitted to the preponderating influence of the Middle Kingdom. The nomad hordes of the north and west, and the States then in process of formation in the south, all entered into relations with the Chinese. The ambassadors whom they sent to the Court brought with them information as to the people they represented, which was duly consigned to the archives of the Empire by its historiographers. The officials sent by the Chinese in return to the peoples about them contributed their quota of geographical and ethnographical facts, until ultimately the documents on the subject became so numerous that native scholars judged it well to summarise them into one great work. It was thus that the great encyclopædia associated with the name of Ma-touan-lin was formed. Its first publication was in 1322.

The limits of the world as known to the early Chinese are stated by M. de Rosny to be: in the north, Southern Siberia and Kamchatka; in the east, the Kurile Islands, Japan, the Loochoo Archipelago, and that of the Philippines; in the south-east, Borneo and Celebes; to the south, Java, Sumatra, and Ceylon; to the west, Arabia, Persia, and the States bordering on the Caspian. Some scholars have professed to discover the Roman Empire under the name Ta-tsin, and America, which a mission of Shamans are said to have discovered in the fifth century, under that of Fousang. In the work before us the writer gives, from Ma-touan-lin and other sources, the statements of the early Chinese writers with regard to the various races inhabiting these regions; but he warns us more than once that these ancient documents, though of great value in teaching us about peoples little known to us, must be used with the utmost reserve, and only after undergoing a searching examination and criticism. The present instalment of the work deals only with the races to the south, south-east, and east, such as the Japanese, Ainos, Siamese, &c. Its value as an ethnographical and geographical work can only be known to the one or two living Europeans who have made a special study of the subject; but it places beyond doubt the fact that students of the ethnography and historical geography of the Far East will have to reckon with the works of their remote Chinese predecessors before their knowledge can be regarded as complete.

COLOUR

M. M. A. ROSENSTIEHL has made an interesting contribution to the science of colour in the form of a *brochure* recently published under the auspices of the Société Industrielle of Rouen, and entitled "Les premiers Éléments de la Science de la Couleur." In this treatise, which is a model of brevity and of demonstrative clearness, the author shows that the empirical methods which have hitherto prevailed amongst colourists of all classes are radically imperfect. These methods are

based entirely upon the study of colouring *matters*, and ignore altogether the fundamental distinction between colour as a property of such matter, and colour in the physiological sense of a particular affection of the organ of sight. It is to the study of colour by means of colour-sensations that our attention is directed; and it is to the synthesis and analysis of the retinal impressions that we are to look for exact views on the relationships of the colours. The distinction in question once stated is so obvious that the author's claim for recognition of the new system or method as the necessary complement of the older will be at once admitted. But the author's aim is not so much to obtain the intellectual assent of those accustomed to the propositions of abstract science, as rather to convince colour-artists of every denomination of the direct utility of the method—to show them, in fact, that it supplies the means of solving problems in colouring with rapidity and certainty, and furnishes valuable criteria with which to strengthen the æsthetic judgment.

The chief obstacles to the general acceptance of the method lie in the erroneous views which underlie the well-worn proverb, "Il ne faut pas disputer des gouts et des couleurs." While, in opposition to these tenets, the author contends for the admission of more positive views, and of the experimental method upon which they are based, he very distinctly disclaims the idea of substituting taste and artistic inspiration by a set of mathematical rules. "Taste," he says, "must ever remain the supreme judge of the æsthetic value of any combination of colours."

It is true that the artistic instinct confers upon its possessor a comparative independence of the methodical selection of colour; but this instinct, or intuitive perception of harmony, is by no means an unerring guide, nor without the influence of prevailing ideas. Most of these are of necessity incomplete, and many are demonstrably false: and the artistic instinct therefore needs development and correction. In the abstract which we shall give of the author's treatise, we shall give due prominence to the evidences of these shortcomings.

The elaboration of the empirical system still prevalent we owe to Chevreul. It is based entirely upon the study of colouring-matters, and its scales of colour-relationships are purely arbitrary. The theoretical treatment of colour, on the other hand, has been chiefly, and indeed necessarily, confined to the investigations of the spectrum. Early in this century, Young, the father of our modern science of light, formulated a theory of colour-sensation, a theory, that is to say, which co-ordinated the physical phenomena of coloured light with the phenomena of its appreciation by the eye. Colour, we know, is the expression of wave-length; the sense of colour was referred by Young to the agency of distinctive retinal nerves, each endowed with the capacity of selective excitation by rays of certain wave-lengths. He recognised, further, three primary divisions of wave-lengths, corresponding to red, blue, and yellow light. The later researches of Maxwell have given results confirmatory of this view, and additional testimony to the wonderful insight of this great philosopher. But we are not concerned at this moment with the theories and speculations of pure science so much as with the more practical question of the advantage to the colourist of correcting impressions derived from the empirical study of pigments, by the study of colour in the light of their main results and consequences. A very praiseworthy effort to bridge over the gap which had so long existed between the science and the art of colouring has been made by Prof. von Bezold in the publication of his work on the "Science of Colour." This excellent treatise, in spite of its translation into English, has, we think, not received the attention in this country which it deserves; this is accounted for in part by its publication in America, but an equally powerful cause is to be found in the conservatism of those to whom it appeals, in the jealousy of invasion by the forces of a new method of a territory rendered sacred by inheritance.

In both treatises considerable importance is attached to the reduction of the various terms in conventional use to the accurate expression of the ideas involved in the scientific investigation of colour. This is a task of considerable difficulty.

M. Rosenstiehl finds the French terms especially difficult to handle. The three principal substantives, *nuance*, *teinte*, and *ton*, he assigns—though with a confession that his choice is somewhat arbitrary—to the three variables respectively which determine a colour, viz. kind or quality (*espèce*), intensity, and purity. In this choice he admits that the terms *ton* and *nuance* may be said to have an inverse relationship to that which they occupy in musical language, but at the same time justifies the selection as most in accordance with present usage, pointing out, moreover, that the analogy between the ear and the eye is so slender that it is not to be sought in the terms which express their sensations. The translator of Bezold finds himself called upon to accommodate himself in his treatment of the subject to the use of the terms hue, tint, shade. To avoid prolixity we give as the result of a careful consideration of the terminology of both authors the following definitions of essential terms:—

(1) Colour in the sense of wave-length must be denominated by *hue*.

(2) The degree of brightness (French, *intensité*) we may express by *tint*.

(3) The degree of purity, *i.e.* non-admixture with white, may be rendered by *tone*.

It is obvious that (2) and (3) are, in regard to the ordinary conditions of vision, interdependent variables, for, as the intensity or illumination increases, the proportion of white increases.

It will be found on trial that, by means of these three substantives, the essential factors of any colour may be expressed. It is clear that habit will prevent our specialising the use of the word colour; but we may limit its use scientifically to the general expression of primary distinctions, reserving the term hue to indicate specially wave-length and variations in wave-length. There still remains, however, the important word *shade* to dispose of, amongst the substantives in conventional use, as well as the numerous adjectives with which they have been conjoined.

The more general use of *shade* has been to express the idea contained in (3), *i.e.* the toning of colours by addition or removal of white, and this use may be retained. At the same time, in order that our nomenclature may be precise, we must obviously avoid such expressions as a "red *shade* of orange, using instead "red-orange hue," or even "red hue of orange," or again, "dark *shade* of green," meaning thereby a green of medium tone perhaps, but of low illumination; the correct expression here would be "a green, a *dark* or *low tint*" (*couleur foncée*).

The term *couleur saturée* is applied by M. Rosenstiehl to a pure colour, or the corresponding visual sensation: such colours are obviously never met with in the arts; those which approximate to saturation he terms *couleurs franches*. These adjectives are perhaps best translated by *integral* and *full* respectively.

The spectral hues are *integral; full* colours or tones are those which give the impression of quantity of colour.

The term *gamut* or *scale* is used in two senses: first, to indicate a graduated succession of tones, *i.e.* the gradations of a given hue through its several tones to white; and second, a graduated succession of tints, or the gradations of a given hue through its several tints to black.

The *æsthetic gamut* or *scale* is the term applied by the author to graduated modifications of one and the same colour-*sensation;* its special significance will become

more apparent as we proceed in our examination of M. Rosenstiehl's work.

For the investigation of colours, or rather of colouring-matters, the author employs concentric disks, which are kept in rapid rotation by mechanical means of the simplest character. These disks may be coloured uniformly or in sectors of various hues; the well-known result of the rapid rotation is in the latter case the mixture of the sensations of light, then fusion into a single uniform coloured impression. In the study of the degradation of colours by admixture, it is necessary to have both a black and a white. The white is obtained by means of precipitated barium sulphate applied to a suitable surface; the black is obtained by means of a small chamber before which the disks rotate, this chamber being lined with black velvet. The admixture of black is then produced by cutting from the disk a sector; the disk being then placed before this chamber adds the sensation of black to that of colour in the proportion of the size of the sector removed to that of the disk. A special apparatus is described for measuring the sectors of the disks, as is also the very necessary instrument by which the disks are cut with or without the simultaneous removal of sectors.

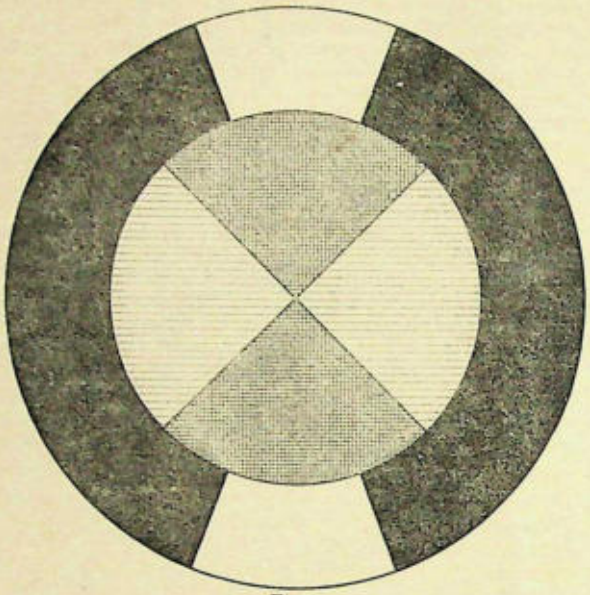


Fig. 1.

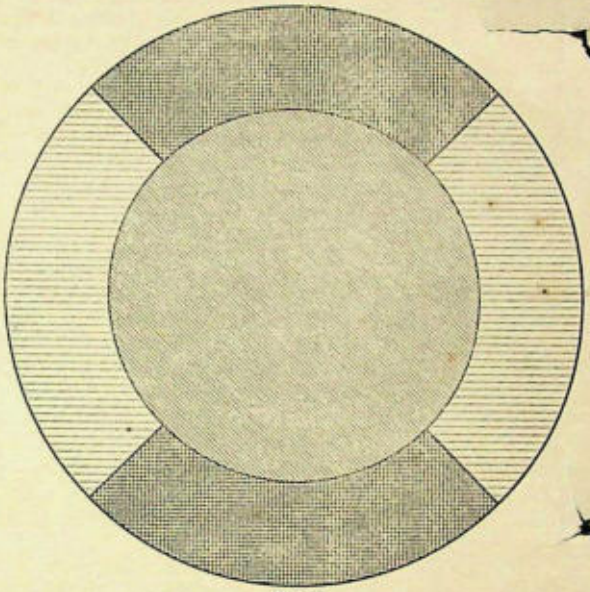


Fig. 3.

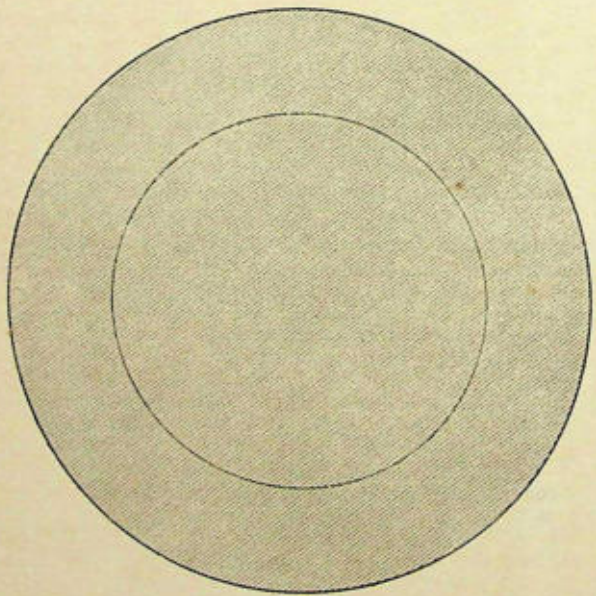


Fig. 2.

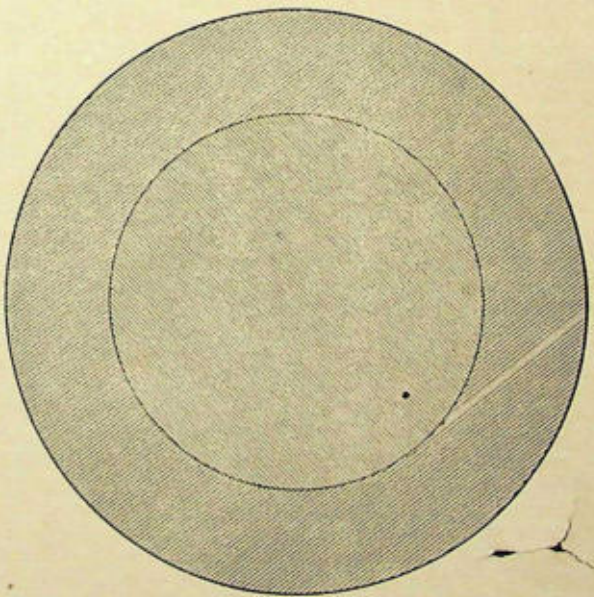


Fig. 4.

The author's experimental results are given in a series of coloured plates, to which descriptive notes and explanations are attached. Some of these we proceed to reproduce. Plate 1 in the book is a study of complementary colours or hues. The superposed disks are represented both at rest (Fig. 1) and in motion (Fig. 2); the mechanical details, such as the attachment of the disks to the re-

volving axis, are suppressed for the sake of clearness. Under the condition of rapid rotation both disks appear to be coloured a uniform grey.

Thus in a single experiment is demonstrated (1) that blue and yellow are complementary colours, (2) that particular tones of blue and yellow produce by mixture of retinal impressions a white of low tint—in fact, by measuring the sectors composing the outer annulus, a white of 2-9ths the intensity of that of the annulus, which is produced by barium sulphate. Other binary combinations will be found to produce similar results, *e.g.* red and blue-green, violet and yellow-green. In fact given any hue, a second may be formed by means of this apparatus, such that the combination of the retinal impressions proper to each shall produce the sensation of white, the degree of this sensation varying with the tone of the constituents of the combination.

From the experimental investigation of complementary hues the definition of intensity is readily deduced. In the sectors of the plate we notice equality of area. Had we taken a fuller yellow of the same hue, the grey produced with the blue sector of equal area would have shown a yellow cast, and to restore the neutral grey or low white we must increase the area of the blue at the expense of the yellow. The relative intensity of complementary hues is thus defined to be the reverse of the sectors necessary to produce neutrality of hue.

The use of the particular yellow pigment of Fig. 1, coloured in the original chromate of lead, is dictated by the lowness of tints of all our blue pigments; the purest of our ultramarines, smalts, and aniline blues do not possess one-third the intensity of chromate of lead; and the same is true of the greens and violets.

The study of complementary colours leads directly to the discussion of the basis of this phenomenon, whether, *i.e.* it is physical or physiological? It is in this department of the subject that confusion of ideas has longest persisted. Although it was pointed out by M. Plateau as long ago as 1829 that the mixture of colouring-*matters* and of colour-*sensations* are distinct phenomena, the classical experiment of Muschenbroek, dating from 1762, is still retained by lecturers and text-books, together with erroneous interpretations. Newton himself fell into the same error in his discussion of the recombination of the spectral colours. The author puts the matter in the clearest light by pointing out that there are a number of mixtures producing the sensation of white light,—that psychological identity, therefore, is no criterion of physical identity.

The distinction is perhaps most clearly demonstrated by a plate of figures representing the superposed disks at rest and in motion. The outer annulus is composed of alternate and equal sectors of blue and yellow, the inner disk being coloured with a mixture of blue and yellow pigments in equal proportions. The distinction in appearance produced by motion affords the clearest demonstration of the point in question (Figs. 3 and 4).

The next portion of the treatise is devoted to the study of mixtures of colours, *i.e.* colour-sensations, which are not complementary. The more important results are those obtained in the so-called "degradation" of pigments. Such pigments, for instance, when applied to a white surface, will be more or less mixed with white, *i.e.* the sensations of white will be more or less conjoined with that of the pigment hue, as the quantity of pigment per unit of surface is less. The author reproduces series of such tones, in the case of Prussian blue and chrome yellow, together with their respective complementaries. In both cases it is found that the progression is accompanied by an alteration in hue, the fuller tones being distinctly redder. It is clear, therefore, that to construct a scale or gamut of tones with any given pigment, in order that this shall have an æsthetic or standard value, each tone must be referred to the same complementary, and the tones due to the pigment alone will need correction in accordance with their demonstrated imperfections, *i.e.* departures from the standards determined by the method of physiological comparison.

The author has very carefully compared such scales of tones with the purely arbitrary scales of M. Chevreul, and has found the differences to be considerable. Such indeed might be inferred indirectly from M. Chevreul's definition of "the tones of a colour"; they are, according to him, "the different degrees of intensity of which a colour is susceptible according as the *substance* by which it is produced (*représenté*) is pure or mixed with white."

A comparison of colour combinations harmonised according to the two systems, will show the æsthetic superiority of the physiological method, judged, that is, by the much abused arbiter, *taste*. It is unnecessary further to insist upon the practical importance of such conclusions. It will doubtless have been already appreciated on the part of the reader that the confusion of ideas which it is the object of this treatise to eliminate cannot have remained without influence upon the education of the eye; nor can he fail to see that the training involved in the practice of the author's experimental method is a valuable æsthetic discipline, as well as a precise study of colour relationships.

We have attempted to give an idea of the difference in appearance of the disks by lines on a white surface.

THE LATE FERDINAND VON HOCHSTETTER

THE numerous friends and admirers of the late Dr. Ferdinand von Hochstetter in Europe and Australasia have to thank his old associate, Dr. Julius von Haast, for a graceful tribute paid to his memory, which takes the form of a sympathetic biographical notice published towards the end of last August at Christchurch, New Zealand. The memoir, which is accompanied by two portraits, from a lithograph and a photograph showing the distinguished naturalist in his twenty-ninth and fiftieth years respectively, is taken for his early career partly from an account in Brockhaus's "Conversations Lexicon," and for the period since the two friends first met at Auckland, N.Z., in 1858, from Hochstetter's writings and private correspondence. Born on April 30, 1829, at Esslingen, Wurtemberg, the future naturalist was at first intended for the Church by his father, Prof. Christian Ferdinand Hochstetter, chief pastor of that town, and himself a botanist of no mean repute. But in the seminary of Maulbronn near Tubingen, his love of science, implanted in the paternal home, grew so strong that, besides theology, he applied himself with great zeal to the study of mineralogy, palæontology, and geology. After taking his degree of Doctor Philosophiæ in 1852 he seems to have finally made choice of a scientific career, and in 1853 found employment on the Geological Survey of the Austrian Empire, soon after receiving the appointment of Chief Geologist for the Bohemian Section. His reports on the geology of the Boehmer Wald were so highly appreciated that he was selected in 1857 as geologist of the *Novara* Expedition, which brought him to Auckland on December 22, 1858. Here his services were at once secured by the Government, and with the reluctant consent of the Commodore of the *Novara* he accepted an engagement of eight months to examine the geology, physical features, and natural history of New Zealand. During this period he made extensive topographical and geological surveys of the provinces of Auckland and Nelson, the results of which were embodied in his standard work, "Neu Seeland," published in 1863, followed in 1867 by the greatly enlarged English edition dedicated to the Queen. Soon after his return to Europe he was appointed Professor of Geology and Mineralogy in the Technical University of Vienna, and after a visit of some months to England in 1860 he settled permanently in the Austrian capital, where, in April 1861, he married

Georgina Bengough, daughter of the English director of the Vienna gas-works. A visit in 1863 to Vesuvius was followed next year by the appearance of the "Geology of New Zealand" and of the "Palæontology of New Zealand," both of great scientific value, and forming his main contributions to the extensive series of the *Novara* publications.

About the same time Hochstetter was commissioned to explore the lacustrine basins in Carinthia and other parts of Austria, where he discovered numerous remains of kitchen-middens and prehistoric lake dwellings similar to those found in the lakes of Switzerland. In 1867 he was elected President of the Imperial Geographical Society of Vienna, a position which he held till compelled by his failing health to resign it in 1882. He now commenced the publication of a whole series of geological and mineralogical text-books for higher schools, which were introduced into many parts of the Austrian Empire, and one of which, on crystallography, was especially distinguished by its clearness and thorough grasp of the subject. Time was now also found to complete his geological essays on the Cape of Good Hope, the Island of St. Paul, the Nicobars, and Java, for the *Novara* series, and also to publish an interesting account of the great earthquake and sea-wave of 1868, in the southern hemisphere, including a calculation of the mean depth of the Pacific deduced from the known velocity of the waves across that ocean. The appointment of Consulting Geologist to the Turkish Great Railway Company brought him in 1869 to the Balkan Peninsula, the results of which journey soon after appeared, partly in the *Proceedings* of the Vienna Geographical Society, partly in the *Year-Book* of the Imperial Geological Institute, and in *Petermann's Mittheilungen*. For these important geological surveys he was decorated by the Sultan with the order of the Mejidié. Notwithstanding the loss of his eldest daughter Julia in 1871, and a chronic affection of the throat, his scientific writings and surveys were now continued with unflagging zeal, including a handbook of geology which formed part of the "Allgemeine Erdkunde"; an atlas of twenty-four geological pictorial views, with letterpress; much harassing work in connection with the Viennese International Exhibition of 1873; and lastly, an arduous journey of over two months in the summer of 1872 to the Urals and Siberia as consulting geologist to a large mining association. Then came his honourable appointment as teacher of science to Crown Prince Rudolph in 1872, followed in 1875 by his election to the Rectorship of the Technical University, and in 1876 to the position of Imperial Intendant (Chief Curator) of the Imperial Austrian Museum of Zoology, Ethnology, and Natural History. He had hoped to witness the completion of this magnificent building, which has been in progress for many years; but, although it was nearly ready for occupation as early as the summer of 1881, he did not live to see it opened to the public. In the interests of the Museum he visited Denmark, Holland, Belgium, and North Germany in 1876, and was soon after busily engaged superintending excavations in Carinthia, Bohemia, and other parts of the empire, which resulted in the discovery of rich palæontological and archæological treasures, prehistoric burial-places, skeletons of the extinct cave bear, remains of fossil man, a large number of bronze ornaments, weapons, and implements. Towards the end of 1879 his health began to decline. He suffered much about this time from pains in the legs and arms, accompanied by sleeplessness and other symptoms which later developed into an incurable attack of diabetes, terminating on July 21 last a laborious and blameless life devoted entirely to the advancement of the natural sciences. Indefatigable to the last, he found time in the midst of his multifarious labours to issue a report in 1883 on some Mexican antiquities discovered by him in the Ambrose Collection in Tyrol, and which had originally been sent by Fernando Cortez to the Emperor Charles the Fifth. His last contribution to science was a paper read in February of the present year before the Vienna Geological Institute, giving an instructive account of the celebrated mineralogical collection now removed to the New Imperial Museum. Hochstetter's life may thus be described as an epitome of the history of the natural sciences in Austria during the last quarter of a century. Dr. von Haast's appreciative memoir concludes with the appropriate lines from Goethe:—

> "Fest steh' dein Sarg in wohlgegönnter Ruh;
> Mit lockrer Erde deckt ihn leise zu,
> Und sanfter als des Lebens, liege dann
> Auf dir des Grabes Bürde, guter Mann!"

NOTES

Prof. G. H. Darwin, of Cambridge, and Prof. Daniel Oliver, of the Royal Gardens, Kew, have been nominated by the Council of the Royal Society for the award of the two Royal Medals conferred by the Crown. The Copley Medal is to be given to Prof. Carl Ludwig, of Leipzig, in recognition of the great services which he has rendered to physiological science. Prof. Tobias Robertus Thalén, of Upsala, is to have the Rumford Medal for his spectroscopic researches; and the Davy Medal is awarded to Prof. A. W. H. Kolbe, also of Leipzig, for his researches in the isomerism of alcohols. The two Leipzig Professors are Foreign Members of the Society. Prof. Darwin and Prof. Oliver are Fellows, the former well known for his mathematical investigations on the rigidity of the earth and on tides, the latter for his investigation of the classification of plants and for the important services which he has rendered to taxonomic botany.

In speaking recently at the Academy of Music in Philadelphia to a large audience on the wave-theory of light, Sir William Thomson made the following remarks on the employment of the metrical system:—"You, in this country, are subjected to the British insularity in weights and measures; you use the foot, and inch, and yard. I am obliged to use that system, but I apologise to you for doing so, because it is so inconvenient, and I hope all Americans will do everything in their power to introduce the French metrical system. I hope the evil action performed by an English Minister whose name I need not mention, because I do not wish to throw obloquy on any one, may be remedied. He abrogated a useful rule, which for a short time was followed, and which I hope will soon be again enjoined, that the French metrical system be taught in all our national schools. I do not know how it is in America. The school system seems to be very admirable, and I hope the teaching of the metrical system will not be let slip in the American schools any more than the use of the globes. I say this seriously. I do not think any one knows how seriously I speak of it. I look upon our English system as a wickedly brain-destroying piece of bondage under which we suffer. The reason why we continue to use it is the imaginary difficulty of making a change and nothing else; but I do not think in America that any such difficulty should stand in the way of adopting so splendidly useful a reform."

It is stated that Lord Rayleigh has resigned the Cavendish Professorship of Experimental Physics. The electors are Sir W. Thomson, Sir William (Justice) Grove, Profs. Liveing, Stokes, Darwin, R. B. Clifton (Oxford), and Stuart, and Mr. W. D. Niven.

Dr. Thomas Wright, F.R.S., of Cheltenham, died on the night of Monday last. This sad announcement will be received with much regret by all who take interest in the progress of geology and palæontology. We hope to give some account of the deceased naturalist next week.

THE presentation of prizes and certificates to the students of the Finsbury Technical College, and of the South London School of Technical Art, and also to the candidates at the Technological Examinations held this year in London will take place at the Fishmongers' Hall on the 4th proximo at 7.30 p.m. The Lord Mayor will preside, and the prizes will be presented by the Lord Chancellor.

NEWS from Japan states that Prof. Milne, of Tokio University, is about to establish a subterranean observatory at Jacashima, a very deep coal-mine not far from Nagasaki. The object of this observatory is to determine what connection exists between the earthquake phenomena and meteorological phenomena belonging to the earth's surface, such as storms, barometrical pressure, tides, tidal waves, &c.

M. HANSEN-BLANGSTED contributes to *L'Exploration* an interesting article on the struggle between trees in the Danish forests. The chief combatants are the beech and the birch, the former being everywhere successful in its invasions. The paper refers especially to the district of Silkeborg in the heart of Jutland. Forests composed wholly of birch are now only found in sterile sandy tracts; everywhere else the trees are mixed, and wherever the soil is favourable the beech rapidly drives out the birch. The latter loses its branches at the touch of the beech, and devotes all its strength to its upper part, where it towers above the beech. It may live long in this way, but it succumbs ultimately in the fight—of old age if of nothing else, for the life of the birch in Denmark is shorter than that of the beech. The writer believes that light is the cause of the superiority of the latter, for it has a greater development of its branches than the birch, which is more open, and thus allows the rays of the sun to pass through to the soil below, while the tufted, bushy top of the beech retains them, and thus preserves a deep shade at its base. Hardly any young plants can grow under the beech except its own shoots; and while the beech can flourish under the shade of the birch, the latter dies immediately under the beech. The birch has only been saved from total extermination by the facts that it had possession of the Danish forests long before the beech ever reached that country, and that certain districts are unfavourable to the growth of the latter. But wherever the soil has been enriched by the decomposition of the leaves of the birch the battle begins. The birch still flourishes on the borders of lakes and other marshy places, where its enemy cannot exist. In the same way in the forests of Zeeland the fir forests are disappearing before the beech. Left to themselves the firs are soon replaced by the beech. The struggle between the latter and the oak is longer and more stubborn, for the branches and foliage of the oak are thicker, and offer much resistance to the passage of light. The oak also has great longevity, but sooner or later it, too, succumbs, because it cannot develop in the shadow of the beech. The earliest forests of Denmark were mainly composed of aspens, with which the birch was apparently associated; gradually the soil was raised and the climate grew milder; then the fir grew and formed large forests. This tree ruled for centuries, and then ceded the first place to the holm oak, which is now giving way to the beech. Aspen, birch, fir, oak, and beech appear to be the steps in the struggle for the survival of the fittest among the forest trees of Denmark.

WE learn from *Science* that the U.S. Signal Service is about to undertake the publication of a general bibliography of meteorology and allied topics (such as earthquakes, terrestrial magnetism, and meteors), and requests from the writers of all countries a complete list of their contributions to the literature of these subjects, including the titles of all separate works, papers, and published observations. The number of titles already on hand is about 35,000. Especial attention is invited to the importance of full titles, with details of size, and place and date of publication. References to periodicals should be on this pattern:—

"Quetelet, Lambert Adolphe Jacques,
Sur les orages du mois d'Avril, 1865.
Bruxelles, *Acad. Sci. Bull.* XIX., 1865, 535-537."

Correspondence should be addressed to the Chief Signal Officer, U.S. Army, Washington.

ERMANNO LOESCHER of Turin has just issued the fifty-first catalogue of the literary treasures contained in his "Libreria Antiquaria." The present number is devoted chiefly to geography, travel, and antiquities, and the contents are conveniently arranged under four heads: America, Africa, China with Japan, Geography and Travels. Amongst the entries, which number 429 altogether, the bibliophile will find much to interest him.

HERR J. OLSEN, a Norwegian botanist, who has been studying the fungi in the vicinity of Bergen during the summer, has found a *Gomphidius gracilis* at Hovland. This variety has never before been found in Scandinavia, and belongs to England. Of other varieties new to Norway which he has discovered may be mentioned *Rhizopogon luteolus* and a *Boletus*. The flora of Tysnaes Island is stated to be identical with that of England.

THE following letter has been received by Prof. E. Ray Lankester, F.R.S., the Secretary of the Marine Biological Association, announcing a donation from the Royal Society in aid of the fund (now approaching 5000*l.*) which is being raised for the purpose of building and fitting a marine laboratory and experimental aquarium at Plymouth:—"Royal Society, Burlington House, London, W., Nov. 1, 1884. Sir,—Your letter relative to the Marine Biological Association was laid before the Council at their meeting on Thursday last, and I am directed to inform you that the Council have voted the sum of 250*l.* from the 'Donation Fund' in aid of the 'Marine Biological Association,' as a token of their sympathy with an effort which, they have every reason to believe, will contribute largely to the progress of biological science in this country.—I beg to remain, yours obediently, M. FOSTER, Sec. R.S."

AMONG other interesting papers in the *Proceedings* of the Perthshire Society of Natural Science for 1883-84 we notice: dimorphism in oak-gall makers and in their galls, by Prof. J. W. Trail, F.L.S.; evolution and some things said regarding it, by Rev. G. Milroy, D.D., in which a "creative" and "spontaneous" view of the origin of life is discussed with studied dispassionateness. We are glad to observe the flourishing state in which this Society seems to be.

PROF. DE LACOUPERIE is bringing to a conclusion a work on the aboriginal and non-Chinese races of China, which will be published shortly by Messrs. Field and Tuer. It will deal with one section of the learned author's researches into the *origines Sinicæ*, in which he has been engaged for several years, and which have been so successful in some important respects. One of the most curious results of the work will be to demonstrate the real youth of the Chinese as a homogeneous and powerful people. It is based wholly on original researches into Chinese literature, and this is, we believe, the first time that the ethnology of early China has been studied from the works of the Chinese themselves, or indeed at all. The work deals with the various tribes which have successively occupied China proper, and which are intimately connected with the Indo-Chinese races, the latter being in fact the modern representatives of the early occupants of China. The originality of the subject, as well as of the sources from which it is treated, should render the volume one of great scientific and general interest. The work was originally prepared as an introduction to Mr. Colquhoun's new book "Among the Shans," but it gradually

grew to such an extent under its author's hands that it became too large for such a purpose, and this, as well as its independent value, rendered it desirable to have a separate publication. Mr. Colquhoun's volume, which is on the point of publication, will, however, contain an introduction by Prof. de Lacouperie on the cradle of the Shan race, which, curiously enough, he places far away on the borders of Shensi.

PROF. ENRICO CAPORALI continues to develop the scheme formulated in the first number of *La Nuova Scienza* with great vigour and learning. The third number, for the quarter ending September 1884, shows even greater energy and grasp of the subject than its predecessors. The editor's views are now quite clear—opposition alike to the two extremes of materialism and dogmatism, and the establishment of a new philosophy reconciling the subjective methods of the old schools with the objective standpoint of the new. Evolution in the Darwinian sense is accepted without reserve, and the germs of life are sought in the very lowest forms of matter—the crystal, the molecule, and the atom itself. Thus evolution receives its broadest expression, and begins from the very first as well for the vital force as for crude matter itself. The first genesis of psychis is in fact referred to a unity arising out of the fusion of lower chemical species in a higher chemical species, which forms the connecting link between *chemical* and biological psychogenesis. In it individuals begin to react in such a way that the opposition between subject and object may almost be said to have already begun. The theory is ingenious and skilfully worked out; but the unusual interest taken on the Continent in this periodical is probably due mainly to the remarkable learning, clearness, and consistency with which the editor's views are advocated. In the present number the chief articles are:—Modern Italian Thought, the Pythagoric Formula of Cosmic Evolution, and the French Anti-Clerical Evolution.

A HIGH-LEVEL meteorological station has been recently established by Mr. Wragge on Mount Lofty, about 2200 feet high, and ten miles from Adelaide, South Australia. With Mr. Wragge's great energy and ability valuable results will doubtless be obtained from this new high-level station in connection with the excellent meteorological service of the colony.

IN the Report on Weights and Measures presented to Parliament by the Board of Trade, under the Weights and Measures Act, 1878, Sir T. H. Farrer remarks in reference to the metric system, that an opinion has been expressed by the Board of Trade that the time has now arrived when this country might with advantage join the International Convention on Metric Standards, under proper conditions; provided such a course is not to be taken as an adhesion, on the part of the United Kingdom, to the metric system. These observations appear to be intended as a reply to the eighth resolution of the Conference of the International Geodetical Association, held in Rome in October last, which expresses a hope that, if the rest of the world accepts the meridian of Greenwich for the unification of longitude, England will find in this agreement an additional motive for taking a new step in favour of the unification of weights and measures, by adhering to the Metrical Convention of May 20, 1875.

TWO years ago Prof. O. Sars, of Christiania, was given some mud taken from the bottom of a lake in Australia by Dr. Lumholtz, a Norwegian geologist. Recently he has made experiments with the same in small aquaria, and has succeeded in producing from the dried mud quite a fauna of Australian freshwater invertebrates.

ACCORDING to *L'Exploration*, Commander de Amezaga, of the Italian navy, has handed to the Ministry of Marine at Rome the collections made during the recent voyage of the corvette *Carracciolo*. The voyage lasted more than two years and a half, during which time she touched at Montevideo, Valparaiso, Callao, Guayaquil, Sydney, Singapore, and Aden. Important hydrographical investigations were made in the Straits of Magellan and on the coasts of Fiji, Tahiti, and among the islands of the South Pacific. The collections relate principally to anthropology, ethnology, the fauna and flora of Peru and Australia, Peruvian pottery, mineralogy, and zoology. In the Anthropological Section there are three Peruvian mummies in perfect preservation, although they probably date back a thousand years before the Spanish Conquest. They are distinguished from the Egyptian mummies by being in a crouching position instead of at full length. In the Ethnological Section there is a curious specimen of Carib art found at the summit of Mont Cristi, near Guayaquil.

THE *Times* announces the death of the celebrated naturalist and traveller, Dr. Alfred Brehm, in his fifty-fifth year. The son of a Thuringian ornithologist, he devoted much of his own attention to the study of birds, but all animal nature was his province, and his observations and researches are recorded in volumes of high importance and value. While still a very young man he spent several years in the north-east districts of Africa, and later in life undertook frequent scientific tours in distant lands, including a visit to Siberia and Turkestan. In 1862 he accompanied the Duke of Coburg-Gotha to Abyssinia, and in 1877 acted as scientific guide to Prince Rudolph in the country of the Danube. The deceased was for some years Director of the Zoological Gardens at Hamburg.

A MAGNIFICENT meteor was observed at Mülheim, on the Rhine, on the evening of October 30 last. Its direction was from north-east to south-west, its duration two to three seconds. While visible its progress was accompanied by a hissing sound, and it finally exploded with a loud report and brilliant blue-reddish light, leaving a bright trail behind which was still visible half a minute later.

TWO prehistoric tombs have been recently opened near the villages of Latdorf and Gröna near Bernburg (Germany), under the direction of Prof. Virchow. Three skeletons, an urn, a comb, a bronze ring, a flint knife, and half a horseshoe were found. The excavations have now been continued under Dr. Fischer's direction, and more objects brought to light, among others curious necklaces made of the teeth of bears, wolves, and foxes. The age of the tombs is said to be over 3000 years. The objects found will be preserved in the museum of the Bernburg Antiquarian Society.

WE have received from Mr. Henry Simon, of Manchester, a copy of a pamphlet by Mr. Breckon, Mr. Simon's representative for the Cleveland district, on the question of the manufacture of metallurgical coke in connection with the saving of the by-products. An account of the present position of the question in England is added, as well as a reprint of papers on the subject read by Mr. Simon, Mr. Dixon, and Mr. Smith before the Iron and Steel Institute and the British Association.

THE tobacco plantations of Southern Hungary are threatened by a terrible pest, viz. the so-called wire-worm, which differs from the ordinary tobacco-worm, inasmuch as it enters the stem of the plant just above the root and then works its destructive way right up to the flowers. Plants thus attacked yield no tobacco whatever, as the leaves turn yellow and fall shortly after the worm has attacked the stem. The tobacco-worm merely attacks the root. The large plantations of Maslak, which are celebrated for their excellent produce, have been nearly all destroyed this year by the wire-worm, while in other districts the tobacco-worm has done much damage.

A LARGE Horticultural Exhibition is to be held at Berlin in September 1885.

A COFFEE plantation has been established by a landowner in the neighbourhood of Rome. It is stated that he realised a fair profit with this year's harvest, which consisted of 2 tons of coffee per hectare.

A NEW mud-crater has formed at the foot of Mount Etna, measuring some 500 metres in diameter. The mud ejected by it flows towards Monte Furmento and the pine forest of Biancavilla.

THE additions to the Zoological Society's Gardens during the past week include a Vervet Monkey (*Cercopithecus lalandii* ♀) from South Africa, presented by Mr. J. A. Cameron; an Asiatic Wild Ass (*Equus onager* ♂) from South-Western Asia, presented by Lieut.-Col. R. A. Crawford; a Short-eared Owl (*Asio brachyotus*), a Lesser Kestrel (*Tinnunculus cenchris*) from Griqualand West, South Africa, presented by Mrs. L. Weil; a Common Cormorant (*Phalacrocorax carbo*), British, presented by Mr. S. S. Mossop; a Macaque Monkey (*Macacus cynomolgus*) from India, deposited; two Tasmanian Wolves (*Thylacinus cynocephalus*) from Tasmania, a Reindeer (*Rangifer tarandus* ♂) from Labrador, a Golden-winged Woodpecker (*Colaptes auratus*) from North America, a South American Rat Snake (*Spilotes variabilis*) from South America, purchased.

OUR ASTRONOMICAL COLUMN

THE SATURNIAN SYSTEM.—Dr. W. Meyer, late Assistant Astronomer at the Observatory of Geneva, has published in t. xxix. of *Mémoires de la Société de Physique et d'Histoire Naturelle de Genève* a determination of the dimensions of Saturn's rings and of the orbits of six satellites, and the mass of the planet, founded upon observations made at the Observatory, with a filar-micrometer on the Merz refractor of 10 inches aperture, presented to that institution by the late Prof. Plantamour. The observations in question were made during the opposition of 1881, and upon a system which it was believed would give the measures a superiority over those obtained with the same instrument in the previous year. The memoir on Saturn and his satellites, which has been separately published, is preceded by a very minute description of the Plantamour equatorial by Prof. Thury. The measures are printed in detail with the elements of reduction employed; they extend from August 15 to December 19. Dr. Meyer considers that Mimas was certainly observed on five nights, though he remarks: "Même dans la colossale lunette de Vienne, c'est un objet très délicat, qui est rarement visible quand il n'est pas près d'une élongation." On November 4, at 10h. 31m., a very faint object was observed, approximately in the position—$x = 254''$, $y = -35''$, which, by means of Prof. Asaph Hall's ephemeris, Dr. Meyer identifies as Hyperion. In the discussion of the orbits of the satellites (Enceladus, Tethys, Dione, Rhea, Titan, and Japetus) provisional elements are assumed, and are corrected in the usual manner by equations of condition. In order to determine the mean motions, the Geneva results are compared with those of Bessel in the case of Titan, while for other satellites the comparison is made with the epochs deduced by Jacob from his measures at Madras in the years 1856-58, it being considered that, in view of the precision attaching to them, little would be gained by having recourse to the older observations, especially as difficulties attend their explanation in many cases.

The mass of the ring is concluded to be very minute, certainly very much less than the value assigned by Bessel; it is stated that with the aid of Tisserand's theory, taken in connection with the results of observation, $\frac{1}{1647}$ was found for a higher limit. The most probable mass of the planet deducible from the Geneva observations is $\frac{1}{3482{\cdot}5}$, agreeing within the probable error with that assigned by Jacob, and that derived by Prof. Asaph Hall from the Washington measures of Japetus.

The following are the periods of the satellites and their mean distances from Saturn, determined by Dr. Meyer:—

	Sidereal revolution d. h. m. s.	Mean distance In arc "	In equatorial radii of Saturn
Enceladus ...	1 8 53 6·92 ...	34·350 ...	3·866
Tethys ...	1 21 18 25·02 ...	42·751 ...	4·812
Dione	2 17 41 9·29 ...	54·757 ...	6·163
Rhea	4 12 25 11·57 ...	76·484 ...	8·608
Titan	15 22 41 23·16 ...	176·910 ...	19·911
Japetus ...	79 7 49 24·84 ...	514·711 ...	57·930

THE VARIABLE STAR U GEMINORUM.—Mr. Knott has succeeded in observing another maximum of this irregular variable, which appears to have taken place on October 22, though there was very little change for four days after that date. On October 18 it was below 13·3 m. From his previous observations compared with this one, Mr. Knott infers that there has been a double period in 160 days.

ENCKE'S COMET.—M. Otto Struve has notified that an ephemeris of this comet, extending from the beginning of the present month to the beginning of May next, has been prepared by Dr. Backlund, and that it was intended to communicate it to astronomers direct from Pulkowa.

WOLF'S COMET.—M. Gonnessiat, of the Observatory at Lyons, has calculated elements of this comet from observations extending over forty-five days: he finds the period of revolution 6·862 years. The following ephemeris is deduced from his orbit:—

At Paris Midnight

	R.A. h. m. s.	N.P.D. ° ′	Log. distance from Earth	Intensity of light
November 21	22 57 13	93 6·0	0·0035	0·74
23	23 2 11	93 31·4		
25	23 7 11	93 54·9	0·0169	0·70
27	23 12 13	94 16·4		
29	23 17 18	94 36·0	0·0300	0·65
December 1	23 22 23	94 53·8		
3	23 27 30	95 9·8	0·0425	0·61

The intensity of light on September 21 is taken as unity.

GEOGRAPHICAL NOTES

AT the last meeting of the French Geographical Society Dr. Paul Heis read a paper upon the results of his journey through the valley of the Meikong, and further north into the unexplored region which separates Indo-China, properly so-called, from Tonquin. Dr. Heis has made several discoveries likely to be of service to anthropologists, geologists, and mineralogists, and has brought back with him a collection of insects and reptiles, as well as a meteorological register, which was checked four times a day during the whole of his journey. Leaving Saigon on December 12, 1882, he ascended the Meikong as far as the 18th parallel, at which point he turned off from the main stream in order to go up its affluent, the Nancham, and endeavoured to reach Luang-Prabang through the hitherto unexplored region known in Annam as the principality of Tranninh. This region is infested by Chinese brigands, called Hos, who drove him back to the Meikong, and seized the greater part of his baggage. Reascending the river to Luang-Prabang he remained there for eight months, exploring the country in various directions, notably along the Nancham, which took him close to the region of the Hos, so that he was again compelled to retrace his steps. Being prevented from returning eastward, he went through the Siamese part of Burmah, reascended the Meikong as far as Chieng-sen, thence, passing from the basin of the Meikong to that of the Meinam, he reached Chieng-mai, and so made his way on foot to Bangkok, following the course of the Meinam. From Bangkok he went to Chantalun, on the west coast of Siam, and thence on foot to Baltambang, traversing the plain of the Saphyrs, where 4000 Burmese are employed in the search for precious stones. After visiting the ruins of Angkor, he reached Saigon on June 12 last.

THE oldest Geographical Society in Europe has hitherto been regarded as that of Paris, founded in 1821, but according to a paper recently read before the Verein für Erdkunde at Dresden by Dr. Ruge, this honour belongs to the "Cosmographic Society" of Nuremberg. It was established about 1740, and first came before the public in 1746, and was connected with Homann's establishment in Nuremberg. The founder of the latter was the well-known cartographer, Johann Homann, on

whose death in 1724 it descended to his son. The latter, having died childless, gave the business to a relative named Ebersberger, and a friend named Franz, provided they always retained the name of Homann in the title of the firm. Franz endeavoured to introduce originality into their maps, thus coming in contact with many geographers, and ultimately founding the "Cosmographic Society," which was divided into mathematical, geographical, and historical sections. In a work published in 1750—the "Kosmographische Nachricht und Sammlung auf das Jahr 1748"—the Society complained loudly of the defective condition of mapping and surveys in the German States, and criticised unfavourably existing maps of Germany, as well as suggested the best modes of improving them. The paper then describes the principal members of the Society, their projects for the increase of geographical knowledge—among others a lottery to procure funds. Gradually, however, the leading spirits were called away to various German universities, or to Russia; the Seven Years' War prevented any steady work of the kind advocated; Franz and Tobias Meyer died, and the "Cosmographic Society" ceased. Its labours appear to have been confined to remedying defects which lay at hand, to supplying good popular maps of Germany, and to obtaining more accurate information as to German geography.

In August last the ship *Fenoring*, Capt. Nilson, arrived at Philadelphia from Ivigtut, in Greenland, reporting that an Eskimo had found on an ice-floe in the Julianehaab Bay, the lower part of a tent, the sides of a wooden chest, and some other things marked *Jeannette*, a bill of lading, and some cheques signed "De Long," a pair of oilskin trousers marked "Louis Noros," and a bearskin which covered something of the shape and size of a human body, but which the Eskimo did not examine on account of his superstitious prejudices. On another floe he found a quantity of sailors' apparel. The Eskimo brought some of the articles to Julianehaab, and gave them to the governor, Herr Lytzen, who at once set out to recover all the rest, but the Eskimo was unable to find the spot again. Herr Lytzen now states that among the articles are two sides of a wooden chest, on which is written in pencil, "General orders, telegrams, sailing orders, discipline, ship's papers, various papers, various agreements, charter party. . . ." The last words are not very clear. On the other board is written, "Before sailing." There is also a torn book of cheques, on which is printed, "For deposit with the Bank of California," and a pair of oilskin trousers marked "Louis Noros." The most remarkable circumstance of this discovery is naturally the spot in which it was made, as these articles must in the course of three years have drifted on an ice-floe from long. 155° E. to 46° W.! They can hardly hail from the place where the *Jeannette* was crushed, as she sank, and the surrounding ice-floes were ground to dust by the catastrophe. But we know from the reports of Messrs. Dannenhower and Melville that the crew, after leaving the vessel, camped for a few days on some ice-floes, in order to divide the provisions. This took place near the New Siberian Islands, and probably the tent had been erected where the remains were now found. As nobody had then died, there cannot have been any corpse under the bearskin. Which way the ice-floe has drifted can only be conjectured; but by a rough calculation the distance is about 2500 nautical miles, and, as it has been covered in about 1000 days, the average rate of drifting is 2½ nautical miles per day, without allowing for deviations.

"Emperor William," "Prince Bismarck," and "Count Moltke" are the names given to three cataracts by Herr Gustav Mederstein on his exploring tour up the Parana River in the province of Misiones (Argentine Republic). They belong to a middle group of some hundred cataracts of the Iguassi River, which at that spot forms the boundary between the Argentine Republic and Brazil. The river's breadth above the falls is about 5 kilometres; the "Emperor William" is the middle one of the three cataracts, and the total height of the falls is about 50 metres. At a distance of some 16 kilometres below the falls the Iguassi joins the Parana.

M. Thouar, who has already travelled in South America in search of the Crevaux Expedition, is about to commence a new journey of exploration, which is to last two or three years. He intends investigating the delta of the Pilcomayo, and endeavouring to open a great trade route between Bolivia and Paraguay. In this work he will, it is said, receive the active support of several South American Governments. During the journey he will collect the materials for a great work on South America.

The Expedition which had left Loango, led by Lieut. Delizie, in order to carry provisions to De Brazza's Mission at Stanley Pool, was abandoned by about two hundred carriers on the shore of Lake Loudima. It arrived at the Manyanga Station on the Congo (a station of the International Society) on July 18, and prepared to make a new start.

AN ACCOUNT OF SOME PRELIMINARY EXPERIMENTS WITH BIRAM'S ANEMOMETERS ATTACHED TO KITE STRINGS OR WIRES[1]

These experiments were regularly commenced in September 1883, and continued at intervals up to June 14, 1884. A preliminary note descriptive of the apparatus and method employed appeared in the *Quarterly Journal* of the Royal Meteorological Society in 1883. As, however, some improvements have since then been made in the mode of flying and estimating the heights, it may be as well to give a brief account of the scheme *de novo*.

First of all two kites are now flown tandem, the upper one being a small kite about 4 feet high, which is easily got up, and which, when it has reached an altitude of about 100 feet, where the wind is always considerably stronger than at the earth's surface, is used to lift up the larger main kite (7 feet high) which bears the string (latterly wire) to which the instruments are fastened. It also helps to keep the latter steady when up, and prevent any sudden and dangerous descent of kites and instruments. The larger kite is now made of tussore silk of the diamond pattern and capable of folding up like Archer's patent portable kites. The tail, which is in reality a most important adjunct, and usually the first part of the apparatus to give way, is made of six large wire-rimmed canvas cones fastened to a swivel which allows them to revolve without twisting their cord.

In the first experiments the main kite was flown with a strong flax cord, but latterly, at a suggestion by Sir William Thomson, piano-cord steel wire has been used similar to that employed in Sir William's deep-sea sounder. This I have found a great improvement on the string. It is double the strength, one-fourth the weight, one-tenth the section, and one-half the cost, the only drawback being that, unless great care be exercised, it is very liable to kink and rust. To obviate the latter I have got my supply for the coming year electroplated.

It is also necessary to have wire all through, otherwise a disagreeable discharge of electricity is apt to take place at the junction of the wire and string in ordinary weather, a fact to which some of my friends would be able to testify. When the wire is continuous, and in contact with the iron of the winder which is riveted to the ground, I have found no perceptible shock in ordinary weather. The winder was made for me by Messrs. Elliott Bros., and though by no means perfect, is capable of being riveted to the earth so as to hold the kite in a powerful wind, and being furnished with a ratchet and spring catch, can be locked so as to allow me to attend to the anemometers, take observations with the theodolite, &c.

The anemometers are of the ordinary Biram pattern, 6 inches in diameter, and suspended to a gun-metal rod so as to swing in the vertical plane of the wire, the rod being fastened to the wire by clamps at its ends. When the large kite is about 100 feet or so from the winder, and steady, an anemometer is fastened to the nearest 100-foot mark and its indication and the time noted. The wire is then payed out a certain distance, and another anemometer attached, and so on, the interval between the lowest instrument and the winder being regulated by whether the differences of velocity are required for a comparatively high or low altitude respectively. The altitudes are measured by taking the vertical angles of the instruments every ten minutes with a theodolite placed at the winder, and combining their average value for the whole period with the lengths up to each instrument. The method employed is necessarily approximate, as I cannot leave the winder very well and take simultaneous observations at the ends of a base line. It is, however, one which I have reason to believe to be very fairly accurate. A certain allowance for curvature is made up to the lowest instrument. The arc between the two instruments is then taken to be approximately equal to its chord, and from this and the vertical angles the chord to the highest instrument is calculated, and thence its vertical height. This method

[1] Paper read at the Montreal meeting of the British Association by Prof. E. Douglas Archibald.

has occasionally been checked by observations taken at the ends of a base of 891 feet, and with such satisfactory results, that in the present case, where the observations being relative, great accuracy in measuring the absolute heights is not required, I have decided to adopt it in preference to the latter infinitely more cumbrous method.

Numerous observations have been made without success, accidents of all kinds happening both to kites and instruments, sufficient to deter any one who was not imbued with a little faith that all would eventually come right. I have therefore only been able so far to collect the results of a select few, viz. 23 in all, in which the conditions were favourable.

Hitherto I have only used kites as a *point d'appui* for observations on the differential velocity of the air at different heights, a purpose for which they are obviously exceptionally fitted. I am hoping, however, during the coming year, with new and improved apparatus and assistance, for which I have received a Government grant, to employ the same means of elevation for observations of temperature, pressure, height of cloud-strata, &c.

Anemometer Observations on Kite-Wire

Date and time of day	Instrument	Height in feet H	Velocity in feet per minute V	Time in minutes T	True direction of wind D
1883					
Sept. 8	B	278	1561	98	N. 22° W.
4.53 p.m.	A	77	989	82	
Sept. 10	A	257	1542	106	S. 8° E.
12.25 p.m.	B	160	1352	85	
Oct. 6	B	425	1177	121	N. 7° E.
3.59 p.m.	A	178	833	109	
Oct. 20	B	380	1163	75	N. 85° W.
.29 p.m.	A	146	882	59	
Oct. 20	A	217	1209	34	N. 85° W.
5.12 p.m.	B	98	864	25	
Oct. 24	B	230	1907	25	S. 82° W.
4.12 p.m.	A	110	1248	19	
Nov. 10	A	383	1771	130	N. 48° W.
12.31 p.m.	B	138	1499	109	
Nov. 10	B	405	1791	114	N. 75° W.
3.1 p.m.	A	148	1539	102	
1884					
Feb. 16	A	232	2079	26	S. 38° E.
4.42 p.m.	B	107	1638	20	
Feb. 23	B	430	2534	90	S. 37° W.
4.31 p.m.	A	294	2441	85	
Feb. 27	A	130	1147	56	S. 53° E.
5.26 p.m.	B	40	746	45	
March 8	B	270	1392	73	S. 49° W.
5.13 p.m.	A	88	1012	37	
March 15	B	268	1632	103	S. 48° E.
4.50 p.m.	A	79	1119	89	
March 19	A	433	1518	62	S. 52° W.
4.44 p.m.	B	215	1234	53	
March 20	B	344	2384	79	S. 87° W.
3 14 p.m.	A	167	2016	66	
April 2	A	446	1639	78	S. 23° E.
5.49 p.m.	B	212	1165	68	
April 4	B	430	2202	101	S. 44° E.
3.34 p.m.	A	228	1916	79	
May 14	D	422	2038	112	S. 38° W.
3.13 p.m.	C	292	1936	99	
	B	185	1904	90	
May 26	B	495	1994	69	N. 77° E.
2.58 p.m.	D	207	1879	59	
May 29	D	646	1769	98	S. 64° E.
3.44 p.m.	B	310	1048	90	
May 30	B	631	2102	97	N. 37° E.
3.38 p.m.	D	329	2025	88	
May 30	D	643	2039	87	N. 35° E.
5 p.m.	B	334	1987	78	
June 14	A	618	2040	52	N. 1° E.
11.5 a.m.	C	324	1950	38	

The height of the place of observation is 500 feet above sea-level.

Of course it is not intended at this early stage to attempt to draw any but the most temporary conclusions from such sparse data. There is no doubt that if observations could be taken every hour a distinct diurnal variation in the difference between the velocity at two given heights would be observed, the velocity at the greater altitude probably tending towards a minimum about the same time that the velocity at the earth's surface reached its maximum. This would, however, only be found to be the case when the heights were about 1000 feet or more. Apart from actual determination by help of the instruments, however, the existence of such a diurnal variation has been several times forcibly brought to my notice by the fact that while during the middle of the day the kite frequently flies with great difficulty owing to the presence of vertical ascending and descending currents; towards evening, when the wind at the surface has often died away altogether, the kite flies at a higher altitude and pulls harder and steadier than it did during the day. This has so often occurred that I have ceased noting it as anything extraordinary. I may observe that such a condition is precisely what one would expect if the theory of the diurnal variation in the velocity of the surface wind given by Dr. Köppen in the *Zeitschrift der Oesterreichischen Gesellschaft für Meteorologie* for 1879, be accepted. According to this theory the expansion of the lower strata by solar action during the day, causes an intermixture of the air (*luft austausch*) to take place between the upper and lower layers, by which the velocity of the lower layers is increased by the greater velocity which the descending air brings with it from above, while the upper layers have their velocity decreased by the smaller velocity with which the ascending lower air retarded by the asperities of the earth's surface, is endowed. Thus while the mean velocity of the atmosphere might remain about the same, the differences between the velocities above and below should undergo a diurnal period, the minimum difference occurring somewhat after midday. I was glad to see the other day that some observations on the velocity of the wind at some lofty observatory (I think Pike's Peak) showed that the diurnal period in the wind velocity at 8000 or 9000 feet, in exact opposition to what occurs at the earth's surface, exhibited a *minimum* about midday.[1]

Another feature that has been brought out by observing the flight of my kites, which frequently fly at heights of from 1300 to 1500 feet above the sea and thus enter the clouds, is the existence of a *courant ascendant* under cumulus and cumulo-stratus clouds. When such a cloud comes over, the kite rises up until the string is at an angle of 60° or more; but in proportion as it rises, so its pull becomes weak; the kite in fact lies on its face, and thus losing nearly all the horizontal component, the curvature of the string increases very much, and if an instrument is attached to it, it is sure to come down. After such a cloud has passed I have frequently noticed the apparent existence of a downward current which causes the kite to descend and at the same time increase its pull by the pressure being exerted more against a vertical surface.

Regarding the observations themselves, I am not aware that any similar ones have previously been made, except by Mr. Stevenson of Scotland. His plan was to fix anemometers to a pole 50 feet high or place them at different heights up a mountain. In the latter case it is not certain that the velocities represent what would occur in the free atmosphere at the same level. In the former, one is limited to poles of moderate height, and I do not at present see that anything else can compete with a kite-wire for greater heights; balloons, captive or otherwise, being of course out of the question where wind is concerned. Mr. Stevenson seems finally to have adopted a very simple formula for the increase of the velocity with the height, viz. that it is exactly proportional, or $\frac{V}{v} = \frac{H}{h}$. That though this might be true up to 50 feet it is certainly not true for greater heights I showed pretty conclusively in NATURE for March 29, 1883 (p. 506), where a discussion of Dr. Vettin's cloud observations favoured the formula $\frac{V}{v} = \left(\frac{H}{h}\right)^{\frac{1}{4}}$ through a range of more than 20,000 feet.

Though I do not wish to try and determine any formula at this preliminary stage, it may be interesting to note the exponent

[1] This seems also to be the case on Ben Nevis, regarding which Mr. Buchan says, "In each of the months the maximum velocity is during the *night*, and the minimum during the *day*, being thus the reverse of what occurs at low levels and on plains" (*vide Journal* of the Scottish Meteorological Society, 3rd series, No. 1, p. 17).

yielded by the observations I have made, when grouped together roughly according to altitude. The results are :—

No. of obs.	Mean upper height	Mean lower height	Mean upper velocity	Mean lower velocity	Approximate value of exponent in formula
6	249	93	1630	1145	$\frac{1}{4}$
8	412	173	1751	1474	$\frac{1}{5}$
4	634	324	1987	1902	$\frac{1}{16}$

Thus, while the velocity invariably increases as we ascend, the rate rapidly diminishes after the first 200 or 300 feet. It must, however, be remembered that the place of observation is itself 500 feet above sea-level, and though this would probably not affect the results near the surface, the air above 200 feet must be moving with very nearly the same velocity as it would have at its real elevation above a sea-level surface. Adding therefore the 500 feet to both heights in the case of the two last groups, we get, for the value of x, $\frac{1}{4}$ and $\frac{1}{5}$ instead of $\frac{1}{5}$ and $\frac{1}{16}$. These two values are probably nearer the truth than those in the table, and hover round the mean value $\frac{1}{4}$, which I have already stated was found to hold for Vettin's cloud velocities up to 25,000 feet. In any case it is plain that Mr. Stevenson's formula cannot be taken to hold beyond his 50-foot pole.

Further observations will, I trust, give a trustworthy basis for determining the variations in the velocity-increment corresponding to the direction and absolute velocity of the wind as well as those corresponding to season, humidity, temperature, and pressure. To thoroughly investigate the velocity-increment under all such conditions, and thus to afford data to the physicist who desires to construct the hitherto unwritten science of aërodynamics, will be one of the objects of my experiments during the coming year.

P.S. *October* 22.—Since the foregoing observations were made I have succeeded in getting readings with the anemometers at heights of over 1100 feet above the ground, or 1600 feet above sea-level.

THE CLASSIFICATION AND AFFINITIES OF DINOSAURIAN REPTILES[1]

IN this paper the author presented briefly the results of a study of Dinosaurian reptiles on which he had been engaged for several years. The complete results will be published in a series of monographs now in preparation. The material on which the investigation is mainly based consists of the remains of several hundred individuals of this group collected in the Rocky Mountains by the author, and now preserved in the museum of Yale College. Other important American specimens have been examined by the author, who has also studied with care the more important specimens of this group in the museums of Europe. The investigation is not yet completed, but the results already attained seem to be of sufficient interest to present to the Association at this time.

In previous publications on this subject the author had expressed the opinion that the *Dinosauria* should be regarded, not as an order, but as a sub-class, and his later researches confirm this view. The great number of subordinate divisions in the group, and the remarkable diversity among those already discovered, indicate that many new forms will yet be found. Among those already known there is a much greater difference in size and structure than in any other sub-class of vertebrates, with the exception of the placental mammals. Compared with the Marsupials, living and extinct, the *Dinosauria* show an equal diversity of structure and size.

According to present evidence, the Dinosaurs were confined entirely to the Mesozoic Age. They were abundant in the Jurassic, and continued in diminishing numbers to the end of the Cretaceous period, when they became extinct. The great variety of forms that flourished in the Triassic renders it more than probable that some members of the group existed in the Permian period, and their remains may be brought to light at any time. The Triassic Dinosaurs, although very numerous, are known to-day mainly from footprints and fragmentary osseous remains; hence, many of the forms described cannot at present be referred to their appropriate divisions in the group. From the Jurassic, however, during which period Dinosaurian reptiles reached their zenith in size and numbers, representatives of no less than four well-marked orders are now so well known that different families and genera can be very accurately determined, and almost the entire osseous structure of typical examples, at least, can be made out with certainty. Comparatively little is yet known of Cretaceous Dinosaurs, although many have been described from incomplete specimens. All these appear to have been of large size, but much inferior in this respect to the gigantic forms of the previous period. The remains best preserved show that, before extinction, some members of the group became quite highly specialised.

Regarding the Dinosaurs as a sub-class of the REPTILIA, the forms best known at present may be classified as follows:—

SUB-CLASS DINOSAURIA.—Premaxillary bones separate; upper and lower temporal arches; rami of lower jaw united in front by cartilage only; no teeth on palate. Neural arches of vertebræ united to centra by suture; sacral vertebræ co-ossified. Cervical and thoracic ribs double-headed. Ilium prolonged in front of acetabulum; acetabulum formed in part by pubis; ischia meet distally on median line. Fore and hind limbs present, the latter ambulatory and larger than those in front; head of femur at right angles to condyles; tibia with procnemial crest; fibula complete. First row of tarsals composed of astragalus and calcaneum only, which together form the upper portion of ankle joint.

(I.) Order SAUROPODA (LIZARD-FOOT).—Herbivorous. Premaxillary bones with teeth. Large antorbital opening. Anterior nares at apex of skull. Post-occipital bones. Anterior vertebræ opisthocœlian; cervical ribs co-ossified with vertebræ; pre-sacral vertebræ hollow; each sacral vertebra supports its own transverse process. Fore and hind limbs nearly equal; limb bones solid. Feet plantigrade, ungulate; five digits in manus and pes; second row of carpal and tarsal bones unossified. Sternal bones parial. Pubes projecting in front, and united distally by cartilage; no post-pubis.

(1) Family *Atlantosauridæ*.—A pituitary canal. Ischia directed downward, with expanded extremities meeting on median line. Sacrum hollow. Anterior caudals with lateral cavities. Genera: Atlantosaurus, Apatosaurus, Brontosaurus.

(2) Family *Diplodocidæ*.—Dentition weak. Brain inclined backward. Large pituitary fossa. Two antorbital openings. Ischia with straight shaft, not expanded distally, directed downward and backward, with ends meeting on median line. Caudals deeply excavated below. Chevrons with both anterior and posterior branches. Genus: Diplodocus.

(3) Family *Morosauridæ*.—Small pituitary fossa. Ischia slender, with twisted shaft, directed backward, and sides meeting on median line. Anterior caudals solid. Sacral vertebræ solid. Genus: Morosaurus. European forms of this order: Bothriospondylus, Ceteosaurus, Eucamerotus, Ornithopsis, Pelorosaurus.

(II.) Order STEGOSAURIA (PLATED LIZARD).—Herbivorous. Feet plantigrade, ungulate; five digits in manus and pes; second row of carpals unossified. Pubes projecting free in front; post-pubis present. Fore limbs small; locomotion mainly on hind limbs. Cervical ribs free. Vertebræ and limb bones solid. Osseous dermal armour.

(1) Family *Stegosauridæ*.—Vertebræ bi-concave. Neural canal in sacrum expanded into large chamber; ischia directed backward, with sides meeting on median line. Astragalus co-ossified with tibia; metapodials very short. Genera: Stegosaurus (Hypsirhophus), Diracodon; and in Europe, Omosaurus (Owen).

2. Family *Scelidosauridæ*.—Astragalus not co-ossified with tibia; metatarsals elongated; four functional digits in pes. Known forms all European. Genera: Scelidosaurus, Acanthopholis, Cratæomus, Hylæosaurus, Polacanthus.

(III.) Order ORNITHOPODA (BIRD-FOOT).—Herbivorous. Feet digitigrade, five functional digits in manus and three in pes. Pubes projecting free in front; post-pubis present. Vertebræ solid. Cervical ribs free. Fore limbs small; limb bones hollow. Premaxillaries edentulous in front. A premandibular bone.

(1) Family *Camptonotidæ*.—Clavicles wanting; post-pubis complete. Genera: Camptonotus, Laosaurus, Nanosaurus; and in Europe, Hypsilophodon.

(2) Family *Iguanodontidæ*.—Post-pubis incomplete. Premaxillaries edentulous. Known forms all European. Genera: Iguanodon, Vectisaurus.

[1] Paper read at the Montreal Meeting of the British Association, by Prof. O. C. Marsh.

(3) Family *Hadrosauridæ*.—Teeth in several rows, forming with use a tesselated grinding surface. Anterior vertebræ opisthocœlian. Genera: Hadrosaurus (Diconius ?), Agathaumas, Cionodon.

(IV.) Order THEROPODA (BEAST-FOOT).—Carnivorous. Premaxillary bones with teeth. Anterior nares at end of skull. Large antorbital opening. Vertebræ more or less hollow. Feet digitigrade; digits with prehensile claws. Pubes projecting downward, with distal ends co-ossified.

(1) Family *Megalosauridæ*.—Anterior vertebræ convexo-concave; remaining vertebræ bi-concave. Pubes slender. Astragalus with ascending process. Genera: Megalosaurus (Poikilopleuron), Allosaurus, Cœlosaurus, Creosaurus, Dryptosaurus (Laelaps).

(2) Family *Labrosauridæ*.—Lower jaws edentulous in front. Cervical and dorsal vertebræ convexo-concave. Pubes slender, with anterior margins united. Astragalus with ascending process. Genus: Labrosaurus.

(3) Family *Zanclodontidæ*.—Vertebræ bi-concave. Pubes broad elongate plates, with anterior margins united. Astragalus without ascending process. Five digits in manus and pes. Genera: Zanclodon (?), Teratosaurus.

(4) Family *Amphisauridæ*.—Vertebræ bi-concave. Pubes rod-like. Five digits in manus, and three in pes. Genera: Amphisaurus (Megadactylus ?), Bathygnathus (?), Clepsysaurus, Palæosaurus, Thecodontosaurus.

(*a*) Sub-order CŒLURIA.—(5) Family *Cœluridæ*.—Vertebræ and bones of skeleton pneumatic. Anterior cervicals convexo-concave; remaining vertebræ bi-concave. Cervical ribs co-ossified with vertebræ. Metatarsals very long and slender. Genus: Cœlurus.

(*b*) Sub-order COMPSOGNATHA.—(6) Family *Compsognathidæ*.—Cervical vertebræ convexo-concave; remaining vertebræ bi-concave. Three functional digits in manus and pes. Ischia with long symphisis on median line. Genus: Compsognathus.

(*c*) Sub-order CERASTOSAURIA.—(7) Family *Ceratosauridæ*.—Horn on skull. Cervical vertebræ plano-concave; remaining vertebræ bi-concave. Pubes slender. Pelvic bones co-ossified. Osseous dermal plates. Astragalus with ascending process. Metatarsals co-ossified. Genus: Ceratosaurus.

The four orders defined above, which the author first established for the reception of the American Jurassic Dinosaurs, appear to be all natural groups, well marked in general from each other. The European Dinosaurs from deposits of corresponding age fall readily into the same divisions, and, in some cases, admirably supplement the series indicated by the American forms. The more important remains from other formations in this country and in Europe, so far as their characters have been made out, may likewise be referred with certainty to the same orders.

The three orders of herbivorous Dinosaurs, although widely different in their typical forms, show indications of approximation in some of their aberrant genera. The *Sauropoda* for example, with *Atlantosaurus* and *Brontosaurus*, of gigantic size, for their most characteristic members, have in *Morosaurus* a branch leading towards the *Stegosauria*. The latter order, likewise, although its type genus represents in many respects the most strongly marked division of the Dinosaurs, has in *Scelidosaurus* a form with some features pointing strongly toward the *Ornithopoda*.

The carnivorous *Dinosauria* now best known may all be placed at present in a single order, and this is widely separated from those that include the herbivorous forms. The three sub-orders here defined include very aberrant forms, which show many points of resemblance to Mesozoic birds. Among the more fragmentary remains belonging to this order, this resemblance appears to be carried much farther.

The *Amphisauridæ* and the *Zanclodontidæ*, the most generalised families of the *Dinosauria*, are known only from the Trias. The typical genera, however, of all the orders and sub-orders, are Jurassic forms, and on these especially the present classification is based. The *Hadrosauridæ* are the only family confined to the Cretaceous. Above this formation there appears to be at present no satisfactory evidence of any *Dinosauria*.

The peculiar orders *Hallopoda* and *Aetosauria* include carnivorous reptiles which are allied to the *Dinosauria*, but they differ from that group in some of its most characteristic features. In both *Aetosaurus* and *Hallopus* the calcaneum is much produced backwards. In the former genus the entire limbs are crocodilian, and this is also true of the dermal covering. In both of these genera there are but two sacral vertebræ, but this may be the case in true Dinosaurs, especially from the Trias. Future discoveries will probably bring to light intermediate forms between these orders and the typical Dinosaurs. The *Crocodilia* have some some strong affinities with the *Dinosauria*, especially with those of the order *Sauropoda*. The extinct genus *Belodon* of the Triassic, for example, resembles *Diplodocus*, particularly in the large antorbital vacuities of the skull, the posterior position of the external nasal aperture, as well as in other features. The *Rhynchocephala*, represented by the genus *Hatteria*, have several important characters in common with the *Dinosauria*, and, as the former is evidently an ancient type, it is probable that a real affinity may exist between these two groups.

That birds are closely related to Dinosaurs there is no longer any question. In addition to the various characters which these groups have been known to share with each other, two more may be added in consequence of discoveries made during the past year. The genus *Ceratosaurus*, a carnivorous Dinosaur from the Jurassic of the Rocky Mountains, recently described by the author, has the pelvic bones co-ossified, as in all known birds, living and extinct, except *Archæopteryx*. The same reptile, moreover, has the metatarsal bones firmly united, as in all adult birds, with possibly the single exception of *Archæopteryx*, while all the known *Dinosauria*, except *Ceratosaurus*, have both the pelvic and the metatarsal bones separate. The exception in each case brings birds and reptiles near together at this point, and their close affinity is now a matter of demonstration.

THE DANISH EXPEDITION IN GREENLAND

WE have on previous occasions referred to the Expedition under Lieuts. Holm and Garde, which has for more than a year been engaged in exploring the east coast of Greenland, and we are now able to supplement this with an interesting report from Lieut. Holm, written in the spring, from the winter quarters of the Expedition, and received some time ago by sailing-vessel at Copenhagen.

The place where the Expedition wintered is called Namortalik, and lies on the east coast, about fifty miles, as the crow flies, from Cape Farewell. It is also called Björneorten (the "bear-haunt"), from the many bears in the neighbourhood. After an excursion lasting two months and a half during the summer of 1883, the Expedition returned in September to Namortalik, but the huts for wintering not being finished, they started for a week's further excursion to the Fredriksdalsfjord, between Namortalik and Cape Farewell.

It was not until the end of October that the Expedition could begin their regular scientific observations at the station, but after that date they were continued without interruption through the winter. As, however, the chief object of the Expedition was to explore the east coast in boats, the scientific observations have not been so rich as those, for instance, of the Danish International Expedition at Godthaab in 1882-83 (NATURE, vol. xxix. p. 337); but every effort was made to adhere as strictly as possible to the programme of the International Polar Commission. The meteorological observations were made every third hour from 8 p.m. to 8 a.m., and the magnetic observations every hour except at 3 and 4 a.m. On the 1st and 5th of every month the magnetic instruments were read every fifth minute during eight hours and every twentieth second during one hour.

With reference to the climatological conditions of the east coast, we learn that the winter is very raw and severe, although it cannot be said to be of excessive duration. The pleasant, calm, frosty weather which is experienced in North Greenland seldom prevails on the east coast, but in its stead there are frequent and sudden changes and violent storms; there being, for instance, one day 20° C. of frost, and the next several degrees of heat, while heavy rains and snows alternate. In consequence of these sudden changes it is impossible in East Greenland to employ the mode of locomotion so valuable in other parts, viz. the dog-sledge. The only means of conveyance here is by boat. If, therefore, the sea is frozen over for a time, the inhabitants remain where they are, and wait patiently until a higher temperature removes the obstacle. The ice never becomes firm enough to bear a man and sledge.

Up to January last the temperature had not fallen lower than 15°·5 C.—about Christmas—the glass generally standing between

4° and 6°, and even on some days not lower than zero (= 32° F.). This was particularly the case whilst the north-east "Föhn" wind prevailed, to which East Greenland is indebted for its comparatively mild winters; but there are places where the ice lies firm throughout the winter. On December 5, during a "Föhn" wind, the thermometer rose to + 10° C. After the beginning of the new year, however, the cold became more severe, and the "Föhn" winds less frequent.

Towards the end of January and in February the thermometer sometimes registered 20° C. of frost, and on March 9 it fell to − 21°·5, the lowest temperature registered during the winter.

Some interesting particulars are also given of the almost unknown district in which the Expedition wintered. The station Namortalik is described as situated on an island, and as having a population of 250 souls. The island, which bears the same name, is surrounded by several others, which, lying further out to sea, are visited during the spring by the natives, who catch seals and eider-ducks there. To the north the scenery of Greenland is seen in all its grandeur and beauty; wild mountains with lofty cones rising above the clouds. These are on the beautiful but almost unapproachable island of Sermersk. If the air be clear, and the weather calm and sunny, the little island lies so peacefully in the ocean that one feels tempted to climb the lofty mountains; but when the storm hovers around the peaks, half hidden in drifting clouds, and the Polar Sea is a mass of foam, the giant forms of the mountains deter even the boldest. The mainland is rugged, like the island just mentioned; in fact, the whole southern portion of Greenland is a region of wild mountains, furrowed by tremendous ravines, and rising to a height of nearly 8000 feet, from which enormous glaciers descend to the sea. The landscape produces by its wildness and desolation very striking impressions.

There are thirty little turf-covered houses at Namortalik, including a bakery and a brewery. The so-called "Royal Commerce of Greenland," a Danish Company, has also a depot here. There is, besides, a Lutheran mission, a church, and a school attended by half-caste Greenlanders.

The Expedition has erected two observatories on the rocks, about 1000 feet from the dwelling-houses, but connected by telephone.

Close to Namortalik is the Tasermint Fjord, some fifty miles in length, one of the loveliest in South Greenland. On its shores the vegetation is very luxuriant in summer, and the heat and mosquitoes are so troublesome that one could imagine one's self in the tropics. This fjord is of great importance to the Namortalik people, as its shores provide them with fuel, its streams and waters with salmon, seals, and herrings, and its mountain-slopes with ptarmigans, Polar hares, and foxes.

When the summer commenced, the Expedition intended to leave their quarters, and continue the exploration of the east coast; but there is at present no news of their achievements this summer. The programme is, however, to explore the east coast by sea and land as far north as possible, and to get into communication with the natives whenever opportunity offers, in which latter attempt nearly all previous Expeditions have been disappointed.

At the beginning of this winter one half of the Expedition was to return to Namortalik, while the second endeavoured to spend the winter as far north as possible. The Expedition will leave Greenland in the autumn of next year.

SCIENTIFIC SERIALS

Journal of Botany, August to November.—The most important article in the recent numbers of this magazine is Mr. Charles Bailey's paper on the structure, &c., of *Naias graminea*, Delile, var. *Delilei*, Magnus, illustrated with four plates and many woodcuts. This interesting addition to the British flora—first found in 1883 in a canal in Lancashire—is a native of warmer climates, not being indigenous anywhere in Europe, and has probably been introduced with Egyptian cotton. Mr. Bailey gives an exhaustive account of the morphology of its various organs, and especially of its mode of fertilisation. The *Naias* belongs to a class of plants that may be called "protozoophilous," the pollen being carried to the stigma by aquatic animals of low organisation, in this instance by the currents caused by the rotating cilia of species of Vorticellidæ.—Most of the other articles in these numbers are of more limited interest, being topographical papers on the flowering plants or cryptogams of particular districts, or descriptions of new or little-known species.—Additional instalments are also given of Mr. J. G. Baker's synopsis of the genus *Selaginella*, which is still uncompleted, the species now described amounting to 180.

Nuovo Giornale Botanico Italiano, July to October.—The greater part of the space in the July number of this magazine is occupied by descriptive papers. The paper of most general interest is that by A. Piccone, on the algæ of the Red Sea. He shows that the algal flora of this sea shows much closer affinities to that of the Indian Ocean than of the Mediterranean. It is characterised by the small number of diatoms and of green algæ generally, by the entire absence of Laminarieæ, and, above all, by its extraordinary richness in species of *Sargassum*, many of them endemic.—In the October number are a synopsis of the flora of Sicily, and a list of the "pronubi" or insect-fertilisers of flowering plants in Calabria and Piedmont; also a note by R. Pirotta, showing, from an examination of the oospores, the identity of *Cystopus capparidis*, parasitic on the caper, with *Cystopus candidus*, the common parasite of cruciferous plants.

SOCIETIES AND ACADEMIES

LONDON

Linnean Society, November 6.—Sir J. Lubbock, Bart., President, in the chair.—A letter was read intimating that their late President, Mr. G. Bentham, had bequeathed in his will a legacy of 1000*l.* to the Society.—A notice of invitation for the Fellows to attend the centenary (December 4) of the Royal Bohemian Society of Natural History in Prague was also read from the chair.—Mr. W. T. Thiselton Dyer exhibited the following plants and their products:—(1) *Vaccinium arctostaphylus*, from which the Trebizonde tea ("Thé-du-Bu-Dagh") is prepared at Amassia and Tokat. The tea has a pleasant odour, but a somewhat harsh taste when drunk. (2) *Pueraria Thunbergiana*, specimens of this Corean plant and of the cloth made from it. (3) *Pachyrhyza sinensis*, with the native name of "Kopoo," a leguminous plant from the fibres of which the yellow and more expensive summer cloth is made.—Mr. Thos. Christy showed and made remarks on a specimen of *Kola acuminata*.—Mr. R. A. Rolfe afterwards exhibited examples of British oak-galls produced by Cynipidean insects of the genus *Neuroterus*. These were the silk-button gall formed by *N. numismatis*, the globose gall produced by *N. ostreus*, the smooth-spangle gall formed by *N. fumipennis*, the scarce-spangle gall formed by *N. laeviusculus*, and the common spangle gall produced by *N. lenticularis*, as also a purple variety of the latter gall. He stated that the plan and details of the galls depend on the nature of the irritating fluid deposited by the insect; but on the other hand the different species of oak seem to have an influence in determining certain variations as to colour, and, it may be, general growth, of the galls.—Mr. Geo. Brook read a paper on the development of the Five-bearded Rockling (*Motella mustela*) in which the following points were enunciated:—(1) Whereas there is only one large oil globule in the normal egg of *Motella*, sometimes this is subdivided into from two to eight or even more; but in these cases there is always an abnormal development which often results in the death of the embryo. In those that survive, the small oil globules always coalesce to form one large one before the embryo hatches. (2) In the further development of the newly-hatched embryo there is a cranial flexure produced which is analogous to that so characteristic of Elasmobranchs. This is caused by the rapid development of the dorsal portion of the head, while the ventral portion remains comparatively quiescent. Later, the ventral portion plays its part, and, with the development of the jaws the brain is pushed back to its normal position. (3) As in other pelagic Teleostean eggs there is no circulation observable either in the embryo or in the vitellus up to the time of hatching, nor indeed for some days afterwards. (4) In *Motella* the anal gut does not open on the ventral surface for at least a week after hatching. Ryder has shown the same to be the case with the cod-fish, so that the young *Gadida* would not appear to be in a position to take solid food at nearly so early a period in their existence as is usual with Teleosteans. Mr. Brook also called attention to the influence of temperature on the rate of development of pelagic eggs, and suggested that, until we know the temperature at which the various observations are made on these forms, no true comparison can be established.—The next communication was on a collection of

plants made in Timor Laut by Henry O. Forbes. Therein a short account is given of the nature of the islands and of the general character of the vegetation, after which comes a technical list of about eighty plants.—Prof. Oliver adds a note that, "This collection, so far as it goes, is made up in great part of the more widely diffused species of the Indian Archipelago. The most interesting plants appear to be: one in fruit only, referred to the meliaceous genus *Owenia*, probably *O. cerasifera*, Muell., of Queensland; a fine *Mucuna*, of the section Stigolobium; a *Schefflera*, an araliaceous genus hitherto only received from New Caledonia, and a fruit of possibly a *Sterculia*. Mr. Forbes himself is inclined to regard the Timor Laut flora and fauna as having affinities with the Moluccan (Amboina) region.—A paper by T. H. Potts was read, containing notes on some New Zealand birds. This consisted chiefly of field observations on the habits of the quail hawk, harrier, owl, kaka, kea, long-tailed cuckoo, kingfisher, and native wren.—There followed a note on the reproduction of the heterœcismal Uredines by Charles B. Plowright. Therein the author affirms that, when the reproduction of these fungi takes place without the intervention of Ascidiospores, the resulting Uredospores are far more abundant than in the case when they arise from the implantation upon the host plant of the Ascidiospores, this inference being supported by various detailed observations of the author.

Zoological Society, November 4.—Prof. W. H. Flower, F.R.S., President, in the chair.—Mr. Sclater exhibited and made remarks on the skin of a Woolly Cheetah (*Felis lanea*), obtained at Beaufort West, South Africa, sent to him by the Rev. G. H. R. Fisk, C.M.Z.S.—The Secretary exhibited, on behalf of Major W. Brydon, B.S.C., C.M.Z.S., an egg of Blyth's Tragopon; and on behalf of Mr. J. C. Parr, F.Z.S., a specimen of the chick of the Vulturine Guinea-fowl (*Numida vulturina*) hatched in Lancashire.—The Rev. H. H. Sclater, F.Z.S., exhibited a specimen of the Barred Warbler (*Sylvia nisoria*) obtained on the Yorkshire coast.—Mr. H. E. Dresser, F.Z.S., exhibited specimens of the Barred Warbler (*Sylvia nisoria*) and of the Icterine Warbler (*Hypolais icterina*), killed in Norfolk.—Mr W. B. Tegetmeier, F.Z.S., exhibited a specimen of the File-fish (*Balistes capriscus*), which had been recently caught off Folkestone.—Mr. F. E. Beddard, F.Z.S., read a paper on the anatomy of a gigantic Earthworm, *Microchæta rappii*, and pointed out its systematic position. For this very interesting specimen the author was indebted to the Rev. G. H. R. Fisk, C.M.Z.S., of Cape Town.—Mr. A. G. Butler, F.Z.S., gave an account of a collection of Lepidoptera made by Major J. W. Yerbury at or near Aden. The author looked upon this collection as one of the greatest interest, since it not only contained a fine series of the beautiful species of *Teracolus* recently described by Col. Swinhoe, but also many remarkable intergrades between certain long-established species, tending to prove either that hybrids between allied species are fertile, or that in Aden a condition of things still exists which in Asia proper and in Africa has long passed away.—A communication was read from Lieut.-Col. C. Swinhoe, F.Z.S., containing an account of the Lepidoptera collected by him at Kurrachee between the years 1878 and 1880.—A communication was read from Mr. Thomas H. Potts, of Ohinitaki, New Zealand, in which he described a case of hybridism between two species of Fly-catchers of the genus *Rhipidura*.

Mathematical Society, November 13.—Prof. Henrici, F.R.S., President, in the chair.—Prof. Karl Pearson was elected a member of the Society.—The Chairman in very feeling terms referred to the losses the Society and he himself personally had sustained by the deaths of Prof. Rowe, a member of the Council, and of Prof. Townsend, F.R.S., during the recess. After a slight pause, he presented the De Morgan Medal to Prof. Cayley.—The Treasurer's report, showing that the financial position of the Society was most satisfactory, and the Secretary's report having been read, the meeting balloted for and duly elected the following gentlemen to constitute the Council for the present session:—President: J. W. L. Glaisher, F.R.S.; Vice-Presidents: Dr. Henrici, F.R.S., Prof. Sylvester, F.R.S., J. J. Walker, F.R.S.; Treasurer: A. B. Kempe, F.R.S.; Secretaries: M. Jenkins, R. Tucker; other members: Prof. Cayley, F.R.S., Sir J. Cockle, F.R.S., E. B. Elliott, Prof. Greenhill, J. Hammond, H. Hart, Dr. Hirst, F.R.S., S. Roberts, F.R.S., and R. F. Scott.—Mr. Tucker then read abstracts of the following papers:—On the theory of screws in elliptic space (supplementary note), and on the theory of matrices, by A. Buchheim; on sphero-cyclides, by H. M. Jeffery, F.R.S.; results from a theory of transformation of elliptic functions, by J. Griffiths; on the limits of multiple integrals, by H. MacColl; on the motion of a viscous fluid contained in a spherical vessel, by Prof. H. Lamb, F.R.S.; on certain conics connected with a plane unicursal quartic, by R. A. Roberts; note on elliptic functions, on an integral transformation and a theorem in plane conics, by Asutosh Mukhopâdhyây. He then stated that he had found that the six Simson-lines corresponding to the angular points of the pedal and medial triangles of a given triangle with reference to the medial and pedal triangles respectively, the circum-circle being in this case the nine-point circle, co-intersect in a point which lies on the axis connecting the circum-centre and the Symmedian-point, midway between the circum-centre and the ortho-centre of the pedal triangle, and is also the centre of Mr. H. M. Taylor's circle.—The President (Prof. Henrici taking the chair) brought the meeting to a close by reading a paper on certain systems of q-series in elliptic functions, in which the exponents in the numerators and denominators are connected by recurring relations.

Geological Society, November 5.—Prof. T. G. Bonney, F.R.S., President, in the chair.—The Secretary announced the gift to the Society of a water-colour picture of the hot springs of Gardiner's River, Wyoming Territory, U.S.—The following communications were read:—On a new deposit of Pliocene age at St. Erth, fifteen miles east of the Land's End, Cornwall, by S. V. Wood, F.G.S. The deposit in question, about five miles north-east of Penzance, consisted of a tenacious blue clay with shells, resting on sand, and passing upwards into a yellow unfossiliferous clay, overlain unconformably by the earth with angular fragments, under which were buried the ancient beaches of the British Channel. Of over forty species of Mollusca obtained by the author some appeared to be wholly new, others characteristic species of the Red Crag, some not known alive, some still living. Most interesting of all, six species of Nassa were, all but one (*N. granulata*, Sow., or *granifera*, Dujardin), unknown from any formation of Northern Europe, and occurring, living or fossil, only in the southern half of Europe. Of these *Nassa mutabilis*, Linné, lived in the Mediterranean, but otherwise not north of Cadiz, while two others were new species of this southern *mutabilis* group. In the opinion of the author the bed was Pliocene, and newer rather than older, coeval with the Red Crag, but having more affinities with the Pliocene of Italy than with that of the North Sea region, a fact which seemed to indicate that during its deposition the only communication between the Atlantic and the North Sea was round the coast of Britain, a passage unavailable to the Italian group of Nassa on account of the refrigeration of its 9° of latitude. The bed was the deposit of a strait connecting the present St. Ives Bay with Mount's Bay, and detaching the high ground of the Land's End district from the rest of Britain. The shell-bearing part of the clay was 98 feet above mean-tide mark in Hayle Estuary. Dr. Gwyn Jeffreys, in a discussion on the paper, recognised among the fossils of the St. Erth deposit forty-four or forty-five species, eleven or twelve recent, thirty three or thirty-four extinct. A bed near Antibes, in the south of France, seemed to resemble the St. Erth deposit, and the Mollusca of the two should be critically compared.—On the Cretaceous beds at Black Ven, near Lyme Regis, with some supplementary remarks on the Blackdown beds, by the Rev. W. Downes, F.G.S. The cliff section measured 300 feet in height, the Lias occupying 200 feet and the Cretaceous beds 100 feet, of which the lower 25 feet were a black loamy clay, and the upper 75 feet yellowish-brown non-calcareous sands. From one point in the clay the author obtained a few fossils, the most abundant being *Lima parallela*, and 50 feet above that point was a small patch of fragmentary silicified fossils. In the author's opinion the fauna of the sands approached the Blackdown fauna, and from all the evidence he had found, concluded that the conditions of deposition rendered it impossible to recognise in the Cretaceous beds of the West of England the subdivisions of Gault and Upper Green and so well marked to the eastward.—On some recent discoveries in the submerged Forest of Torbay, by D. Pigeon, F.G.S. The submerged forest rested on clay, the soil in which the forest grew, which, again, rested on Trias, a breccia of Devonian fragments intervening in places. During the gales of 1883-84, two aggregations of rolled trap pebbles were found, these pebbles having probably served as smelting-hearths. In their neighbour-

hood were discovered an ingot of copper, some tin slag, a piece of glass, flint implements, &c., together with remains of piles driven into the ground—traces of human work belonging, apparently, to the Bronze Age. The author thought it the more probable view that the clay bed was deposited in a shallow marsh of land-water kept back by the sea-beach, then some hundreds of feet further to seaward, and that the forest, which consisted chiefly of willows, grew on the marsh.

EDINBURGH

Mathematical Society, November 14.—Dr. Thomas Muir, F.R.S.E., President, in the chair.—Mr. John S. Mackay read a paper on the geometrical figure known to the Greeks as "The Shoemaker's Knife."—The following office-bearers were elected:—President: Mr. A. J. G. Barclay; Vice-President: Mr. George Thom; Secretary: Mr. A. Y. Fraser; Committee: Drs. R. M. Ferguson and Thomas Muir, Messrs. R. E. Allardice, W. J. Macdonald, John S. Mackay, and David Munn.

PARIS

Academy of Sciences, November 10.—M. Rolland, President, in the chair.—Additions to the memoir on complex unities, by M. L. Kronecker.—Remarks on the fourth part of the map of Africa, presented to the Academy, on behalf of the Minister for War, by Col. Perrier. This map has been prepared by Capt. de Lannoy, of the War Department, on a scale of 1:2,000,000. The present part comprises the whole of the Congo region, in six sheets, which have been issued for the use of the members of the International Congress now assembled in Berlin to discuss matters relative to West Africa.—Note on Messrs. Renard and Krebs' new balloon, by M. Hervé Mangon. Two ascents were again made on Saturday, November 8, which are described as completely successful. On the first occasion the machine was propelled at an absolute speed of 23 kilometres per hour against the wind blowing at the rate of 8 kilometres per hour. The problem of directing balloons independently of aërial currents is regarded by the author as practically solved by these experiments.—Observations, elements, and ephemerides of Wolf's comet, by M. Gonnessiat. The observations were made with the Brunner 6-inch equatorial of the Lyons Observatory.—Observation of the same comet made with the meridian circle of the Bordeaux Observatory, by M. Courty.—Note on the sinuosities and variations of curvature in the shadows cast during lunar eclipses, by M. P. Lamey.—On an equation analogous to Kummer's equation, by M. E. Goursat.—On algebraic curves of any degree described on a plane, by M. Maurice d'Ocagne.—On atomic and molecular movements, by M. M. Langlois.—On the depth to which sunlight penetrates the waters of the Lake of Geneva, by MM. H. Fol and Ed. Tarasin. From a series of experiments carried out in August and September of this year the authors conclude that light reaches a depth of 170 metres and probably a little more, the luminosity at this point being about equal to that of a clear moonless night.—On a general statement of the laws of chemical equilibrium, by M. H. Le Chatelier.—Note on the polymorphism of the phosphate of silica, by MM. P. Hautefeuille and J. Margottet. The authors infer from several experiments that at temperatures ranging from 300° to 1000° C. this phosphate crystallises spontaneously in four crystallographic forms incompatible with each other, and consequently constituting four distinct chemical species.—On fluoretted apatites, by M. A. Ditte.—On the action of the primary alcoholic iodides on the fulminate of silver, by M. G. Calmels.—Anaytical study of the atmosphere of the city of Algiers, by M. Chairy.—On the hydrate of neutral sulphate of alumina, by M. P. Marguerite-Delacharlonny.—Saponification of the simple aromatic ethers of neutral substances, by M. A. Colson.—The microbe of yellow fever: prophylactic inoculation, by MM. D. Freire and Rebourgeon. After a series of extensive experiments conducted at Rio de Janeiro during the years 1880-84, Dr. Domingos Freire has succeeded in attenuating the virus of yellow fever and reducing it to a vaccinal virus. With this, 400 persons have already been treated with complete success. But fresh experiments will be needed to determine the duration of immunity obtained by this perventive inoculation.—On the effects of inflation of the lungs with compressed air, by MM. Gréhant and Quinquaud.—Researches on the genesis of saccharine in beetroot, by M. Aimé Girard.—On peptonic fermentation, by M. V. Marcano. This new process is described as a simple and economic means of preparing in a few hours extremely pure peptone at a cheap rate. It is capable of being advantageously applied in a large way to the exportation of meat in a far more nutritive and economic form than that of the extracts of meat now in use.—Origin and mode of formation of the phosphates of lime found deposited in large quantities in sedimentary lands: their connection with the iron ores and clays of siderolithic levels, by M. Dieulefait.—Contributions to the anatomy and morphology of the Malpighian vessels in the Lepidoptera, by M. N. Cholodkovsky. Completion of the biological evolution of *Chaitophorus aceris*, Fabricius (sub-Aphis), by M. J. Lichtenstein.—Note on the characteristics of a Tertiary Conifer (*Araucarites Sternbergi*, Goepp.) allied to the Dammareæ (*Doliostrobus Sternbergi*), by M. A. F. Marion.—On a great oscillation of the Cretaceous seas in Provence, by M. L. Collot.—On the limestones containing fossil Echinids occurring at Stramberg, Moravia, by M. G. Cotteau.—Observations of the solar corona in Algeria, by M. E. Fuchs.—Account of a magnificent meteor observed at Morges on November 3, by M. Ch. Dufour.

VIENNA

Imperial Academy of Sciences, October 16.—On bodies with a maximum of density, and on the conclusions derived from their behaviour, by C. Puschl.—On the passing of luminous rays through glass pipes, and on a method based thereupon for determining the refractive indices of condensed gases, by T. Dechant.—On the influence of pressure on the magnetisation of iron and steel rods, by H. T. Ibrailean.—Computation of the orbit of the planet Cœlestina (237), discovered by T. Palisa on June 27, by F. von Oppolzer.—Geographical determination of the place of San'a (capital of the Yemen Vilayet), by E. Glaser.—Calculation of the orbit of Wolf's comet, by K. Zelbr.—On the action of zinc-ethyl on $\alpha\beta$ dichlorocrotonaldehyde, by A. Lieben.

CONTENTS

	PAGE
Bacteriology	49
Heroes of Science	50
Our Book Shelf:—	
Bentley's "Student's Guide to Systematic Botany"	51
Wigan's "Electrician's Pocket-Book."—Prof. A Gray	51
Hinton's "Science Note-Book."—Dr. Karl Heun	51
Bottone's "Dynamo: How Made and How Used"	52
Letters to the Editor:—	
Natural Science in Schools.—Prof. W. A. Shenstone	52
Do Flying-Fish Fly or Not?—Robert W. S. Mitchell	53
Earthquake Measurement.—Dr. H. J. Johnston-Lavis	53
Autumn Flowering.—Joseph John Murphy	54
The Northernmost Extremity of Europe.—W. Mattieu Williams	54
Breeding of the Quadrumana.—Arthur Nicols	54
Fly-Maggots Feeding on Caterpillars.—R. McLachlan, F.R.S.; F. W. Elliott	54
The Sunday Question.—Mark H. Judge	54
A Pugnacious Frog.—Edwin H. Evans	55
A Disease-Germ Myth	55
The Buddhist Theory of Evolution. By J. Starkie Gardner	55
The Rainfall of 1884. By Fredk. J. Brodie	56
Ancient Chinese Geography	58
Colour. (*Illustrated*)	58
The Late Ferdinand von Hochstetter	61
Notes	62
Our Astronomical Column:—	
The Saturnian System	65
The Variable Star U Geminorum	65
Encke's Comet	65
Wolf's Comet	65
Geographical Notes	65
An Account of some Preliminary Experiments with Biram's Anemometers Attached to Kite Strings or Wires. By Prof. E. Douglas Archibald	66
The Classification and Affinities of Dinosaurian Reptiles. By Prof. O. C. Marsh	68
The Danish Expedition in Greenland	69
Scientific Serials	70
Societies and Academies	70

hood were discovered an ingot of copper, some tin slag, a piece of glass, flint implements, &c., together with remains of piles driven into the ground—traces of human work belonging, apparently, to the Bronze Age. The author thought it the more probable view that the clay bed was deposited in a shallow marsh of land-water kept back by the sea-beach, then some hundreds of feet further to seaward, and that the forest, which consisted chiefly of willows, grew on the marsh.

EDINBURGH

Mathematical Society, November 14.—Dr. Thomas Muir, F.R.S.E., President, in the chair.—Mr. John S. Mackay read a paper on the geometrical figure known to the Greeks as "The Shoemaker's Knife."—The following office-bearers were elected:—President: Mr. A. J. G. Barclay; Vice-President: Mr. George Thom; Secretary: Mr. A. Y. Fraser; Committee: Drs. R. M. Ferguson and Thomas Muir, Messrs. R. E. Allardice, W. J. Macdonald, John S. Mackay, and David Munn.

PARIS

Academy of Sciences, November 10.—M. Rolland, President, in the chair.—Additions to the memoir on complex unities, by M. L. Kronecker.—Remarks on the fourth part of the map of Africa, presented to the Academy, on behalf of the Minister for War, by Col. Perrier. This map has been prepared by Capt. de Lannoy, of the War Department, on a scale of 1 : 2,000,000. The present part comprises the whole of the Congo region, in six sheets, which have been issued for the use of the members of the International Congress now assembled in Berlin to discuss matters relative to West Africa.—Note on Messrs. Renard and Krebs' new balloon, by M. Hervé Mangon. Two ascents were again made on Saturday, November 8, which are described as completely successful. On the first occasion the machine was propelled at an absolute speed of 23 kilometres per hour against the wind blowing at the rate of 8 kilometres per hour. The problem of directing balloons independently of aërial currents is regarded by the author as practically solved by these experiments.—Observations, elements, and ephemerides of Wolf's comet, by M. Gonnessiat. The observations were made with the Brunner 6-inch equatorial of the Lyons Observatory.—Observation of the same comet made with the meridian circle of the Bordeaux Observatory, by M. Courty.—Note on the sinuosities and variations of curvature in the shadows cast during lunar eclipses, by M. P. Lamey.—On an equation analogous to Kummer's equation, by M. E. Goursat.—On algebraic curves of any degree described on a plane, by M. Maurice d'Ocagne.—On atomic and molecular movements, by M. M. Langlois.—On the depth to which sunlight penetrates the waters of the Lake of Geneva, by MM. H. Fol and Ed. Tarasin. From a series of experiments carried out in August and September of this year the authors conclude that light reaches a depth of 170 metres and probably a little more, the luminosity at this point being about equal to that of a clear moonless night.—On a general statement of the laws of chemical equilibrium, by M. H. Le Chatelier.—Note on the polymorphism of the phosphate of silica, by MM. P. Hautefeuille and J. Margottet. The authors infer from several experiments that at temperatures ranging from 300° to 1000° C. this phosphate crystallises spontaneously in four crystallographic forms incompatible with each other, and consequently constituting four distinct chemical species.—On fluoretted apatites, by M. A. Ditte.—On the action of the primary alcoholic iodides on the fulminate of silver, by M. G. Calmels.—Anaytical study of the atmosphere of the city of Algiers, by M. Chairy.—On the hydrate of neutral sulphate of alumina, by M. P. Marguerite-Delacharlonny.—Saponification of the simple aromatic ethers of neutral substances, by M. A. Colson.—The microbe of yellow fever: prophylactic inoculation, by MM. D. Freire and Rebourgeon. After a series of extensive experiments conducted at Rio de Janeiro during the years 1880-84, Dr. Domingos Freire has succeeded in attenuating the virus of yellow fever and reducing it to a vaccinal virus. With this, 400 persons have already been treated with complete success. But fresh experiments will be needed to determine the duration of immunity obtained by this perventive inoculation.—On the effects of inflation of the lungs with compressed air, by MM. Gréhant and Quinquaud.—Researches on the genesis of saccharine in beetroot, by M. Aimé Girard.—On peptonic fermentation, by M. V. Marcano. This new process is described as a simple and economic means of preparing in a few hours extremely pure peptone at a cheap rate. It is capable of being advantageously applied in a large way to the exportation of meat in a far more nutritive and economic form than that of the extracts of meat now in use.—Origin and mode of formation of the phosphates of lime found deposited in large quantities in sedimentary lands: their connection with the iron ores and clays of siderolithic levels, by M. Dieulefait.—Contributions to the anatomy and morphology of the Malpighian vessels in the Lepidoptera, by M. N. Cholodkovsky. Completion of the biological evolution of *Chaitophorus aceris*, Fabricius (sub-Aphis), by M. J. Lichtenstein.—Note on the characteristics of a Tertiary Conifer (*Araucarites Sternbergi*, Goepp.) allied to the Dammareæ (*Doliostrobus Sternbergi*), by M. A. F. Marion.—On a great oscillation of the Cretaceous seas in Provence, by M. L. Collot.—On the limestones containing fossil Echinids occurring at Stramberg, Moravia, by M. G. Cotteau.—Observations of the solar corona in Algeria, by M. E. Fuchs.—Account of a magnificent meteor observed at Morges on November 3, by M. Ch. Dufour.

VIENNA

Imperial Academy of Sciences, October 16.—On bodies with a maximum of density, and on the conclusions derived from their behaviour, by C. Puschl.—On the passing of luminous rays through glass pipes, and on a method based thereupon for determining the refractive indices of condensed gases, by T. Dechant.—On the influence of pressure on the magnetisation of iron and steel rods, by H. T. Ibrailean.—Computation of the orbit of the planet Cœlestina (237), discovered by T. Palisa on June 27, by F. von Oppolzer.—Geographical determination of the place of San'a (capital of the Yemen Vilayet), by E. Glaser.—Calculation of the orbit of Wolf's comet, by K. Zelbr.—On the action of zinc-ethyl on $\alpha\beta$ dichlorocrotonaldehyde, by A. Lieben.

CONTENTS

	PAGE
Bacteriology	49
Heroes of Science	50
Our Book Shelf:—	
Bentley's "Student's Guide to Systematic Botany"	51
Wigan's "Electrician's Pocket-Book."—Prof. A Gray	51
Hinton's "Science Note-Book."—Dr. Karl Heun	51
Bottone's "Dynamo: How Made and How Used"	52
Letters to the Editor:—	
Natural Science in Schools.—Prof. W. A. Shenstone	52
Do Flying-Fish Fly or Not?—Robert W. S. Mitchell	53
Earthquake Measurement.—Dr. H. J. Johnston-Lavis	53
Autumn Flowering.—Joseph John Murphy	54
The Northernmost Extremity of Europe.—W. Mattieu Williams	54
Breeding of the Quadrumana.—Arthur Nicols	54
Fly-Maggots Feeding on Caterpillars.—R. McLachlan, F.R.S.; F. W. Elliott	54
The Sunday Question.—Mark H. Judge	54
A Pugnacious Frog.—Edwin H. Evans	55
A Disease-Germ Myth	55
The Buddhist Theory of Evolution. By J. Starkie Gardner	55
The Rainfall of 1884. By Fredk. J. Brodie	56
Ancient Chinese Geography	58
Colour. (*Illustrated*)	58
The Late Ferdinand von Hochstetter	61
Notes	62
Our Astronomical Column:—	
The Saturnian System	65
The Variable Star U Geminorum	65
Encke's Comet	65
Wolf's Comet	65
Geographical Notes	65
An Account of some Preliminary Experiments with Biram's Anemometers Attached to Kite Strings or Wires. By Prof. E. Douglas Archibald	66
The Classification and Affinities of Dinosaurian Reptiles. By Prof. O. C. Marsh	68
The Danish Expedition in Greenland	69
Scientific Serials	70
Societies and Academies	70

THURSDAY, DECEMBER 4, 1884

THE CHOLERA BACILLUS

IN view of the investigations which are going on at the present time, it will be of interest to our readers to summarise the reasons which Koch gives for his conclusion that the comma-bacilli described by him are the cause of cholera. No doubt can remain in the minds of those who have read his paper on the subject, published in the *Berl. Klin. Wochenschrift*, No. xxxi., 1884, and the discussion thereon, that he has devoted an immense amount of time and labour to the question, and that he has dealt with the subject in a most open-minded and conscientious manner. His known character for accurate observation and care in drawing conclusions lend great weight to his statements. We will give a short sketch of his arguments under a series of headings.

(1) The comma-bacillus is a specific micro-organism having marked characteristics distinguishing it from all other known organisms.

Their length is from half to two-thirds of that of tubercle bacilli, but thicker and slightly curved: this curve is generally not more than that of a comma, but sometimes it may be greater, forming even half a circle. Sometimes several bacilli can stick together end to end, giving rise to the appearance of a spirillum. Koch thinks that this organism stands midway between a bacillus and a spirillum. They grow rapidly in meat infusion. They possess the power of active motion. They also grow well in other fluids, in milk more especially. They increase rapidly in blood serum. A very good medium is Koch's gelatinised infusion (peptone, gelatine, meat infusion, made neutral by carbonate of soda), and its cultivation in this material "renders its detection easy and very certain." Shaken up with the liquefied gelatine, poured out on a sterilised glass plate, and kept at a temperature at which the gelatine becomes solid, its colonies are very characteristic: when young, they appear as small, very pale drops, not quite round, but more or less irregular and jagged in contour; they also have a granular appearance, and when larger look like a heap of strongly-refracting pieces of glass; the gelatine becomes fluid in the immediate neighbourhood of the colony, the latter sinks into the gelatine, and thus a small funnel-shaped depression is formed, in the middle of which the colony is seen as a small white point. The liquefaction of the gelatine does not extend more than about one centimetre around the colony. If a tube of solid gelatine is inoculated by dipping a needle in the cultivation, and pushing it into the gelatine, the latter becomes fluid first at the point of entrance of the needle; the colony sinks more and more; a funnel-shaped depression is formed with an appearance as if an air-bubble were present at the top. They can also be cultivated in a meat infusion containing peptone, neutralised and rendered solid by agar-agar. They grow on potatoes, forming colonies closely resembling those of the bacillus of glanders, but not so brown as the latter. They grow best at a temperature between 30° and 40° C.; below 16° C. they cease to grow; freezing does not kill them. They only grow in presence of oxygen. They grow very fast; their vegetation rapidly reaches its highest point: it remains stationary for a time, and then as rapidly ceases, the bacilli dying. They will not grow in meat infusion or the gelatinised material if it is at all acid. They die very rapidly when dried, not retaining their vitality longer than three hours. They do not form spores, corresponding in this respect with spirilla rather than with bacilli; Koch has made an exhaustive series of investigations to ascertain this point. Micro-organisms presenting all these characteristics are the bacilli described by Koch; organisms presenting only some of the characteristics, such as microscopical appearance, but differing in other points, are not Koch's comma-bacilli.

(2) This bacillus is always present in cholera.

Koch states that this bacillus is always present in cases of cholera. He determines its presence not only by microscopical examination, but by cultivation in gelatinised meat infusion. In ten cases in Egypt they were found microscopically (he had not then worked out their characteristics on cultivation). In India he made forty-two post-mortem examinations, and found them in all cases, by cultivation and microscopical examination, in the intestinal canal. The dejections of thirty-two cholera patients were also examined in the same way, and the comma-bacilli were found in all cases; also, in two cases seen in Toulon, and microscopically in sections of the intestinal wall in eight cases sent to him previously from India and Egypt. In almost 100 cases carefully examined these organisms were found, and that in cases occurring in various parts of the world.

(3) It is the only form which is constantly present in this disease.

(4) It is present in greatest numbers in acute and uncomplicated cases.

Koch has found that this is the case, and that on the other hand, in cases which live longer, the bacilli are fewer, and more especially where hæmorrhage or other complications have occurred, other bacteria are most numerous.

(5) It is present in the parts most affected.

According to Koch the lower part of the small intestine is that most affected by the disease, and here the bacilli penetrate into the tubular glands and also in part between the epithelium and basement membrane; in some places they penetrated even more deeply into the tissue. Where death of portions of the mucous membrane had occurred, other bacteria were also present in the tissue, but the comma-shaped ones were always deepest, "giving the appearance as if they had prepared the way for the others."

(6) It is never present in other diseases, in healthy persons, nor has it been found outside the body when no cholera was in the neighbourhood.

This is the keystone of the research, and naturally Dr. Koch has devoted great attention to this point. All his investigations in this direction have been carried out by his usual methods—chiefly by cultivation, aided also by the use of the microscope. He has thoroughly examined thirty bodies of patients who had died of dysentery, intestinal catarrh, "biliary typhoid," one case of ordinary typhoid fever, and several cases where ulceration of the intestines has been present. In none of these did he find comma-bacilli. He failed to find them in a number of cases where he examined the dejections of patients

suffering from dysentery, also in diarrhœa of children, in animals poisoned by arsenic, in impure water from various parts around Calcutta, indeed wherever he met with a fluid containing bacteria he examined it for comma-bacilli, without however finding any (except in one instance, see No. 8). He specially mentions that he has tested saliva and the material on the teeth and tongue, which is always full of bacteria, but always with a negative result. He further refers to his own previous large experience in the cultivation of bacteria, and that of others who have worked at cultivation, this experience being against the presence of this organism, except in cholera. From these facts he feels himself warranted in stating that "the comma-bacilli constantly accompany cholera, and are never found elsewhere."

(7) No other conclusion can be arrived at than that these bacilli are the cause of cholera.

(*a*) It might be said that the choleraic process merely favours the growth of this bacillus. But on this supposition every one must have comma-bacilli in his body, because they are present in cases of cholera occurring in widely-separated parts of the world. This, however, is not the case (No. 6).

(*b*) As the result of the disease, conditions arise which cause the transformation of some ordinary bacterium into comma-bacilli. There is no evidence of such rapid transformation of one form of bacterium into another. The only known case of alteration in the properties of these bodies is the attenuation of anthrax bacilli, &c., but this is merely an alteration in pathogenic action; their form and mode of growth remain unaltered. Outside the body Koch has not, during the course of his investigations, got the slightest evidence of any change in these bacilli.

(*c*) The only conclusion which remains is that the cholera process and these bacilli stand in close relation to each other—in a relation of cause and effect.

(8) Although by experiments on animals direct evidence that the comma-bacillus is the cause of cholera has not been obtained, there are various observations which are almost as good as experiments on man.

In one case in a village near Calcutta Koch examined the water of a tank which supplied the inhabitants with drinking-water, &c. A number of cases of cholera had occurred, and when the water was examined the epidemic was at its height. Comma-bacilli were found in the water in considerable numbers. At a later period, when there were only few cases of illness, the comma-bacilli were few in number, and only found at one part of the tank. This was the only instance in which Koch found these bacilli outside the body. He further refers to the occurrence of disease in washerwomen, and infection from clothing soiled with cholera dejecta.

(9) The natural history of the disease corresponds with the various characteristics of this organism.

The bacilli grow rapidly, soon reach their highest point of development, and then die: this corresponds to what occurs in the intestinal canal. Under ordinary circumstances these bacilli are destroyed in the healthy stomach. This corresponds to the clinical facts of cholera, for, of a given number of individuals exposed to cholera, only some are taken ill, and those almost all suffer from disturbance of digestion—either catarrh of the stomach or intestine, or overloading of the stomach, &c., with indigestible food. The disease dies out in places where the conditions for its continuance are unfavourable: the bacilli have no spores.

These are the facts on which Koch's views are based; lately, however, two researches have been published which strike at the root of the theory, and which try to show that these bacilli are not peculiar to cholera. Dr. Koch has also published a reply.

The first of these researches is that of Dr. Lewis, who finds bacilli in the mouth microscopically identical with the comma-bacilli. Koch's reply (*Deutsche Med. Wochenschrift*, No. 45, 1884) is that he is well aware of the fact that organisms somewhat resembling the cholera bacillus are present in saliva, but that he does not diagnose these bacilli by microscopical characters alone, that if these bacilli are cultivated they will be found to be quite different from those present in cholera. For instance, they will not grow at all in the neutralised cultivating gelatine in which the cholera bacilli grow rapidly. The other research is by Finkler and Prior, who stated that they had found the comma-bacillus in cases of cholera nostras, and who further described spore-formation in them. Koch succeeded in obtaining a specimen of their "pure" cultivations, and found, on shaking up a minute quantity with the liquefied gelatine and pouring it out on a glass plate, that they had a mixture of four different bacilli, and that none of them were the comma-bacilli described by him.

Koch further adds the interesting fact that he has again taken up the experiments on the lower animals (presumably, from the context, on dogs and guinea-pigs), and that by injecting minimal quantities (as little as the 100th of a drop) of the cultivations of comma-bacilli into the small intestine, the animals have as a rule died in one and a half to three days, and the post-mortem appearances of the intestine were the same as in acute cases of cholera, the fluid in the intestine also containing enormous numbers of comma-bacilli.

In two cases of cholera nostras, and in a diseased bee, the writer found bacilli which microscopically closely resembled the comma-bacilli, but it was found that they did not grow in the neutralised gelatinised material, and were therefore not the same organism.

THE HAYTIAN NEGROES

Hayti; or, The Black Republic. By Sir Spenser St. John, K.C.M.G. (London: Smith, Elder, and Co., 1884.)

WHATEVER theory may be adopted regarding the fundamental equality or disparity of the human races, a truthful and unbiased account of the present social condition of the Haytians, by a competent observer, must necessarily prove a valuable contribution to the study of psychological anthropology. These conditions are eminently satisfied in the work before us, written as it is by a man personally above suspicion of any unworthy motive, by a statesman who has associated for some five-and-thirty years with every variety of coloured peoples, by a distinguished diplomatist, who, as British Minister and Consul-General, has resided for twelve years in Hayti itself. On the other hand, no more favourable field could be selected for a study of the negro race than this western and smaller division of this large West Indian island,

second in size only to Cuba, of which it forms a natural continuation eastwards to Porto Rico. Here the eastern and much larger division, known as Santo Domingo, has been mainly in the hands of a "coloured," that is, negroid or mulatto people, since the expulsion of the Spaniards and French early in the present century. But in Hayti the pure negro has always been in the ascendant, and his policy has persistently been to get rid of the white and coloured elements. The whites disappeared, either exterminated or driven into exile, during the struggle with France; and of the present population, roughly estimated at some 800,000 or 900,000, not more than one-tenth are mulattoes, and all the rest full-blood Africans. The Haytians may, in fact, be regarded as a section of the negro race transplanted bodily to their present domain, where they have had it all their own way since the close of the last century. Whatever differences may exist, are all in their favour; for they here find themselves separated from the old baneful associations, and surrounded on all sides by the civilising influences of more cultured peoples. The physical environment is also more favourable, the climate being on the whole decidedly superior to that of the African sea-board, while the well-watered lowlands are described as amongst the most fertile tracts on the globe.

And what is the outcome of fully three generations of political autonomy under these exceptionally advantageous conditions? Practically a reversion to, or, more correctly speaking, an almost uninterrupted perpetuation of, the African tribal organisation in its very worst aspects. Such is the general conclusion conveyed by a careful study of Sir S. St. John's work, which may be briefly described as a formidable indictment against the negro race as such, and a crushing reply to those sentimental philanthropists who go about preaching the doctrine of the inherent equality of all mankind. In a few well-digested chapters he deals comprehensively with the history, government, trade, industries, and social institutions of the "Black Republic," and on all these branches of the question his verdict is in the highest degree adverse. "I could not but regret," he writes, "that the greater my experience the less I thought of the capacity of the negro to hold an independent position. As long as he is influenced by contact with the white man, as in the southern portion of the United States, he gets on very well. But place him free from all such influence, as in Hayti, and he shows no sign of improvement. On the contrary, he is retrograding to the African tribal customs, and without exterior pressure will fall into the state of the inhabitants of the Congo. I now agree with those who deny that the negro could ever originate a civilisation, and that with the best of education he remains an inferior type of man. He has as yet shown himself totally unfitted for self-government, and incapable as a people of making any progress whatever. To judge the negroes fairly, one must live a considerable time in their midst, and not be led away by the theory that all races are capable of equal advance in civilisation" (pp. 131-132).

This general conclusion is amply supported by overwhelming evidence collected at first hand by a shrewd observer, whose official position enabled him to obtain accurate information regarding every phase of Haytian political and social institutions. That the successive "empires" and "republics" were mere burlesques; that the administration of justice has always been a farce; that civic virtues are absolutely unknown; that, in a word, "politically speaking, the Haytians are a hopeless people" (p. 133), will probably be accepted without demur by the intelligent reader. But that fetish worship, cannibalism in its most repulsive forms, and all the abominations associated with the secret "Vaudoux" rites, are still rampant, and encouraged if not actually practised by the very highest State functionaries, including Presidents themselves, would certainly be received with a smile of incredulity, were the facts not attested by evidence of the most unimpeachable character. Even so the revelations made in connection with this loathsome subject almost exceed the bounds of belief, and could not be accepted, were we not assured that they are "founded on evidence collected in Hayti, from Haytian official documents, from trustworthy officers of the Haytian Government, my former colleagues, and from respectable residents—principally, however, from Haytian sources" (Introduction).

To the question, Who is tainted by the Vaudoux[1] worship? the answer is, "Who is not?" Yet a prominent feature of this horrible cult is the sacrifice of "the goat without horns," that is, of some human victim, often supplied by the parents themselves, who also share in the feast at which their murdered offspring is devoured. At a trial held in 1864, four women were convicted on their own confession of having killed and eaten a girl, six years old, delivered to them by the aunt, and of feeding up another child to be sacrificed and eaten on the Feast of the "King of Africa." A Spanish official present at the trial reported that, if the public prosecutor had done his duty, "not only the witnesses but the mother of the victim herself would have shared the fate of the cannibals proved guilty of having eaten her." Another woman, reproached with having devoured her own offspring, retorted, "And who had a better right? Est-ce que ce n'est pas moi qui les ai fait?" And in 1878 a case came under the notice of the author, in which two women were caught in the act of eating the flesh of a child raw. "On further examination it was found that all the blood had been sucked from the body" (p. 225).

In common with many other observers, the author noticed "that negro boys up to the age of puberty were often as sharp as their coloured fellow-pupils," adding that "there can be no doubt that the coloured boys of Hayti have proved, at least in the case of one of their number, that they could hold their ground with the best of the whites" (p. 266). But it is equally certain that after reaching puberty further progress appears to be arrested, so that the negro remains intellectually a child to the last. This remarkable phenomenon is probably due to the premature closing of the cranial sutures in the negro race, as suggested by Filippo Manetta, who also noted the sudden arrest of development in adults. "The intellect seemed to become clouded, animation giving place to a sort of lethargy, briskness yielding to indolence. Hence we must needs suppose that the evolution of the negro and white proceeds on different lines. While with the latter the volume of the brain grows with the expan-

[1] Apparently a corruption of the West African word *Vodun*, implying a species of ophiolatry, in which the great serpent, an all-powerful supernatural being, on whom all things depend, is worshipped by secret rites, nocturnal orgies, and human and animal sacrifices.

sion of the brain-pan, in the former the growth of the brain is on the contrary arrested by the premature closing of the cranial sutures and lateral pressure of the frontal bone." [1]

The chapter on the curious French Creole patois current amongst the Haytians will be found instructive by students of such jargons. Its euphonic laws and peculiar structure, or rather absence of structure, are illustrated by a number of passages from popular songs and proverbs, such as the characteristic —

"Nègue riche li mulatte,
Mulatte pauvre li nègue."

That is —

"Negro enriches mulatto,
Mulatto impoverishes negro."

Beyond oral compositions of this sort there is no local literature, and the public records, diplomatic communications, and correspondence of all sorts are written in more or less grammatical French. None of the full-blood blacks have aspired to the honours of authorship, or attempted any sort of literary composition beyond an occasional political essay or manifesto. In this as in all other respects there seems to be an impassable gulf even between them and the coloured portion of the population.

The book is furnished with a useful map of Hayti; but there are neither illustrations nor index.

A. H. KEANE

OUR BOOK SHELF

Hilfsbuch für den Schiffbau. Von Hans Johow. (Berlin: Julius Springer, 1884.)

THIS handsome volume belongs to the class of publications known as "pocket-books," of which there are many examples, in English, adapted to the use of various branches of engineering. It is essentially a compilation of facts, formulæ, and methods likely to prove useful to ship-builders in the course of their ordinary work; and it will bear favourable comparison with anything of the kind previously published. In the range of its information, and the extent as well as variety of the sources drawn upon, Mr. Johow's book surpasses all others intended for the use of ship-builders; evidencing wide research and a thorough acquaintance with the literature of the profession. It cannot fail to prove valuable as a book of reference in the offices of all ship-yards, and should be of great assistance to draughtsmen, especially in carrying on calculations or details of design.

The arrangement of the book is excellent, and it is admirably produced, the numerous tables and diagrams, as well as the mathematical investigations, being clearly printed and easily followed in reading. This has been accomplished without making the volume large or expensive. Five principal sections embrace the contents.

The first section contains a mass of general information and tables, designed to facilitate reference and save labour. In the mathematical subdivision of this section appear tables of the squares, cubes, square root, cube root, &c., of numbers up to 1000; trigonometrical tables; algebraical and trigonometrical formulæ of various kinds. Another subdivision deals with "mass and weight," giving full particulars of the weights and measures of various countries, and tables for conversion of one system to the others. Tables of weights of materials follow, and are very extensive and well arranged; in addition, there is a brief summary of the principles of strength of materials, including Wöhler's valuable investigations on the "fatigue" of metals. Brief chapters are also devoted to the theory of heat, chemistry, and galvanism; and finally a good deal of information is given on details of design, fastenings, &c.

The second section deals with the theory of ship-building. It gives particulars of various systems of mechanical construction for the forms of ships; deals with the problems of buoyancy and stability, and describes methods of calculation; gives approximate formulæ for use in preliminary investigations; and deals in a practical fashion with ocean waves, propulsion of ships by sails, the action of the rudder, fluid resistance, and propulsion by steam power. Under the last heading appears a most comprehensive summary of the various methods proposed for approximating to the engine-power required to give steamships their assigned speeds. Lastly there is a chapter on compass-correction.

The third section deals with more practical questions relating to the lading and freeboard of ships; their outfit of anchors, chains, boats, pumps, &c.; the armaments of war-ships; the methods of testing materials used in ship-building, &c.

In the fourth section are contained detailed information relating to the propelling machinery, boilers, and propellers of ships; the rules of the Board of Trade for boilers; and tables, &c., for use in trials of speed.

The fifth and last section contains details of the laws and regulations affecting German and foreign shipping, various rules for calculating tonnage, and our Board of Trade regulations for passenger-steamers. An excellent index concludes the book.

It cannot be supposed that such a great mass of information has been brought together and greatly condensed without some sacrifices and possible errors; but the author has evidently taken pains to insure accuracy, and his book should command a wide circulation both in Germany and abroad.

W. H. W.

A Synopsis of Elementary Results in Pure and Applied Mathematics: containing Propositions, Formulæ, and Methods of Analysis, with Abridged Demonstrations. By G. S. Carr, M.A. Vol. i., Sections x., xi., xii. (London: Francis Hodgson, 1884.)

OUR notices of the former sections will be found in vol. xxii. (p. 582) and vol. xxvi. (p. 197). These sections are occupied with the Calculus of Variations (pp. 441 to 459), Differential Equations (pp. 460 to 545), and the Calculus of Finite Differences (pp. 546 to 560). In the first section we have not detected any mistakes of any importance, in fact only one or two typographical faults. The second section commences with an unfortunate slip in the numbering of the articles, which is not pointed out until the next sheet is commenced (p. 473). In this section there are numerous errata, of which we indicate a few. In § 3276 the first term in the last line should have the mark of differentiation with regard to x affixed. We note mistakes in §§ 3342, 3382, 3392, 3394, 3399, 3407, 3431, 3447, 3499, 3520, 3521, 3537, 3570. These corrections are mostly for wrong references, and the articles are cited for the benefit of students. The last section appears to be quite right, with the exception of a typographical error in § 3703. We have not undertaken to work out and verify each article, but we have gone through each, and the above small list of mistakes will give an idea of the care exercised in the editing of this part. We repeat our former advice, viz. that a student who wishes to refer to the "Synopsis" for refreshing his knowledge of the above-named branches should at the time of his reading his text-book have this manual by him for verification. The sections are mainly based upon Jellett (for Variations), and Boole (for the two latter sections).

[1] "La Razza Negra nel suo stato selvaggio, &c." p. 20. (Turin, 1864.)

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.*]

Natural Science for Schools

I WAS glad to see that "Science Master" had pointed out some of the difficulties in the way of applying the principles laid down in Prof. Armstrong's valuable paper in your number for November 6 (p. 19). The difficulties to which he has adverted relate mainly to those gratuitously thrown in the way of sound and useful practical teaching in grammar-schools by boards of examiners. Another difficulty I ventured to point out in the brief discussion upon Prof. Armstrong's paper at the Educational Conference of the International Health Exhibition, but it did not receive the attention which I think it deserved—partly, perhaps, owing to press of business, and partly, perhaps, also to the fact of the naturally somewhat strong representation of South Kensington interests at a conference held within the shadow of the Brompton Boilers. Prof. Armstrong appeared specially to recommend his mode of teaching "in science classes, such as those held under the auspices of the Science and Art Department," and towards the end of his paper he seems to recognise only one difficulty in the way of introducing it generally, viz. it "undoubtedly involves more trouble to the teacher than that ordinarily followed," and he appears to hint that the present method is mainly due to the incapacity of the teacher, as he says, "I do not believe that it is because the Department consider it" (the system) "a satisfactory one; but they know full well that it would be unwise to legislate far in advance of the intelligence and powers of the majority of the teachers." There are many teachers who are only too anxious to teach, not chemistry merely, but physics and other branches of science upon a sensible system, and who would willingly take considerable *trouble* to attain that end, but the difficulty is that, were they to do so, they would not get paid for their work. The insane system of *payment by results* is responsible for the greater part of the bad and indifferent teaching of science in this country, and the real trouble is, not that something better is in advance of the intelligence and powers of the majority of *teachers*, but that it is in advance of the intelligence and powers of the majority of *examiners*. The Department accept as their primary axiom that no teaching is to be paid for except that which can be exactly tested and appraised by certain examiners; and so no teaching, whatever its educational value, is counted worth anything by them except that which is susceptible of being weighed and measured. I took the liberty at the discussion of asking Prof. Armstrong whether he had ever taught a class on his methods, and if that class was presented to the Department for examination, and if so what was paid for it, and I made bold to express my own opinion that the result would be either *nil* or despicably small. My question received no answer, but I got plentifully snubbed—firstly, that a science teacher should even think of such a subject as remuneration, and secondly, I was informed that practical teaching always paid best. But as it appeared that my critics had misapprehended the point at issue, and were not speaking of the kind of teaching advocated by Prof. Armstrong at all, but thought that *practical* teaching meant allowing the class to see certain experiments performed by the teacher himself—a mode of teaching which I am quite agreed with the reader of the paper in considering quite *unpractical*—I did not feel satisfied that my question was answered, and with your permission will again propound it. It is not a sufficient answer to say that the most practical teachers earn the best results—I am a science teacher of quite sufficiently long experience to know that—*provided it is strictly on the lines laid down by the Department.* What I doubt is whether *sensible* practical teaching would produce any pecuniary results.

Certainly, in what is called (*lucus a non lucendo*) practical chemistry it would not: there nothing but test-tubing can be weighed and measured; and whereas in former years a knowledge of the modes of preparing and experimenting with certain of the more common elements and compounds counted for something in the elementary stage, it has lately, by successive alterations in that direction in successive issues of the Directory, become more exclusively test-tubing.

In physics I presume the intelligent teacher would be glad to teach his class in light, heat, and sound, to make some of the more important measurements, to verify the laws of reflection and refraction, to measure the refractive index of glass, to calculate the foci of various lenses, to determine the latent heat of water and steam, and the specific heat of one or two substances and a few other similar things, not many of which could be introduced in a course of thirty lessons of one hour each; in electricity and magnetism, to establish the laws of intensity, to construct an electroscope, a galvanometer, and a Wheatstone's bridge, to measure the resistance of a few lengths of wire, to determine the E.M.F. of a "cell," &c., in which case the same limits would soon be reached. But would such a course pay? I venture to say not, and the Department have not even given to practical physics the scant encouragement which they afford to so-called practical chemistry. I say *scant encouragement*, because, by a series of red-tape regulations, which are strictly adhered to, they do their best to render the study of practical chemistry needlessly expensive to the committees and unremunerative to the teachers.

I shall probably be told—firstly that the teacher of a science class has no need to limit himself to thirty hours for a course; and secondly, that he should not make remuneration his first consideration. On the first point I reply that he is practically limited in most cases by the length of time during which it is possible to get students to attend: the month of September is as early as it is practicable to commence a course, and the examinations are early in May, so that one lesson a week, allowing for necessary holidays, cannot much exceed thirty lessons. To give two lessons per week would be to occupy the time of two classes for the remuneration—generally poor enough—of one; this, of course, virtually brings us to the second point, as to which I would say that, as in other professions men do not work for inadequate remuneration, I do not see why the science teacher should be expected to be more philanthropic; that neither the clergyman, the lawyer, nor the physician professes to regard money as his chief consideration, yet that the remuneration of each of these professions is far before that of the science teacher, at all events of him who works for the Science and Art Department; and lastly, that that particular line of criticism does not usually come from those who are themselves working from philanthropic motives, but from those who are pretty well paid for their labours, and who would despise the modest reward of the "*payment by results*" teacher.

I hope I shall not be misunderstood as disagreeing with Prof. Armstrong's views; it is, on the contrary, because of my full agreement with them and that I am anxious that those science teachers who are sufficiently advanced in intelligence (and I am persuaded that they are not so rare as Prof. Armstrong seems to think) to adopt a truly educational mode of teaching, should have no needless obstacles thrown in their way, that I venture to address you and to repeat before a larger audience those arguments which I made use of before the smaller auditory at the Health Exhibition.

I for one should be only too glad to see the scope of the science teaching under the Science and Art Department widened, and to know that encouragement was given to the intelligent and advanced teacher to get out of the grooves in which it appears to be the present policy of that Department to retain him.

WALTER A. WATTS

Farnworth Grammar School, November 20

Do Flying-Fish Fly?

I CANNOT pretend to the great experience of Mr. R. W. S. Mitchell in observations on aerial movements of the flying-fish when for a brief space he leaves his native element; but during one voyage from the Isthmus of Panama to England *viâ* the West Indies I lost no opportunity (of many) of watching these beautiful creatures, sometimes very close indeed to our steamer. The opinion I formed at the time and still retain was that there was constant very rapid motion of the great lateral fins whilst out of the water, so rapid, indeed, that the strokes of the fins could not be counted. From what Mr. Mitchell says, he evidently counted the strokes of the wings (pectoral fins), not by seeing the movements of these, but by the "impressions made on the oily surface of the water," impressions apparently similar to those made by a cormorant or other diver when taking wing from the sea.

The movements of the side fins whilst the fish was in the sea or touching the surface, would be much slower than would be the

ease when it was wholly in the air, because, to be of any use then, the strokes would have to be so rapid as to be scarcely countable, as is the case with certain sea fowl (notably auks) which use their wings (with a comparatively slow stroke) whilst swimming *under* water, but when flying move them so rapidly that the strokes can either be counted with difficulty or not at all. On watching flying-fish whilst in the air, I noticed a flickering of the fins, indicating what I believe to have been rapid motion.

As Mr. Mitchell's observations, on which he chiefly relies, were made when looking down from the high bows of a steamer, the "waving from side to side" of the tail of the fish, being a lateral motion, was clearly seen, whilst the movements of the side fins would be less easily discernible.

Finally, could the impetus acquired by the fish, when springing from the water, carry it through the air "50 or 100 yards" (Mr. Mitchell's estimate) without the aid of any additional propelling force during its flight? If so, the initial velocity must have been very great.

JOHN RAE

4, Addison Gardens, W., November 27

The "Jeannette" Drift

IN NATURE of November 20 (p. 66) you give an account of the finding of some relics of the *Jeannette*, which have been picked up on an ice-floe at Julianhaab, in lat. 61° N., long. 46° W., near the south point of Greenland, and which must have drifted from the New Siberian Islands in lat. 75° N., long. 155° E., where the *Jeannette* was squashed three years ago. This I consider a most important find with regard to Arctic navigation and discovery. The question arises, How did the ice-floe get to Julianhaab? I propose the following solution. The Siberian Islands bear nearly due north from Julianhaab, and in a straight line up Davis's Strait, Baffin's Bay, Smith's Sound, Lincoln Sea, &c., and across at a distance of about 250 knots from the Pole. I think it most probable that the floe may have drifted through "the unknown," or what Osborn calls "the land of the white bear," the large unexplored area to the west of Banks's Land, and have got into Baffin's Bay through one of the sounds on its west coast—either by Jones's Sound, where the tide runs eastward at the rate of two knots an hour ("Inglefield," p. 77), or by Banks's Strait and Lancaster Sound.

We know that the icebergs come *down* Baffin's Bay and Davis's Strait into the Atlantic, and the floe has had fair success in navigating through a distance of 2700 knots to reach Julianhaab in three years.

I cannot for a moment suppose that this ice-floe has come from the Siberian Islands, *viâ* Francis Joseph Land, Spitzbergen, Iceland, to Greenland, a distance of 3600 knots, for that course would have been directly *against* the Gulf Stream, in which no floe could last three years, even if it were 26 feet thick, as Inglefield found them in Jones's Sound, or 40 feet thick, as McClure found them in Banks's Strait. McClure found the current west of Point Barrow going 2 knots per hour to the south, evidently making for Behring's Strait, while of the north-west point of Banks's Land the drift was north-east 1 knot an hour, evidently going towards Lancaster Sound.

I therefore conclude that the *Jeannette* relics could not have come westward, they *must* have come eastward, and this proves that there is a course open which is unknown to us.

I would suggest that a number of very strong buoys, capable of resisting ice-pressure, should be set adrift on ice-floes on various parts of the Siberian coast, each numbered indelibly, so that when recovered it could be ascertained whence they started, and their course *might* possibly be ascertained from the Esquimo, who may have seen them, or by other means. This experiment is worth a trial.

R. S. NEWALL

Ferndene, November 30

A Meteor Visible in the Daytime

AT Waterpark, just below Waterford City, about 4 p.m. on October 15, my attention was attracted by a flash of increased light. Looking up, I saw in the south-south-west, about half way between the horizon and the zenith, a bright meteor slowly sailing nearly due west, its apparent size about half that of the full moon, intensely white in colour at the centre, passing into blue at the circumference. It described a low arc, and was in sight for several seconds, leaving a trail of indigo blue with lighter luminous edges. The meteor disappeared behind some clouds which concealed the sun at a considerable altitude above the horizon.

JAMES GRAVES

November 27

Noon-Glow

WHILE waiting at the telescope shortly before noon this date to note place of sun-spots at meridian passage, masses of cloud formed suddenly in a clear sky overhead, and drifting slowly due south, obscured a peculiarly brilliant sun. No sooner had direct light been intercepted than the upper air above cloud and sun's place appeared filled with the latterly common white glare (as of attenuated peat-smoke highly illuminated), which soon became suffused with the now familiar rose-tint, apparent also between the clouds and on south-south-west horizon, but not beneath the sun on meridian. The sun's apparent meridian altitude being 16°, the superior limit in altitude of rose-tint was 39°; the colouring being monotone throughout, and not to be confounded with that of halos. Fearing ocular deception, as often happens from fatigue of eyesight, I asked an intelligent companion to verify observation, more especially as the diffused white glare at first slightly masked the tinting as compared with that of other "glows." It seems, however, plain that the terms "fore-glow" and "after-glow" no more cover the entire field than the Krakatoan dust.

D. J. ROWAN

Kingstown, November 24

Rosy Glow about the Moon

AFTER watching for some time this evening a lovely twilight in the west, which though bright and luminous was not remarkable for strong colour, I turned toward the south-east, when the moon, now well up, was shining through detached fleecy clouds, and was surprised to see about her a rosy-coloured glow, very like that so often seen about the sun; the nearer clouds, though very high, telling as a cold almost greenish grey upon it. This glow, of course, was much lower in tone than that about the sun, but both in character and extent just like it, and quite distinct, and broader than those prismatic hues often seen about the moon, and called by sailors "cock's eyes" or peacock's-eyes. This was at 4.45 p.m., and as the twilight faded the glow disappeared, from which I infer that it was caused by vapour lying high enough in the south-east to catch some of the very last rays of the sun, but too far east to give a glow in the west.

I see that a correspondent of the *Standard* telegraphed that on the evening of the 25th "a sunset equal in splendour to those of last autumn was seen over the Yorkshire wolds. The predominating hue was a rich crimson." The weather here was cloudy that evening, but between narrow openings in the clouds the sky was the colour of rich painted glass of a ruby-red tint about 4.30 p.m.

ROBERT LESLIE

6, Moira Place, Southampton, November 28

Wild Fowl Decoy

MAY I ask if any of your readers who are interested in wild-fowl decoys will send me the names and positions of any past and present ones they may happen to know or have heard of. I am endeavouring to save the history of decoys from oblivion, and though I have many hundred letters, maps, and sketches connected with this interesting subject, still I may have a great deal of information yet to obtain. I think the subject deserves a standard work, or I would not trouble you.

RALPH PAYNE GALLWEY

Cowling Hall, Bedale, November 24

Prehistoric Man

DURING October last, the sanitary authorities of Gloucester City had occasion to make some excavations in the timber-yard of Messrs. Booth and Co., and in the Bristol Road adjoining this yard, for the purpose of laying down a new sewer. In the course of this operation the workmen disinterred, from a bed of plastic clay, three human skeletons, occupying a position which appears to suggest that the remains in question are probably those of prehistoric man.

Arriving accidentally on the spot some two or three days after the actual find, I learned, to my great regret, that the skulls, two of which had passed through my friend Mr. Wm. Booth's

hands, had been cast on one side, reduced to fragments, and finally buried in the concrete foundation of the new sewer, no one supposing that the discovery represented anything more than some modern interment.

My friend had, however, seen one of the skeletons complete and *in situ*, extended at full length, face downwards, in the clay, while I succeeded in gathering a basketful of bones, including fragments of four left-hand femora, thus, probably, attesting the presence of more individuals than the number to which the workmen deposed.

Some of these bones I extracted from the clay itself, the remainder being found among the excavators' ejecta. Almost all of them are broken and have their cavities, even the spongy tissues and diploë of the cranium, completely filled with the clay in which they were discovered. They are easily broken into fragments by hand, have little organic matter remaining in them, and a few exhibit indications of having been gnawed by animals.

The clay-bed itself showed no signs of disturbance, such as would indicate a burial. On the contrary, it was evident that the bones had been quietly covered with river deposits as they lay, and, although near each other, the skeletons did not occupy a common resting-place.

The remains occurred at a depth of 5 feet 6 inches below the surface, 36 feet above Ordnance Datum, and 3 feet above the highest known modern flood-line, given on the authority of Mr. Martin, engineer to the Severn Navigation Commissioners.

It is clear, therefore, that the clay-bed in question must have been deposited at a time when the River Severn ran, and its flood-loams were laid down, at levels higher by many feet than those of the present day, or, in other words, at some time antecedent to the historic period, during which there is no reason to suppose that our rivers ever met the sea except at existing horizons. DANIEL PIDGEON

Holmwood, Putney Hill, November 22

Fly-Maggots Feeding on Caterpillars

AFTER Mr. McLachlan's remarks in NATURE for November 20 (p. 54), on Dr. Bonavia's note upon the above subject, it is hardly necessary to say that your correspondent, F. N. Pierce (November 27, p. 82) is undoubtedly mistaken in saying that he has bred the house-fly, *Musca domestica*, from Lepidopterous larvæ. If he has really bred *Musca domestica*, it is a new fact, and I should be very glad to see a specimen. I have had some considerable experience in breeding Lepidoptera, and have frequently bred out Dipterous parasites; these have invariably been *Tachinids*, mostly of the genus *Exorista*. To the ordinary observer they very closely resemble *Musca domestica*, but the same observer would very probably call all the various species of *Musca*, *Anthomyia*, *Homalomyia*, *Stomoxys*, &c., which frequently occur in houses, "house-flies." The general appearance of many of these genera is very much the same, and the term "house-fly" is such a vague one that I remember a good microscopist once showed me a slide labelled "upper and lower wing of house-fly"! some Hymenopteron caught on a window apparently furnishing the materials.

The Diptera are unfortunately much neglected in this country, and many groups are very little known. This is especially the case with the *Tachinina*, and Lepidopterists who breed them would benefit science by pinning the specimens and sending them to one or other of the few students of this order of insects.

4, East Street, Lewes, November 29 J. H. A. JENNER

YOUR correspondent, Mr. F. N. Pierce, in NATURE for November 27 (p. 82) merely continues the error suggested by Dr. Bonavia's note on this subject. It is not the larvæ of the house-fly (*Musca domestica*) that he has found as parasites on his butterfly and moth caterpillars, but the larvæ of a *Tachina*, a Dipterous genus of the *Muscidæ*, too well known among even mere collectors, I should have thought, for such a mistake to be made. There is of course a superficial resemblance.

M. E. S.

The Forbes Memorial

MAY I make use of your widely circulated pages to say that I purpose in a few days to send to press a list of the subscribers to the Forbes Memorial, to be bound up with the issue of the zoological memoirs of our lamented friend; the Memorial Volume is now nearly ready, and I shall be glad to hear from any of the friends of Mr. W. A. Forbes who have not already communicated with me on the subject. May I add that it was agreed by the Committee that subscribers should receive a copy of the volume for every guinea subscribed.

F. JEFFREY BELL

5, Radnor Place, Gloucester Square, W.

THOMAS WRIGHT, M.D., F.R.S.

IT is perhaps hardly sufficiently recognised how much the progress of science has been helped by the leisure-hour occupations of busy professional men. No branch of science has profited more from this source than geology, and no calling has furnished so many helpful labourers as medicine. The career of Dr. Wright, whose recent death is so sincerely regretted, supplies one of the most notable examples of a life apparently absorbed in the laborious duties of a medical practitioner, yet wherein time was found for the pursuit of a long series of original and valuable researches in palæontology. To those who knew him only as a doctor, it might well seem that his whole time and thought were given to the duties of his medical practice. Those, on the other hand, who met him as a geologist and palæontologist could hardly realise that he had any other occupation than the study of the fossils which he treasured and described with such enthusiasm.

Dr. Wright was born in Paisley in 1809. Having a near relative engaged in the practice of medicine, he chose the same profession for himself, and received the earlier part of his education at Glasgow. Before he had completed his studies, he was induced to quit medicine and take part in the development of the manufacturing arts, then making rapid strides in Scotland. But finding the change unsuited for his temperament he turned back with a sense of relief to the profession he had abandoned, resumed his medical studies in Dublin, and finally graduated in 1846. Soon thereafter, circumstances led him to settle in Cheltenham, where he has since spent the whole of his long and honoured life. His devotion to the healing art, and his bent towards a scientific treatment of his subject, were soon recognised, and he became successively attached to the Dispensary and General Hospital, and finally Medical Officer of Health for Cheltenham and surrounding districts. He was twice married, and leaves a son and two daughters by the second marriage.

In the early days of his career Dr. Wright manifested his love for scientific investigation. While still a student in Dublin he devoted himself with ardour to the study of human anatomy, and especially to the application of microscopic research in that department of inquiry. His eyesight, however, not proving strong enough to bear the strain of microscopic work, he finally exchanged that pursuit for the cultivation of palæontology, which from the position of Cheltenham in the midst of richly fossiliferous rocks, lay temptingly open to him. Ranging over the abundant organic remains of the Lias and Oolites of his neighbourhood, he chose the Echinoderms as his special subject, and began to publish the results of his observations. His early papers gained for him the friendship and co-operation of Edward Forbes. It was arranged that the two naturalists should conjointly describe the Echinoderms of the British Secondary formations, Forbes taking the Cretaceous, and Wright the Jurassic forms. The former did not live to carry out his part of the programme, which was accordingly completed by his colleague. The monographs on the Secondary Echinoderms were published by the Palæontographical Society, and form an enduring monument of Dr. Wright's patient and minute research. But while engaged in these investigations, he did not neglect other departments of Jurassic palæontology. In particular, he devoted himself with

unwearied industry to the collection and comparison of the Cephalopods of the Lias, and at length, after some forty years of preparation, began his great monograph on "The Lias Ammonites," a work of much research, of which the concluding part is about to be issued, and which forms an enduring landmark in the history of English palæontology. In the course of the inquiries rendered requisite for this exhaustive treatise, he not only made himself acquainted with the fossil localities and public and private collections in this country, but paid visits to many parts of the Continent to study the contents of foreign museums and to confer with his fellow-labourers in the same field scattered over France, Switzerland, and Germany. He was engaged, at the time of his death, upon a monograph of British Cretaceous Starfishes, which he had nearly completed.

The value of his scientific work has been fully recognised by his contemporaries. He was early elected as a Fellow of the Royal Society of Edinburgh. Subsequently he joined the Geological Society of London, and from that body eventually received its highest honour—the Wollaston Medal. In 1879 he was elected into the Royal Society. He was President of the Geological Section of the British Association at the Bristol meeting in 1875. His published papers and memoirs are numerous, but the largest and most important are his monographs in the publications of the Palæontographical Society.

It was not alone by original research that Dr. Wright strove to foster the progress of his favourite science. As one of the fathers of the Cotteswold Field Club, as President of the Literary and Philosophical Association of Cheltenham, as a frequent lecturer on scientific topics not only in Cheltenham, but in Bristol, Bath, Worcester, and other towns; and generally by the enthusiasm with which, amid all the obstacles of his busy professional life, he contrived to find leisure for the cultivation of science, he was unquestionably one of the living forces that stimulated the growth of science all over the West of England. His death is therefore a serious deprivation, and will be mourned by all in that region to whom scientific progress is dear.

To a narrower but still a wide circle his removal from among us is the loss of a leal-hearted friend. Those who were thus privileged will cherish the memory of that cheery face with the bright twinkle of eyes that were as brimful at one time of merriment as, at another, they were suffused with sympathy; the joyous laughter that rang out clear and strong from a heart in which there was no guile; the earnest brow and hand upturned behind the ear as the talk went on over his favourite pursuits; the bursts of enthusiasm as some new fact or novel deduction dawned on him, and the play of humour that was ever ready to break out like a beam of summer sunshine. Dr. Wright made his final expedition in August last year, when he joined the writer of these lines in the Island of Arran. Already the symptoms of his fatal malady had shown themselves, and he knew what they foreboded. But he carried with him nevertheless his characteristic sunniness of nature. Seated on the bare mountain-side with the purple heather and yellowed bracken around him, the sea in front, and his own native Renfrewshire hills in the blue distance, he became almost a boy again as he told his reminiscences of old times and watched the sports of children among the gray boulders. Ripe in honours as in years, it seemed as if he had come back to his early northern air to drink it once more, and review his past before he should quit us for ever. He would saunter for hours in the quiet glen, with no companion but his own thoughts and the sights and sounds of Nature, which were an ever-gushing fountain of pleasure to him. Cherished is every memory of him, but most of all those parting days spent with him at the foot of the mountains and by the shore of the restless sea.

A. G.

ROBERT A. C. GODWIN-AUSTEN, F.R.S.

IN many respects Mr. Godwin-Austen stood out apart from his fellow-geologists in this country. He wrote comparatively little, but what he did write was always weighty and full of suggestiveness. Instead of loading the literature of science with a pile of little papers, each containing some trifling addition or supposed addition to the sum of knowledge, or some criticism well- or ill-founded of the work of others, he allowed his ideas to mature, and published them from time to time in luminous essays which many years afterwards may be read over again with profit as well as pleasure. He began to write about half a century ago, his earliest papers being devoted to the geological features of Devonshire, of which, at that time, very little was known. By degrees he extended the area of his observations eastwards into the south-eastern counties. His essays "On the Valley of the English Channel" (1850), and "On the Superficial Accumulations of the Coasts of the English Channel, and the changes which they indicate" (1851), were among the most thoughtful contributions that had ever been made to the elucidation of the existing outlines of sea and land. This department of inquiry was one that peculiarly fascinated him. Hence, when his friend Edward Forbes died and left his "Natural History of the European Seas" only half completed, he himself chivalrously finished it, and supplied some chapters which only an accomplished and far-sighted geologist could have written. His various papers on drift-gravels, on boulders in the Chalk, and other superficial phenomena, are all marked by the same grasp and breadth of treatment.

But perhaps the paper which has chiefly contributed to give Mr. Godwin-Austen his ascendency among English geologists and to make his name known beyond geological circles is his now well-known essay "On the Possible Extension of the Coal-Measures beneath the South-Eastern Part of England" (1855). In this remarkable memoir he brings to bear his detailed knowledge of the rocks of the south-west of England, the north of France, and the adjoining tracts of Belgium. He marshals all his facts in such a way as to enable us, as it were, to strip off the thick cover of Mesozoic formations and trace the deep-seated connection of the Palæozoic area of Southern England and the Continent. At the time when he wrote, nothing was actually known of the subject, but he predicted that a submerged Palæozoic ridge would be found extending from the south-west of England into France and Belgium. The results of the deep borings of recent years have fully verified this prediction.

Mr. Godwin-Austen, in his prime, was a frequent speaker at the meetings of the Geological Society, where his keen penetrative criticism and caustic sarcasm formed a prominent and valuable feature in the debates. Some of his most suggestive and pregnant views of geological questions were thrown off in the course of these debates, and were never otherwise published by him. He never courted publicity, but rather shrank from it as an incumbrance under which he would not willingly be fettered. For many years past he has lived as a retired country squire at his beautiful residence near Guildford, taking full interest in the progress of science, and glad to see his fellow-workers in geology under his roof, but seldom venturing into the turmoil of town and the disputatious atmosphere of learned societies. It is some consolation to geologists, who mourn the quenching of one of their luminaries, that his place is taken by a son who, by scientific labours in India and in this country, has proved himself a worthy successor.

CHARLES CLOUSTON

THE Rev. Chas. Clouston, LL.D., of Sandwick Manse, near Stromness, who died on the 10th ult. at the very advanced age of eighty-four years, was a man who

deserves more than a passing notice in our columns. To name one only of his many claims to scientific recognition, he commenced meteorological observations in Stromness in the year 1822, and continued them, either there or in the adjacent parish of Sandwick, to within a fortnight of his death in 1884.

He belonged to the old Norse stock in Orkney, coming from the township of Clouston in Stennis. Two families of this name now live in the township, having succeeded to their farms, by direct descent, for over 400 years. He studied in Edinburgh University, and had at first been destined for the medical profession. He became a Licentiate of the R.C.S. in Edinburgh in 1819, and at his death was probably the father of the College. When in 1826 he entered on his duties as assistant and successor to his father, in the combined parishes of Stromness and Sandwick, there was no medical man in the latter place. For nearly fifty years he acted as the local doctor, in addition to his clerical duties, giving advice and medicines *gratis*. His father had been minister of Stromness for over sixty years, so that father and son had kept up a continuous ministry for 120 years. He received the degree of LL.D. from the University of St. Andrew's many years ago.

In the year 1862 Dr. Clouston's reputation as a careful meteorological observer was so well established that Admiral FitzRoy intrusted to his charge an anemometer, which has been kept in constant operation for the space of twenty-two years. The original instrument was replaced by a new one in 1869. A discussion of the results of the first five years' records (1863-68) appeared in the *Quarterly Weather Report* for 1871. In addition to his regular observations and deductions therefrom, which he occasionally published, he wrote an essay, "An Explanation of the Popular Weather Prognostics of Scotland, on Scientific Principles," which gained the prize allotted by the Marquis of Tweeddale in 1867. His observations for the last thirty years, at least, have been regularly published by the Registrar-General for Scotland.

Dr. Clouston was not only a meteorologist, but an ardent follower of every branch of science which came in his way. In his "Guide to the Orkney Islands," a reprint of a portion of "Anderson's Guide," he modestly says, "Taking the Orkney Flora, as Dr. Neill left it, to include 462 specimens, and adding our own contribution of 156, it now contains 618 species." In archæology he took an active part in the exploration of Maes How, and the House of Skaill, both of them within a walk of his home.

Dr. Clouston leaves a widow, two sons, and two daughters, but more than one member of his family passed away before him. In conclusion, we can only say that a visit to Sandwick was ever a rare treat; the warm hospitality of the manse, and the interest of the conversation carried on round the table, could not fail to leave an impression which will not easily wear away.

ON THE AUTUMNAL TINTS OF FOLIAGE

AFTER the fine display of autumnal tints which we have lately seen it may, I trust, be of interest to some of the readers of NATURE if I give an account of the chief conclusions to which I have been led by carefully studying the subject for many years.

As a general rule the colour of leaves in their normal condition depends on a variable mixture of two perfectly distinct green pigments and of at least four perfectly distinct yellow substances. The development of the autumnal tints is mainly due to the disappearance or change of the green constituents and to the production of highly-coloured pigments by the oxidisation of previously existing very pale or colourless substances. It is, in fact, due to a more or less complete loss of the vitality which previously counteracted these chemical changes, and the order in which the tints are developed can be easily explained, if we assume that the death of the leaves takes place somewhat gradually. The first visible effect of the reduced vitality is the change in the green pigments. In many cases they appear to be converted into colourless products, since the resulting bright yellow leaves differ from the normal green in the absence of chlorophyll, and merely contain the usual previously-existing yellow pigments. At the same time it is quite possible that an increased quantity of some of these yellow substances may be formed as a product during the change, but of this there is no positive proof. In the case of such trees as the alder, the chlorophyll does not thus disappear, but is changed by the presence of a weak acid into a very stable brownish-green product which resists further change. The production of bright yellows or dull browns thus clearly depends on whether the chlorophyll does or does not disappear before being modified by the action of acids, as may be verified experimentally by exposing suitable solutions to sunlight. It is, however, very clear that the manner in which it changes depends very much on the conditions of the case. Thus, if chlorophyll is exposed to sunlight dissolved in bisulphide of carbon, a reddish-coloured product is formed, and though this differs very greatly from the red pigment met with in many autumnal leaves, it seems probable that under some conditions the chlorophyll in leaves is changed by the action of light into a red substance. By taking green sorrel leaves and keeping them somewhat fresh by sticking the stalks into moist ground, I found that those exposed to the sun with the under side upwards turned to a bright red, whereas those kept in the shade did not develop any fine colouring. We may often see that partially broken leaves or twigs undergo this change when all other parts of the tree remain green, and this and various other facts lead me to conclude that the change of chlorophyll into a red product depends on a certain amount of reduced vitality as well as on little-understood conditions varying in different kinds of plants. Though I fully admit that there are some facts not easy to understand, yet on the whole it seems to me that these principles fairly well explain why certain leaves turn red in autumn. Slight frosts reduce their vitality in such a manner that the chlorophyll is changed by the action of the light into a red product. Thus, according to the character of the season and the nature of the plants, the first effect of the reduced vitality in the leaves is that the chlorophyll is removed so as to show their normal yellow colour, or is changed into a red pigment, or is altered into a comparatively stable dull brown green product. These are the three extreme changes, but in many cases intermediate mixed results give rise to such less perfect and well-marked tints as dirty yellows and reds.

The next series of changes is best studied in the case of those leaves which in the first instance turn to a bright yellow, and it appears to me that they depend mainly, if not entirely, on the production of deeply-coloured pigments by the oxidisation of tannic acid and other more or less colourless substances. The difference in the resulting tint seems to depend on the nature of these substances. Thus, for example, the tannic acid in the yellow oak leaves changes into a brown substance, whereas the quino-tannic acid in yellow beech leaves changes into the fine orange-brown colour which makes those trees so ornamental in autumn. On the contrary, the bright yellow poplar leaves rapidly pass to a dark dirty brown by the alteration of another constituent. Other kinds of leaves give rise to tints of an intermediate and less well-marked character. In many cases it is almost impossible to draw the line between the colour of this stage in the change and the final dark and dirty browns of dead and decaying leaves. For fine effect very much depends upon the production of each special tint in a fairly pure state, so as to show bright yellows, reds, and browns. This seems to be influenced by the character of the weather.

It is also, of course, important that the half-dead leaves should hang long on the trees, so as to develop their full colouring before being blown off by the wind.

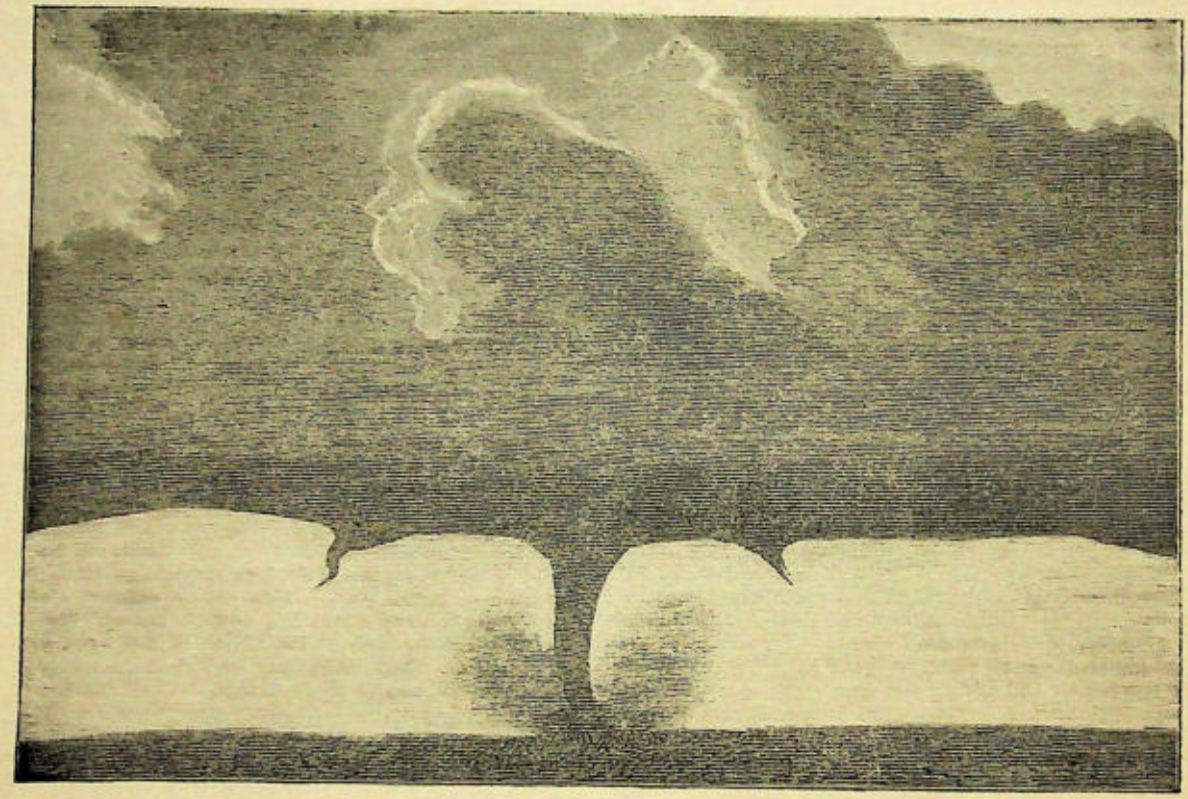
Taking thus all the facts into consideration, it appears clear that all the bright and beautiful tints of autumn are merely the earliest stages of decomposition, and are due to the more or less considerable triumph of chemical forces over the weakened or destroyed vitality of the living plant. One cannot but feel that this is a very unpoetical way in which to regard the magnificent tints of a fine autumnal landscape, but it is no less true than that the coloured clouds of evening mark the departing day.

H. C. SORBY

A TORNADO PHOTOGRAPHED

I SEND you to-day a photograph of a genuine Dakotah cyclone, or, rather, tornado, which was taken by F. N. Robinson, Howard, Miner County, D T., August 28, 1884. The storm passed twenty-two miles west of the city. It was first noticed at 4 o'clock p.m., moving in a south-easterly direction, remaining in sight over two hours; killing several people, and destroying all property in its course. I believe it to be unique as a portrait of this class of storms, and I have thought you might care to reproduce it for NATURE. EDWARD S. HOLDEN

Washburn Observatory, University of Wisconsin, Madison, November 14



METEOROLOGY OF MAGDEBURG[1]

THE second report, just published, of the Meteorological Observatory of Magdeburg presents some special features of interest. The observations with the instruments in more general use are given in very convenient forms in detail and abstract.

Magdeburg was one of the first observatories to adopt the barograph of Dr. Sprung, which is certainly one of the best barographs we possess. After the purchase-cost of 40*l*., the annual outlay in working it and preparing its curves of continuous registration for the lithographer is trifling. The curves are also of high value as accurate representations of the variations of atmospheric pressure. The whole of these curves are reproduced by Dr. Assmann in an elaborate series of lithographs, on which the inch of pressure is on a scale of four inches, and the twenty-four hours of the day extend over five inches and a half. By this large scale the minuter changes of pressure are represented with great distinctness, and their relations to changes of wind, cloud, and other weather conditions can be more clearly seen. Dr. Assmann draws attention to five of the small changes from August 27 to 30 as disturbances due to the Krakatoa eruption.

The hourly values have been taken from these curves, and the means for the months calculated and added to the report. From these means and those of the previous year, a first approximation to the diurnal oscillation of the barometer for this part of Europe is obtained. The result is peculiarly interesting from the transitions it shows in the hourly variations of the summer pressure as compared on the one hand with the variations which occur at the stations of the German Seewarte on the North and Baltic Seas, and on the other with those which occur at places more in the interior of the Continent. Unfortunately for the prosecution of several inquiries raised by these differences, hourly hygrometric observations are not available from any of these first-class meteorological observatories.

Another interesting feature are the twelve lithographs which represent the continuous registrations of the sunshine recorder, on the scale of 0·4 inch for each hour These lines, which show the sunshine and inferentially the state of the sky in respect of cloud, give valuable information regarding certain hygrometric states of the atmosphere. Hence, with the aid of these and the barometric curves, the influence on the diurnal curve of

[1] "Jahrbuch der Meteorologischen Beobachtungen der Wetterwerte der Magdeburgischen Zeitung." Herausgegeben von Dr. R. Assmann. Jahrgang II. 1883. (Magdeburg, 1884).

pressure of such widely-contrasted states of weather as continuous strong sunshine and continuous cloud may be investigated.

The direction and force of the wind for each hour of the year is given in full. As regards force, the results show for each month a minimum during the night, or, rather, early morning, and a maximum at noon or shortly thereafter. The extremes of difference occurred in December and June, the maximum being only one-fifth greater than the minimum in December, whereas in June the wind blew with more than double the velocity during the hours about noon than it did from 2 to 4 a.m. It may be remarked here that also in June the sunshine attained to the annual maximum. The relations of the hourly variations of wind direction and force to some of the more decided disturbances of the barometric curves are interesting and striking; and still more striking and important would have been the comparisons of the minute disturbances in the barometric curve with similar disturbances shown by continuous registrations of direction and velocity of wind.

The rest of the report is taken up with observations, either once or thrice a day, of the temperature of the soil at depths, in metres, of 5, 3, 1, 0·15, 0·05, and 0·00; daily observations with maximum and minimum thermometers under a thin covering of earth, exposed on bare soil, and immediately over short grass; daily observations with five maximum and five minimum thermometers at heights, in metres, above the ground, of 0·05, 0·20, 0·40, 0·60, 0·80, and 1·00; observations with the solar radiation thermometer at a height of 102 feet, and on the evaporation,—all indicative of the spirit of activity and research which happily characterises this Observatory.

ON A HYDRIFORM PHASE OF "LIMNOCODIUM SOWERBII"

IT is now four years and a half since Mr. Sowerby first discovered the fresh-water jelly-fish in the tank at Regent's Park, and since that time no definite advance has been made towards clearing up the mystery of their life-history.

Prof. Lankester has continued to make observations and experiments of various kinds, in which I have assisted him, but we have hitherto had no opportunity of examining the tank after the withdrawal of the water. This year, however, Prof. Lankester arranged with Mr. Sowerby that we should be present at that operation. This took place on Thursday last. We collected a large quantity of the sediment and portions of the roots of various plants, and Prof. Lankester kindly placed the whole of this material in my hands for further investigation. I soon discovered upon some of the *Pontederia* roots numerous specimens of a minute organism which proved to be hydroid in nature, and evidently a phase in the life-history of *Limnocodium*.

Further particulars, including an account of its remarkable structure, and the possible theories as to its connection with the Medusiform person, I reserve till next week, when Prof. Lankester has kindly offered to communicate them for me to the Royal Society.

I may add that Mr. Sowerby has kindly made arrangements at the Botanic Gardens for keeping the *Pontederia* roots in water in the warm tank during the winter, and that, with Mr. Thiselton Dyer's kind permission, I have placed one of the roots in the Royal Gardens at Kew.

ALFRED GIBBS BOURNE

NOTES

THE Lords of the Committee of Council on Education have received information, through Her Majesty's Principal Secretary of State for Foreign Affairs, that Her Majesty's Consul at Antwerp has been appointed British Commissioner for the International Exhibition which is to be held at Antwerp next year, and that Mr. P. L. Simmonds has been appointed by the Executive Council of the Exhibition at Antwerp their Agent-General for Great Britain and Ireland. The Exhibition in question is a national undertaking under the immediate patronage of His Majesty the King of the Belgians and of the Belgian Government. The President of the Exhibition is H.R.H. the Count of Flanders, and the Vice-President the Minister of Agriculture, Industry, and Commerce. The office of the Agent-General is at 35, Queen Victoria Street, and communications from intending exhibitors should be addressed to him there.

A REMARK was made at the Royal Society dinner on Monday touching the rapidly increasing number of awards of Royal medals not only to Cambridge men, but to men at Cambridge. In connection with it we may refer our readers to an appreciative article in Tuesday's *Times* on Natural Science at that University, in which the immense progress made during the last twenty years is well brought out. The results which may follow from the growth of a Medical School, and of Girton and Newnham, are indicated. The article concludes with the statement that the new studies, for good or ill, have taken root firmly. "They have already exercised a strong depolarising effect upon the cherished traditions and practices of the older studies. Everything is looked at in a new light, from a scientific point of view; and nothing which cannot stand the scientific test is allowed to pass unchallenged. The outcome of all this can be but dimly foreseen."

AT the annual meeting of the Fellows of the Royal Society of Edinburgh, held on Monday, the 24th ult., the following were elected office-bearers for next year:—President: Thomas Stevenson, M.I.C.E.; Vice-Presidents: Rev. W. Lindsay Alexander, D.D., Robert Gray, A. Forbes Irvine of Drum, Edward Sang, LL.D., David Milne Home, John Murray; General Secretary: Prof. Tait; Secretaries to Ordinary Meetings: Prof. Turner, Prof. Crum Brown; Treasurer: Adam Gillies Smith, C.A.; Curator of Library and Museum: Alexander Buchan, M.A.; Councillors: Prof. Cossar Ewart, Prof. James Geikie, Rev. Dr. W. Robertson Smith, Stair Agnew, Prof. Douglas Maclagan, M.D., Hon. Lord Maclaren, Rev. Prof. Flint, D.D., Prof. T. R. Fraser, M.D., Prof. Chiene, J. Y. Buchanan, Prof. Chrystal, Prof. Dickson.

THE University of Edinburgh has just suffered a severe loss by the sudden death of its Principal, Sir Alexander Grant. Many men of science in all parts of the world, who attended the Tercentenary Celebration last April, will remember the prominent and successful part played by the Principal in that remarkable gathering. Full of fresh zeal from this recent triumph of the University, he only a month ago opened the winter session by giving an address to the students, and seemed likely for many years to keep his post and witness a still further increase of that unexampled prosperity which the University has enjoyed under his rule. But this was not to be. He was struck down by an apoplectic attack on Sunday last in his fifty-eighth year.

M. COCHERY, the French Minister of Postal Telegraphy, has ordered the employment of the pneumatic system, which has now been completed in Paris, for the conveyance of ordinary letters to the several railway stations after the closing hours of the different post-offices, the charge being fixed at three deniers for each letter. This is said to be a step preliminary to the carriage of letters, instead of postal cards, by the tubes at an accelerated rate.

WE have received from Messrs. De La Rue and Co. their Diaries—pocket and otherwise—for the ensuing year, and also a charming collection of Christmas cards. The former are as beautifully finished and as full of scientific information and data

as usual. Some of the new series of Christmas and New Year's cards have also a scientific side to them, as they refer to flowers and birds, form and colour being carefully studied, and perhaps even more carefully given than they are in many books of botany and natural history. The series which gives us the story of a fox hunt by monkeys on dogs contains some very masterly drawing.

MR. NEWALL has forwarded to us a sketch of the face of one of several watches which he designed and had made some years ago by Mr. D. Glasgow, of Myddleton Square, President of the Horological Institute. The "hours" are replaced by a large round dot, which is easily seen even on a dark night in the Observatory, and there is no need for figures or a double row of them to count up to 24 o'clock, as has been suggested.

WE have received vol. xx. of the *Transactions* of the Royal Society of Victoria, being a record of the work of the Society for last year. The longest paper in the number is one by Mr. Howitt, on the rocks of Noyang; two communications by Messrs. Blunt and Jamieson deal with the influence of light on bacteria, while Mr. Ralph discusses the occurrence of bacteria (bacilli) in living plants. In a paper on modern fireproof and watertight building materials, Mr. Behrendt refers specially to Trägerwellblech ("bearing corrugated iron plates") and asphalte. Mr. Ellery, the President of the Society, communicates notes on the recent red sunsets, which he attributes to the prevalence of vapour in the higher regions of the atmosphere; on the rainfall map recently issued by the Government of Victoria; and on the early history of telegraphy, the invention of which he attributes to Mr. Edward Davy, at one time of the Assay Office in Melbourne. Mr. MacGillivray gives the fifth and sixth instalments of his lists and descriptions of new or little-known Polyzoa. The remaining papers printed in the volume (although many more were read before the Society) are:—On the caves perforating marble deposits, Limestone Creek, by Mr. Stirling; incandescent lamps for surgical and microscopical purposes, by Mr. Joseph; electric lighting for mines, by the same author; notes on the dressing of tin ore, by Mr. Newberry; and notes on hydrology, by Mr. Steane.

A PROJECT which, if executed, would render the Paris Exhibition of 1889 for ever memorable, has been published by M. Eiffel, the French engineer, and is described in *La Nature*. It is to erect in the grounds of the Exhibition an iron tower 300 metres in height, that is, twice as high as the Great Pyramid, and more than twice the height of the Strasburg Cathedral; 160 metres he considers as the limit of height possible in a structure of which stone is the principal material, and hence iron is proposed. The base of the tower is of pyramidal shape, and is to be 70 metres high, and the superficial area at this height will be 5000 square metres; above this there are to be three other stages, or stories, in which will be rooms which it is proposed to use for various purposes, scientific and other. The towers of Notre Dame will be mere pygmies beside this colossal structure, and will not reach to its first floor. The projector points out that, in addition to its monumental character, the structure will be useful for strategical purposes in war time, on account of the vast range of view, for meteorological and astronomical observations, for at such a height the clearness of the air and the absence of fogs would render observations possible which cannot be made on the ground. The tower might also be used for the electric light. The whole exhibition and the surrounding neighbourhood might thus be lighted from a central point. Many scientific problems may, it is suggested, be investigated from the tower, such as the resistance of the air to different weights, certain laws of elasticity, the study of the compression of gas or vapours, of the oscillation of the pendulum. In shape it is to resemble an enormous lighthouse, gradually tapering from a wide base to the summit.

WE learn from *Science* that the Norwegian bark *Loveid*, recently arrived in Philadelphia, reports a very peculiar squall experienced October 18, in lat. 39° 49′ N., long. 69° 5′ W. During fine, clear weather, with a light breeze from the north-west, heavy banks of clouds of most threatening aspect suddenly appeared, driving in every direction. Almost immediately a heavy squall of wind and rain struck the vessel, the wind shifting quickly all around the compass. In the midst of this disturbance, which lasted about an hour, a single peal of thunder was heard, and simultaneously a bolt of lightning struck the fore-royal mast-head, and ran down the mast to the royal yard, which was almost destroyed. The lightning, which looked like a ball of fire, then ran out on the horn of the cross-trees, and "burst" with a loud report, scattering sparks all over the vessel. The barometer fell suddenly from 30 to 28·60, and then rose as rapidly, the weather becoming pleasant immediately afterwards. This is rather a peculiar squall, considering the locality and the season.

THE New York *Financial and Mining News* contains an account of the extraordinary effect of an explosion of a large quantity of nitro-glycerine in what appeared to be an extinct oil-well in the Pennsylvanian oil-fields. A careful examination of the soil in the shaft failed to reveal any trace of oil or gas, and at length, as a last resource, it was decided to try the effect of an explosion of a shell containing fifty quarts of this explosive. First a column of water rose eight or ten feet and then fell back; a few moments later the burnt glycerine, mud, and sand rushed up the derrick in a black stream, the blackness gradually changing to yellow. Then, with a roar, the gas burst forth in a cloud which for a moment hid the derrick from sight, and as it cleared away revealed a solid golden column half a foot in diameter shooting from the derrick floor eighty feet through the air, till it broke into fragments on the crown pulley and fell in showers of golden rain for many yards around. This column of oil continued for an hour rushing in a torrent into the air. The branches of the trees around were like huge yellow plumes, and a large stream ran down the hill to a road, where it nearly filled the space beneath a small bridge. In two hours the neighbouring flats were covered with a flood of oil, and the hillside looked as if a freshet had passed over it, while heavy clouds of gas hung low over the woods. Dams were built across the stream in order that the production might be calculated, but they were borne away almost as soon as erected. The people living near the flats fled to the hills; fires had to be extinguished in the district to prevent a conflagration. The outflow was estimated at 8000 barrels in twenty-four hours. Ultimately the stream was diverted into the banks, after much labour and some danger. It was noticed that all the wells in the neighbourhood declined as soon as the outflow here mentioned commenced, the gauges in some of them showing at the end of three days a fall to half their previous depth.

M. JAMIN, Perpetual Secretary of the Paris Academy of Sciences, has been elected a member of the Société française de Navigation aérienne. He will take his seat next Thursday, the 11th inst., and is to deliver a speech on the occasion. He is at present engaged in writing an exhaustive article on aërial direction, which will very shortly appear in the *Revue des deux Mondes*.

ON Saturday night Mr. H. M. Stanley, on leaving Berlin after attending the West African Conference, was entertained at a banquet by the Central Society for Commercial Geography. A peculiar feature of the banquet was an ethnological study in the shape of a group of mummers representing some races of Africa, presumably those of the Cameroon and Angra Pequena regions.

AN earthquake was felt on Sunday and Monday, November 23 and 24, near Briançon, in the valley of Queyras on the banks

of the Guil, a torrent discharging into the Durance, in the Department of the Hautes Alpes. Three days afterwards, on Thursday the 27th, a severe shock was felt at Grenoble, about 100 km. west-south-west from the Queyras valley. It lasted thirty seconds, passing in a direction from west to east. All the houses were shaken, but no injury is reported beyond the fright sustained by the inhabitants. The same night, almost at the same hour, six shocks were felt at Lyons, moving in the same direction; and commotions of a similar kind are announced from Turin and the sea-coast of Provence, at Cannes and Nice in particular.

We regret to hear that M. Dupuy de Lome, the celebrated naval engineer and Member of the French Academy of Sciences, is dangerously ill, and that his life is almost despaired of.

We regret to announce the death, at Paris, at the age of seventy-four, of M. Quet, a distinguished French mathematician, well known for his works in connection with capillarity, electricity, &c., most of which have appeared in the *Comptes Rendus* of the Paris Academy of Sciences.

M. W. de Fonvielle has published a pamphlet on "L'Aérostat dirigeable de Meudon," in which he endeavours to show that the reports current in the French Academy respecting the experiments in question are exaggerated, though at the same time he seeks to do justice to his distinguished countryman, who has twice succeeded in proving that by means of electricity the power of resistance may be imparted to balloons. He concludes by recommending that, the electric fluids having done their part, *la parole est à le vapeur*.

Interesting researches with so-called Paradise fish (*Macropus venustus*) were made at the Berlin Aquarium recently. The fish is a native of China, its body, only a few centimetres long, is of the brightest hues, and its bluish-green fins are so enormously large that the fish seems almost to succumb under their weight. It is easily kept, and breeds frequently in captivity; the temperature of the water it is kept in must, however, not be allowed to sink below 20° C.

One result of the recent expedition sent from Quetta under Sir Oriel Tanner to punish the inhabitants of the Zhob Valley is stated in a telegram from Calcutta to be a complete survey of the whole of that valley. It has been ascertained that the best road from the Gomul Pass to Candahar does not lie, as had been supposed, through the Zhob Valley, but through the valley of the Khwandar, and that the route is practicable for a large army.

Dr. Otto Finsch left Sydney on September 10 by the steamer *Samoa*, *en route* for the Phœnix and Union Islands, where he intends staying for some time and making extensive ethnographical collections.

The *Boletin* of the National Academy of Sciences in Cordova, Argentine Republic (Buenos Ayres, 1884), has a very long paper by Señor Ameghino on his geological and palæontological investigations in the province of Buenos Ayres. The only other paper is by Herr Doering, and deals with the sinking of artesian wells in the Argentine Republic.

The Rev. Henry H. Higgins publishes in a separate form a paper on "Museums of Natural History," read before the Literary and Philosophical Society of Liverpool. After an experience of over a quarter of a century, during which he passed several times every week through museum rooms, the author calculates that out of a thousand visitors to the Liverpool Museum, ten to twenty were students, 780 interested observers, and 200 loungers.

Mr. Charles C. Sherrington, B.A. of Caius College, Cambridge, has been elected to the vacant George Henry Lewes Studentship.

The additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus* ♀) from India, presented by Mr. W. J. Bennett; a Rhesus Monkey (*Macacus rhesus*) from India, presented by Mr. Samuel Levi; an Ocelot (*Felis pardalis*) from America, presented by Mr. H. B. Whitmarsh; two King Parrakeets (*Aprosmictus scapulatus*) from New South Wales, presented by Mr. E. Meek; a Cheer Pheasant (*Phasianus wallichii* ♀) from North India, presented by Mr. E. Buck; a Pig-tailed Monkey (*Macacus nemestrinus* ♂) from Java, deposited; a Rufous-necked Weaver Bird (*Hyphantornis textor*) from West Africa, received in exchange; four Long-fronted Gerbilles (*Gerbillus longifrons*), born in the Gardens.

THE ROYAL SOCIETY ANNIVERSARY

THIS meeting took place on Monday last, the time-honoured date—St. Andrew's Day—falling on Sunday. In the regretted absence of the President, Prof. Huxley, who, the Fellows were rejoiced to learn, is rapidly recovering his health from his sojourn in Italy, the Treasurer, Mr. John Evans, occupied the chair and read the following address:—

The absence of our President from his post to-day must of necessity cast a certain amount of gloom over the proceedings at this our anniversary meeting, and, personally, I feel additional regret that it devolves upon me, as your Senior Vice-President and Treasurer, to be the unworthy occupant of the chair on the present occasion. My regret at the absence of the President is, however, in one respect tempered by a strong hope, in which I am sure that you will all fervently join, that the timely retirement from arduous work which has been enforced upon him by his medical advisers may produce those beneficial results which we all so cordially desire, and that we may ere long again see among us our accomplished and valued President in renewed health and strength.

I must, however, turn from the expression of our hopes for the future, to that of our regrets for the past, and for a short time dwell upon the mournful list of vacancies which the ever-active hand of death has caused in our ranks during the past twelve months. In one respect only can a topic of consolation be found in this list. It is that in extent it is less than that of last year, the total number of our deceased Fellows being only eighteen on the home list and two on the foreign list, while those numbers were twenty-one and two respectively at our last anniversary.

Both the foreign members whose loss we have on the present occasion to deplore were men of the highest distinction in chemical science. Both were residents at Paris, and both had Chairs in the French Academy, of which the one had been since 1868 one of the permanent secretaries. I cannot dwell upon the discoveries and the remarkable career of M. Jean Baptiste André Dumas, whose energy and perspicuity, even when past the limit of fourscore years, all those who of late have had the opportunity of being present at a meeting of the French Academy must have found reason to admire. An appreciative memoir of him by one of our own Fellows, who of all men living is perhaps the best qualified to judge of the value of his labours—Prof. Hofman—written while Dumas was still among us, will be found in the pages of our own *Proceedings* (vol. xxxviii. x.), and those of Nature (vol. xxi. February 6, 1880). It will give some slight idea of the extent of time over which the labours of M. Dumas have extended if I mention that, so long ago as in 1843, he received the Copley Medal at our hands, at a time when his chemical and physiological researches had already extended over a period of twenty-two years. M. Dumas died at Cannes on April 11 last, and among the most touching of the speeches at his obsequies was that of M. Würtz, whose own decease took place on the 12th of the following month.

Although nearly twenty years younger than M. Dumas, M. Karl Adolph Würtz had for a long time been one of the most distinguished leaders of modern chemical science, especially in the department of organic chemistry, and his merits were recognised by this Society in 1864, when he was elected one of our foreign members, and again in 1881, when the Copley Medal was awarded to him.

Among our English Fellows was a contemporary of Würtz, who, like him, had been a pupil of the illustrious Liebig, but whose bent was more on the practical than on the theoretical

side of chemistry—I mean Dr. Angus Smith, whose official labours in favour of pure air and pure water combined both tact and zeal, and were productive of highly beneficial results.

One other chemist has been taken from among us, Mr. Henry Watts, the well-known editor of the "Dictionary of Chemistry," and of more than one issue of "Fownes's Manual."

Our other losses extend over various departments of science. In botany our ranks are thinned by the death of Dr. John Hutton Balfour, formerly Professor of Botany at Glasgow and the Emeritus Professor of that Chair in the University of Edinburgh; and of the veteran Mr. George Bentham, who had nearly completed his eighty-fourth year. During his long and varied experiences of life, botany was his constant pursuit and study; and some thirty years ago, after presenting his fine collections and library to the Royal Gardens at Kew, he devoted himself to labouring there on the Floras of Hong Kong and Australia, and in conjunction with Sir Joseph Hooker, on the "Genera Plantarum," until his health gave way in the spring of last year. The exceptional value of his botanical work was recognised by this Society in 1859, when a Royal Medal was awarded to him, and his regard for the Society has been testified by his making a bequest of 1000*l.* to our Scientific Relief Fund.

Among mathematicians we have lost Dr. Isaac Todhunter, whose educational treatises have for many years been recognised as standard works, and whose elaborate histories of different branches of mathematical science have earned for him a high reputation; and Mr. Charles W. Merrifield, who, in addition to achieving distinction by his educational works on arithmetic and mathematics, did much in the direction of the practical application of science, and at the Royal School of Naval Architecture and Marine Engineering successfully laboured in improving the stability and the sea-going powers of the British Navy.

Another distinguished mathematician whom we have within the last few weeks had the misfortune to lose, was the Rev. Richard Townsend, Professor of Natural Philosophy in the University of Dublin, whose labours in the more abstruse fields of geometrical speculation extended over a period of nearly forty years. Mr. James Rennie was also a votary of mathematical research.

Among practical men of science, the veteran Mr. Charles Manby, who for forty-five years had been Secretary or Honorary Secretary of the Institution of Civil Engineers, will deservedly take a high place.

The anatomical and physiological labours of Prof. Allen Thomson had extended over the longer term of fifty-four years, and few possessed the power of clearer exposition than he, while for acts of personal kindness there must be many besides myself who owe him a deep debt of gratitude.

Among others connected with the medical profession we miss the distinguished surgeon Mr. Cæsar Hawkins, Dr. Alexander Tweedie, and Sir Erasmus Wilson, whose name will long survive, not only in connection with dermatology and the Chair of Pathological Anatomy at Aberdeen, but with the Egyptian obelisk, known as Cleopatra's Needle, the presence of which in London is entirely due to his liberality.

In Mr. R. A. C. Godwin-Austen we have lost one who for nearly fifty years had ranked among the foremost of English geologists. His manifold observations will be recorded elsewhere, but as an instance of his critical powers, I may mention his now classical paper on the possible extension of the Coal Measures beneath the south-eastern part of England, read in 1855, his speculations in which as to the western extension of the axis of Artois, all recent deep borings within the Thames Basin have so fully substantiated.

In Dr. Wright we have lost an accomplished palæontologist whose knowledge of the fossil Echinodermata and Ammonitidæ was almost unrivalled.

The Duke of Buccleuch had for fifty years been one of our Fellows, and in 1867 occupied the position of President of the British Association; while Sir Bartle Frere, although an ethnologist and geographer, will probably be better known as an able and energetic public servant and administrator than as a man of science.

In common with the nation at large, we have to deplore the untimely and unexpected decease of another distinguished statesman, the late Postmaster-General, Mr. Fawcett. A man of rare mental powers, the effect upon him of the greatest of all physical deprivations, the loss of sight, was only to make him rise superior to his misfortune. As a student of political economy he attained a high reputation, and he turned his mastery of the subject to good account when he entered into the sphere of public life towards which his natural aspirations led him. His singleness and honesty of purpose, the inborn justice of his well-balanced mind, his devotion to the public good, and his invariable courtesy, endeared him alike to political friends and opponents; while to those who were brought into more immediate contact with him, his truly sympathetic nature, and the marvellous memory which preserved even minute details of former conversations, gave a charm to his intercourse which none who enjoyed it will ever forget.

As I have already observed, our losses on the home list, including one resignation of Fellowship and one removal from our list, are less than in many former years, being altogether 21 in number; we have, on the other hand, elected 16 Fellows, including one Privy Councillor. It would, however, appear that our numbers are gradually attaining to something like a state of equilibrium, and that if our elections continue to be limited as at present, the roll of the Society will remain at its present standard of about 470 Fellows. Looking at the recognised longevity of scientific men and the age at which many now achieve the distinction of being elected into the Society, it seems to me not improbable that our numbers will ere long show a tendency to increase rather than to diminish.

Of the *Philosophical Transactions* three parts, and of the *Proceedings* eleven numbers, have been published; while the number of papers received during the past year was 100, as compared with 103 in the previous year. Of these the most numerous have been in the departments of electricity and magnetism, though physics and mathematics, chemistry, mineralogy, anatomy, and physiology, botany, and morphology have all had their share.

It is hardly within my province to select any papers that we have published as being the most worthy of mention. The mere fact that they have appeared in the *Philosophical Transactions* is a sufficient voucher for their value. I may, however, call attention to the report of Captain Abney and Dr. Schuster, our Bakerian Lecturer for the present year, on the total solar eclipse of May 17, 1882, which is the outcome of an expedition towards which a grant of 350*l.* was made from our Donation Fund. Some of the results were mentioned by Mr. Spottiswoode in his Presidential Address of 1882, but the value of the details with regard to the corona, and the success which attended the efforts of the photographers, can only be estimated from an examination of the paper itself. The detailed results obtained by the photographers who accompanied the American expedition to Caroline Island in the South Pacific in order to observe the solar eclipse of May 5, 1883, have not yet been brought before the Society.

In respect to biological studies, our record of the past year, though it does not contain the announcement of any very startling results, gives evidence of fruitful activity along various lines of research.

In Botany, Mr. Gardiner has continued his observations on the important subject of the continuity of protoplasm in vegetable cells, which was referred to in the President's Address of last year; he has also brought forward some interesting results derived from an examination of the changes in the gland-cells of Dionæa, which serve still further to illustrate the identity of the fundamental physiological processes in plants and animals. Mr. Bower has dealt with the morphology of the leaf in certain plants, in a memoir both valuable in itself, and noteworthy because hitherto the study of abstract vegetable morphology has perhaps not obtained in this country the attention which it deserves, and which has been given to it in other countries, especially in Germany.

In Physiology two important papers have been presented on the difficult subject of the functions of the cerebral convolutions, one by Drs. Ferrier and Yeo, and the other by Prof. Schäfer and Mr. Horsley. Both contain observations which demand careful consideration by all physiologists.

The results of the study of animal forms which is happily being carried on with great activity, I may say, all over the United Kingdom, are for various reasons principally recorded elsewhere than in the pages of the *Transactions* or *Proceedings* of this Society. Nevertheless, this subject has also been fairly represented at our meetings. Our distinguished and unwearied Fellow, Prof. W. Kitchen Parker, is still continuing his elaborate and valuable researches on the vertebrate skull; and during the past session the Society has had the pleasure of receiving several short papers, expounded in person by their author, from

a veteran in the study of animal morphology, whose first communication to the Society bears the date of 1832. I need hardly say I mean Sir Richard Owen.

A few words must be said with regard to the acquisitions made by our library and collections. Our gallery of portraits has, through the kind liberality of Dr. Wilson of Florence, received two important additions in the form of half-length original portraits of the distinguished mathematicians and philosophers, Leibnitz and Viviani, both of whom were Foreign Members of this Society. When we remember the warmth of feeling with which the rival claims of Newton and Leibnitz to the invention of Fluxions or the Differential Calculus were for many years discussed, and call to mind that the question occupied the attention of a Committee of this Society in 1712, which reported in favour of Newton's claims, we may rejoice that the heat of the controversy is long since over, and congratulate ourselves that the portraits of these rival intellectual giants now hang peacefully side by side on our walls. The portrait of Viviani, the great geometrician, the pupil of Galileo and the associate of Torricelli, and a contemporary of Newton and Leibnitz, finds also a fitting resting-place in our gallery.

Our portfolio of engraved and lithographic portraits of scientific men has been considerably augmented by liberal donations from the executors of our former President, the late Sir Edward Sabine, through Mr. R. H. Scott.

The Lalande Medal, which had been awarded by the French Academy to Sir Edward in 1826, and which, together with a Royal Gold Medal, was presented to the Scientific Relief Fund, was by the Council redeemed from the Fund, and will be preserved among our other medals as a memorial of one who for so long a period rendered important services to the Society. A bronze medal of our distinguished Fellow, Prof. Sylvester, has been presented to our collection by the Johns Hopkins University, at Baltimore.

The library itself has during the past year received by donations about 380 complete volumes, besides about 240 pamphlets, and more than 2400 parts of serials; 24 charts have also been presented to it.

With regard to our finances, I may venture to say, as your Treasurer, that I consider them to be in a satisfactory condition.

I must now turn to some of the subjects which, during the past year, have occupied the attention of the President and Council, and which in more than one instance have brought them into communication with Her Majesty's Government.

In July of last year a letter from the Treasury was received requesting our opinion as to the desirability of subsidising the Armagh Observatory, the income of which had been materially reduced, owing to recent legislation in Ireland. In reply to this an answer was sent pointing out the good work that had been done in the Observatory, and the exceptional character of the institution, and recommending it to the favourable consideration of the Government. Unfortunately, however, the loss of income applicable to the maintenance of an Observatory has not been made good, though the Treasury, "having regard to the advice of the Royal Society, and to the diminution in the income of the Observatory," has granted a sum of 2,000*l.* in aid of its funds, the annual income derived from which sum is to be applied by trustees to the maintenance and purchase of instruments and apparatus.

Another correspondence with the Treasury as to the bathymetrical survey of the lakes within the British Isles did not lead to any concession in favour of such a necessary complement to the National Ordnance Survey, though the omission in our maps of all details relating to the depth of our lakes and the contour of their beds, cannot be justified on practical, and much less on scientific grounds.

In May last the Astronomer-Royal brought under our notice the position of this country with respect to the International Bureau des Poids et Mesures, an institution established by what is commonly known as the Metric Convention; and it was resolved that in the opinion of the President and Council it was highly desirable that our country should take part in the International Commission of Weights and Measures, and contribute the sum which our adhesion would entail. A deputation was appointed to bring the subject under the notice of the Lords of the Treasury, and, after some correspondence, the Society was authorised to enter into informal negotiations with the officers of the Bureau, with the happy result that Great Britain was invited to join the Metric Convention, and through her Ambassador at Paris has, I believe, now given in her adhesion to it, and is entitled to all the privileges accorded by the Bureau. The appliances at the command of the Bureau for the verification not only of the standards of the metric system, but of other units of measure, far surpass in scientific accuracy anything that is at present available in this country, and we now enjoy the double advantage of being removed from the state of isolation in which for some years we have stood in regard to the other nations of Europe, and of now being affiliated to an establishment in which the verification of standards has been carried to the highest perfection. At the same time, it is distinctly understood that our adhesion to the Bureau in no way commits the Government of this country to any change of opinion favourable to the adoption of the metric system, but that our entire freedom to retain our own system of weights and measures is absolutely preserved. Whatever may be the advantages of the metric system from a scientific point of view, the question whether a scale of weights, money, and measures, which in its lowest denominations follows a duodecimal rather than a decimal system, is not better adapted for the convenience of daily life, is one that by many is regarded as fairly open to discussion.

Another event of both scientific and national importance has been the meeting of an International Conference on the subject of a Prime Meridian of Longitude. The desirability of a common starting-point from which to reckon degrees of longitude has long been felt among all civilised nations, especially those of a maritime character, and was discussed at some length during the Congress of the International Geodetic Association at Rome in October 1883. It was not, however, until the end of last year that invitations were issued by the United States Government for different countries to send representatives to an International Conference to be held in the city of Washington for the purpose of discussing, and, if possible, fixing upon a meridian proper to be employed as a common zero of longitude and standard of time-reckoning throughout the globe. The letter of invitation addressed to this country was referred to the President and Council of this Society, with a request to advise the Government whether it was advisable in the interests of science to accept the invitation. In reply, an opinion was expressed as to the high importance, both for the interests of science in general, and of our own country in particular, that our Government should be represented at the Conference, and the Treasury at once sanctioned the expense of sending two delegates to Washington. These were Sir Frederick Evans, the late Hydrographer to the Admiralty, and Prof. J. C. Adams. General Strachey, the Chairman of the Meteorological Committee, was also nominated to represent India, and Mr. Fleming to represent the Dominion of Canada. The delegates assembled at Washington in the month of October last, and proceeded to discuss the questions whether a single prime meridian for all countries should be adopted, and if so, through what point on the earth's surface should that meridian be drawn. After long discussion it was eventually resolved that the meridian of Greenwich should be generally adopted, twenty-two[1] of the nations voting in favour of this measure, and only one, San Domingo, against it. The representatives of France and Brazil abstained from voting. The proposal for the adoption of Greenwich was made by one of the representatives of the United States of America, and was fully discussed. Our own representatives ably supported the proposal, and another of our most distinguished Fellows, Sir William Thomson, who happened to be in America at the time, was courteously invited to attend the meetings of the Conference, and on the request of the President to express his opinions. The arguments adduced in favour of the adoption of Greenwich were such as must commend themselves to all unprejudiced minds. It could hardly be expected that there should be any special spot upon the earth's surface from which longitude would naturally be reckoned, and the whole question, apart from any sentimental or patriotic feelings, is therefore one of the greatest convenience. Were the employment of degrees of longitude as general geographical units entirely unheard-of up to the present time, it would, of course, be a matter of perfect indifference whether the datum was at Greenwich, Paris, the Ferroe Isles, or any other spot. The meridians most in use are those of the two former places, and when we come to consider that, as was pointed out, the shipping tonnage controlled by the Greenwich

[1] The following nations voted in favour of Greenwich:—Austria, Chili, Colombia, Costa Rica, Great Britain, Guatemala, Hawaii, Italy, Japan, Liberia, Mexico, Netherlands, Paraguay, Russia, Salvador, Spain, Sweden, Switzerland, Turkey, United States, and Venezuela.

standard of longitude is about 14,000,000 tons, while that controlled by the longitude of Paris amounts to 1,750,000 tons only, the preponderance of convenience in favour of the former is placed beyond all dispute. The use of nautical charts constructed from the meridian of Greenwich, and also of the Greenwich *Nautical Almanac*, is by no means confined to the British Navy, for numerous other nations have availed themselves of the long-extended labours of our hydrographers, and the computations of our astronomers. At the same time there is no one among us who would for a moment venture to dispute the vast services to science which have been rendered by French astronomers and geographers, nor should we contest the right of French savants to regard Paris as the μεσόμφαλος ἑστία of all other branches of science; the question of a common zero of longitude, however, is not only of scientific but of commercial importance, and we may be confident that eventually our friends on the other side of the Channel, whose metric system has been so largely adopted by other countries, will in their turn sacrifice their own meridian, and adopt that which all neighbouring countries have declared to be the most convenient for general use. If some French locality on the meridian of Greenwich, such for instance as Argentan, were nominally the French datum, the results would be the same so far as maps and charts are concerned, and the natural patriotism of the French nation would remain uninjured.

The adoption of a universal day has also been recommended by the Conference. It is to be a mean solar day to begin for all the world at the moment of mean midnight of the initial meridian, coinciding with the beginning of the civil day and date of that meridian, and is to be counted from zero up to twenty-four hours.

The great volcanic eruption of Krakatoa, in the Straits of Sunda, which took place in August of last year, was followed by remarkable atmospheric and other disturbances, observations on which have been communicated to this and various other learned Societies, and have led to much interesting discussion. The fact, as pointed out by General Strachey and Mr. Scott, that at some barometrical stations the atmospheric wave caused by the eruption was still to be traced until about 122 hours after its origin, and that it must have travelled more than three times round the entire circuit of the earth, shows how vast must have been the initial disturbance causing the wave. The possibility of the remarkable atmospheric appearances which so constantly accompanied the rising and setting of the sun for some months subsequent to the eruption being due to volcanic dust in suspension in the air, offered a farther incentive to investigate the whole history of the eruption. In consequence, the Council in January last nominated a Committee to collect the various accounts of the volcanic eruption at Krakatoa and attendant phenomena, in such form as shall best provide for their preservation and promote their usefulness, and a sum of 100*l.* in all has been granted from the Donation Fund to defray the expenses of the Committee. A Committee of the Royal Meteorological Society, which had already been appointed to study the sunset phenomena of 1883-84, joined forces with our Committee, and their united labours, with Mr. A. Ramsay as secretary, have resulted in the accumulation of a voluminous mass of material. The accounts given in the chief British and foreign scientific serials have been extracted and classified, and the times of the various observations reduced to Greenwich mean time.

The literature on the subject, as Mr. Symons informs me, seems almost inexhaustible, and the Committee, feeling that some limit must be adopted, have now stopped the collection of further data, and are engaged in the discussion of what have already been obtained. The manuscript is classified according to subjects, and each of these is being studied by the members of the Committee most familiar with it. It is to be hoped that in the ensuing session we shall be favoured with some of the results of their labours.

In the Presidential Address of last year mention was made of a series of borings which it was proposed to make across the delta of the Nile in Egypt, and which, with the sanction of the Secretary of State for War, had been intrusted to the officer commanding the Royal Engineers attached to the army of occupation in Egypt. Shortly afterwards a Report from Col. Heriot Maitland, R.E., and Major R. H. Williams, R.E., was received, giving an account of a boring at Kasr-el-Nil, near Cairo, which had been carried to a depth of 45 feet, and of a second boring at Kafr Zaiyat, where a depth of 84 feet was attained. In both cases great difficulties had to be surmounted, but in neither was the solid rock reached beneath the superficial deposits. A second Report from the same officers, dated January 18 last, states that a third boring had been executed at Tantah, this time by the sappers of the Royal Engineers, and not by Arab workmen, though still with but imperfect tools. In this instance a depth of 73 feet was reached, but again without finding the solid rock. Samples of the materials obtained at different depths in these three borings have been forwarded to the Society by the War Department, and Prof. Judd has kindly undertaken their microscopic examination, and will shortly report the results of his labours to the Committee in charge of the subject.

With regard to the continuance of the borings, which seem to promise information of great value and interest, it is to be feared that the attention of the military authorities will for some time to come be attracted to more urgent business, though the Council of this Society has expressed its willingness to grant from the Donation Fund a further sum of 200*l.*, with the view of obtaining better apparatus for boring than that which has hitherto been employed.

The publication of the results of the *Challenger* Expedition, with which a Committee of this Society is to some extent concerned, has made considerable progress during the past year. Mr. Murray informs me that 47 Reports, forming 13 large quarto volumes, with 6276 pages of letterpress, 1051 lithographic plates, many woodcuts, charts, and other illustrations, have now been published. Nine other Reports are now being printed, and the eleventh Zoological volume and the first Botanical volume will be issued during the present financial year.

The work connected with the remaining thirty-six memoirs is making satisfactory progress, a large instalment of the manuscript being already prepared, and many of the plates either already printed off or drawn on the stone.

There has been an unavoidable delay in the case of the two volumes containing the narrative of the cruise and a general account of the scientific results of the Expedition, but it is expected that they will be issued within the next three months, and possibly before the end of the current year.

It was estimated that the investigations connected with the collections and observations made during the Expedition would be completed and published in 1887, and Mr. Murray has every reason to believe that the work will be finished within the estimated time.

The tenth Zoological volume which has just been issued, contains important Reports on the Nudibranchiata, Myzostomida, and Cirripedia, by Drs. Rudolph Bergh, L. von Graff, P. P. C. Hoek, as well as on the Cheilostomata, a sub-order of the Polyzoa, by Mr. George Busk. A first instalment of the Anthropological Report is also given by Prof. William Turner, in a detailed examination of the human crania, upwards of 60 in number, brought home by the Expedition. The total number of crania, however, described and tabulated in the memoir is 143, the whole from aboriginal and as yet uncivilised people. The previous Zoological volume is devoted to an exhaustive examination of the Foraminifera, by Mr. H. B. Brady.

The subject of the International Polar Observations, which were carried out during the twelve months ending with August 1883, has been touched on in recent Presidential Addresses, and in that for 1881 the general outline of the whole scheme was indicated. Now, however, the programme then only sketched out has been more than fulfilled, no less than 14 stations for observers, 12 for the Northern and 2 for the Southern Hemisphere, having been organised. Of all the expeditions, one only, that from Holland, failed to reach its destination, Dickson Harbour, at the mouth of the Obi River, as it was beset by ice in the Kara Sea, in the month of September 1882. The ship which carried the members of the expedition sank in the month of July 1883, but they all reached home in safety, having carried out their observations as fully as lay in their power. One of the two expeditions sent out by the Chief Signal Office, Washington, was not so fortunate. The party under Lieutenant Greely, after spending over two years at Lady Franklin Bay, Smith's Sound, was eventually rescued at Cape Sabine, in July last, but not before many of its members had succumbed beneath the fearful hardships of their protracted Arctic sojourn.

The actual points of observation, going eastwards from Behring Straits, and the States which sent out the expeditions, are tabulated below:—

Point Barrow	The United States.
Fort Rae	Great Britain and Canada.

Lady Franklin Bay	The United States.
Cumberland Sound	Germany.
Godthaab	Denmark.
Jan Mayen	Austria.
Spitzbergen	Sweden.
Bossekop	Norway.
Sodankyla	Finland.
Nova Zemlya	Russia.
Mouth of the Lena	
The Kara Sea	Holland.

In the Southern Hemisphere—

Cape Horn	France.
South Georgia	Germany.

At all of these stations observations were carried on for a year, and at some for even a longer period.

In the month of April last a Conference was held at Vienna, to decide as to the form and mode of discussion and publication of the results, and it may be hoped that these will appear before the end of 1885.

Of the serial publication, "Communications from the International Polar Commission," six parts, with an aggregate of 334 pages, have already appeared, and in it will be found all particulars of the undertaking.

The regulations under which the Government Grant of 4000*l.* is administered have during the past year been again under discussion, and have in some respects been slightly modified. It is, of course, needless to repeat that this grant, though nominally made to the Royal Society, in no way adds to its funds, while its administration rests with a Committee of from sixty or seventy members, many of whom are not of necessity Fellows of our Society. As the grant is now made in two instalments, it has been arranged that the meetings of the Committee shall be held twice in each year, viz., in May and December, which it is hoped will amply meet the convenience of applicants for grants.

In looking back upon the grants which have been made during the past year, I think that a tendency may be observed on the part of the Committee to devote considerable sums in aid of extensive researches rather than to fritter away the money at their disposal in a series of small grants. They have, for instance, allotted the sum of 500*l.* towards the exploration of Kilimanjaro and the adjoining mountains of Tropical Africa, and 200*l.* in aid of an expedition for the exploration of the mountain of Roraima in British Guiana. A grant of 200*l.* has also been made towards a report on the Flora of China; while 300*l.* has been allotted towards the extra accommodation and instruments for magnetic observations in the new Observatory of the Royal Cornwall Polytechnic Society. It will be remembered that, in his Address last year, the President called attention to the discovery by Dr. Huggins of a method of photographing the solar corona without an eclipse; and, for the purpose of making further experiments in this direction, and for carrying on other physical observations at some place of high elevation and of easy access, a grant of 250*l.* was placed at the disposal of a Committee. The place of observation selected by the Committee was the Riffel, near Zermatt, in Switzerland, which has an elevation of 8500 feet, and possesses important advantages both of access, and of hotel accommodation. They appointed Mr. C. Ray Woods, who had had experience in photographing the corona during the eclipse of 1882 in Egypt, and again in Caroline Island in 1883, to take charge of the work under the instructions of Dr. Huggins and Capt. Abney.

Mr. Woods arrived at the Riffel in the beginning of July, when he erected the necessary instruments under a tent of "Willesdenised" paper, and continued at work there until September 21. Unfortunately, the present year has been exceptionally unfavourable for work on the corona, in consequence of an unusual want of transparency in the higher regions of the atmosphere. This probably may be owing to the presence there of ice-crystals or of small particles of matter of some kind, such as, personally, I am tempted to think might be due to the Krakatoa eruption. Whatever the cause, the sky as seen from the Riffel was far from being so clear as it has been during former years. Mr. Woods observed that the freer the lower air was from cloud and mist, the more distinctly came out a great aureola around the sun, which he found to have a diameter of about 44°, and to be of a faint red near the outer boundary, and bluish-white within, up to the sun's limb.

These unfavourable conditions of the atmosphere have made it impossible for Dr. Huggins to obtain any photographs of the corona in England. The great advantage at the Riffel of being free from the light scattered from the lower 8000 feet of air has enabled Mr. Woods, notwithstanding the serious drawback of the persistent aureola, to obtain about 150 photographs, of which more than half are sufficiently good to show the general form, and a smaller number the stronger details of that part of the corona which lies within from 8′ to 12′ of the sun's limb. It would be premature to express any opinion as to the information which may eventually come out from the Riffel plates. They are now being drawn preparatory to a full discussion. In the meantime I may congratulate the Society upon the confirmation of the hope expressed by our President at the last anniversary, "that a new and powerful method of investigation has been placed in the hands of students of solar physics."

Another of the grants made by the Committee has also contributed to important scientific results, as it has enabled Mr. Caldwell to make some important observations on the early stages of the Monotreme ovum, a brief account of which was communicated to the meeting of the British Association for the Advancement of Science at Montreal. A fuller account of the observations, such as is necessary for the adequate appreciation of their importance and bearings, will, I hope, be laid before the Society during the ensuing session, when we shall also probably hear the result of similar investigations in like manner rendered possible by the existence of the Government Grant.

Some slight aid has been rendered from the same source towards the reduction of observations carried on at the meteorological station on the summit of Ben Nevis. This Observatory, situated on the highest point within the United Kingdom, has through the past year been under the charge of Mr. R. T. Omond and two assistants. During the summer months the buildings of the Observatory have been enlarged by the addition of new observing-rooms and increased accommodation for the observers and any scientific workers who may desire to carry on those physical researches for which the climate and position of Ben Nevis afford many facilities.

The erection and equipment of the Observatory have cost more than 5000*l.*; and, in connection with the observations carried on at the top of the mountain, others have been daily made near the sea-level at Fort William. A first report on these conjoint high- and low-level observations, which began in 1881, has been prepared by Mr. Buchan ("*Journal* of the Scottish Meteorol. Soc.," 3rd Series, No. 1 (1884), p. 4). The monthly normals for atmospheric pressure and temperature have been approximately determined for the Observatory. Important results have also been obtained relating to the decrement of temperature with height, for different months of the year and hours of the day, the diurnal variations of the wind's velocity, the very large increase in the rainfall on and near the summit, and the altogether unexpected hygrometric conditions of the air in their relation to the cyclones and anticyclones of North-Western Europe.

Another of the funds at our disposal, the Scientific Relief Fund, requires a few words of mention. Its resources have been considerably enriched during the past year by the legacy of 1000*l.* from Sir William Siemens, and nearly 50*l.* from the medals offered by the executors of the late Lady Sabine; and the legacy of 1000*l.* from the late Mr. Bentham will, it is hoped, ere long be received; but even with these munificent additions the income of the fund will amount to only 250*l.* per annum, while last year the calls upon it amounted, I regret to say, to no less than 450*l.* The incalculable value of such a fund to men of science or their families requiring temporary aid must be apparent to all, and looking at the unfortunate necessity for its existence which the calls upon it prove, I venture to commend it to your support. It will, perhaps, not be out of place here to say a few words with regard to the administration of this fund, the existence of which dates from 1859, and is in a great degree due to the exertions of the late Mr. Gassiot. The Council of the Royal Society takes charge of any sums contributed to the fund and invests them, applying the interest in grants for the relief of such scientific men or their families as may from time to time require or deserve assistance. These grants are, however, made only on the recommendation of a committee of seven members who investigate the cases before them, and applications for relief cannot be entertained except on the recommendation of the President of one of the chartered Societies, viz., the Astronomical, Chemical, Geographical, Geological, Linnean, Royal, and Zoological Societies. Since January 1861, when the first grant was made, the total number of grants has been eighty-eight, and the total sum distributed 4340*l.*

Our Donation Fund has also proved of much service, and several of the applications for comparatively small amounts, which were referred by the Government Grant Committee for the consideration of the Council of the Royal Society, were met by grants from this source. This most valuable fund, the annual income of which is now about 400*l.*, has, during the past year, rendered important aid to various scientific objects. From it considerable grants have been made towards obtaining specimens of Hatteria and Apteryx; for expenses incurred on account of the voyage and investigations of the surveying-ship *Triton*; for collection of materials relating to the Krakatoa eruption; towards the borings in the Delta of Egypt; and, lastly, in aid of the Marine Biological Association.

The close connection of the future of our fisheries with the advancement of certain branches of zoological science was commented upon by our President in his last Anniversary Address, and I have now to record the foundation of two establishments devoted to marine research. The first of these is the station established at Granton, near Edinburgh, mainly through the energetic labours of Mr. John Murray of the *Challenger* Expedition. It consists of a floating laboratory where physical and biological investigations are carried on, and it is provided with a steam yacht for taking observations at sea and procuring specimens for examination. Chemical and other laboratories are now being erected on the shore, close to the inclosed piece of water where the floating laboratory is moored. Two naturalists, a chemist and a botanist, are permanently attached to the station, and have an engineer, a fisherman, and three attendants to assist them in conducting regular systematic observations. 2500*l.* have been spent on the equipment of the station, and it has at present an income of 400*l.* a-year, independent of the grants which some of the permanent staff have received from the Government Grant Committee to aid them in their researches. It is well that it should be known that any scientific observer is at liberty to make use of the station free of charge; indeed, during the past year five gentlemen and one lady have availed themselves of this privilege during short periods of time.

But the movement in favour of such stations has not been confined to Scotland, for I have also to chronicle the foundation of the Marine Biological Association, which originated in a meeting held in these rooms on March 31 last, our President being in the chair, and many of our principal naturalists taking part in the proceedings. The formation of such an Association has long been hoped for by many interested in obtaining a correct knowlege of the life and conditions of our sea-coast, who are now principally indebted to Prof. Ray Lankester for the realisation of their hopes. The operations of the Association will in no way clash with those of the station at Granton, but both institutions will work towards a common end. One effect, indeed, of the new Association will probably be to render all the more fruitful the labours on the more northern shores by instituting similar researches at other parts of the coast of our island.

The work of the Association is as yet in the inceptive stage, but a site well adapted for a marine observatory will, through the liberal endeavours of the Mayor and Corporation of Plymouth, probably be secured in that town, some citizens of which have also promised a noble donation of 1000*l.* towards its erection. The Clothworkers' Company has contributed 500*l.* and the Mercers' Company 250 guineas, while the Council of this Society has also shown its sympathy with the movement by a grant of 250*l.*, and the British Association by one of 150*l.* Handsome donations have also been made by private individuals, and the number of members of the Association is gradually increasing. When once the station is completed and at work, and its aims and operations become better known, I make little doubt that it will receive a much larger share of public support. But before the station can be erected and at work, it is calculated that an outlay of 10,000*l.* is necessary for its building and equipment, of which as yet not quite half is forthcoming, and I venture to take this opportunity of enforcing the claims of the Association upon all who are interested in "the improvement of natural knowledge." As has already been pointed out in the memorandum issued by the Association, "great scientific and practical results have been obtained in other countries, notably in the United States of America, in Germany, France, and Italy, by studies carried on through such laboratories as the Marine Biological Association proposes to erect in this country," and I may add as is already at work at Granton. When we consider the enormous importance of our fisheries, and how large may be the amount of material benefit derived from a scientific investigation of the causes of their increase and diminution, it will, I think, be evident that the work to be carried on at these stations is not only for such a purpose as the development of abstract biological science, important as that may be, but for the advancement of our national resources. It is, therefore, to be hoped that, in addition to the private support which they will receive, they may in some manner be recognised by the nation at large as centres for carrying out systematic investigations into the circumstances determining marine life, from which a portion of our food-supply is drawn, and a much larger portion might probably be derived. The importance of our sea fisheries, which it will be one of the principal objects of the Association to promote, has of late years been more fully recognised, and the recent International Fisheries Exhibition has done much to popularise the subject; while the official appointment of our President also proves that in the opinion of our Government the scientific aspects of our fisheries are not to be neglected.

In the last Presidential Address reference was made to the great desirability of carrying out, on the part of this country, investigations into the nature of cholera in continuation and extension of those so zealously and bravely initiated by the distinguished German inquirer Koch. Although the Society has had no very direct influence in the matter, the Fellows will, I venture to think, regard it as a subject for congratulation that the wish then expressed from this chair has been fulfilled, and that the distinguished expert in such questions—our Fellow, Dr. Klein—is at present engaged in India in the investigation of cholera at the instance of the Indian Government. It is sad to think how much nearer our own shores such investigations might have been conducted; may it be long ere they can be instituted on this side of the Channel.

These remarks have already extended to such a length that I can now only briefly refer to a few of the events of scientific interest which have during the past year occupied the attention of the Society or of a large number of its Fellows. In the month of April last the University of Edinburgh celebrated its Tercentenary with great pomp and no less hospitality, upwards of 120 delegates from various universities and other learned bodies being invited as guests. On this occasion Lord Rayleigh kindly consented to be our representative, and was among those on whom the University conferred the honorary degree of LL.D. The same distinguished Fellow occupied the Presidential chair at the meeting of the British Association for the Advancement of Science at Montreal, on which occasion many of our body took the opportunity of crossing the Atlantic. Owing to the munificent liberality and ungrudging hospitality of our brethren in the Dominion of Canada, the somewhat bold experiment of holding a meeting of the Association beyond the limits of the British Isles has proved a great success, though, perhaps, it is an experiment which would require exceptional conditions to be successfully repeated.

The Society was represented by delegates at the meeting of the American Association for the Advancement of Science at Philadelphia in September last. The Electrical Exhibition at the same place resulted in the formation of a Memorial Library in connection with the Franklin Institute, to which separate copies of the papers relating to electricity that have appeared in the *Philosophical Transactions* have been granted by the Council. An Electrical Congress at Paris, and an Ornithological one at Vienna have also been among the events of the year.

Subscribers to the Darwin Memorial Fund will be pleased to hear that a fine block of marble has been secured for the statue to be erected in the Natural History Museum at South Kensington, and I am glad to learn from Mr. Boehm that his work will probably be completed by the end of this year. When the total cost of the statue has been ascertained, it will be necessary to hold a meeting of the Committee in charge of the Memorial Fund to determine the manner in which the balance is to be applied.

It now only remains for me to thank the Fellows and others conversant with the subjects on which I have touched, for information kindly afforded me; to thank you for the attention with which you have listened to me, and to express a hope that it may not again for many years occur that the Anniversary Address from this Presidential chair shall have to be delivered by deputy.

After the Address the awards of the medals and the election of the Council for the ensuing year were proceeded with; these we

have already referred to. A gloom was cast over the meeting by the announcement of the sudden death of Prof. Kolbe, the distinguished recipient of the Davy Medal.

The Annual Dinner subsequently took place at Willis's Rooms, the Treasurer being supported by the Lord Chancellor, the Marquess of Salisbury, the Lord Mayor, and others.

THE WAVE THEORY OF LIGHT[1]

II.

TO continue our study of visible light, that is, undulations extending from red to violet in the spectrum (which I am going to show you presently), I would first point out on this chart that in the section from letter "A" to letter "D" we have visual effect and heating effect only; but no ordinary chemical or photographic effect. Photographers can leave their usual sensitive chemically prepared plates exposed to yellow light and red light without experiencing any sensible effect; but when you get

The Solar Spectrum.

toward the blue end of the spectrum the photographic effect begins to tell, more and more as you get towards the violet end. When you get beyond the violet, there is the invisible light known chiefly by its chemical action. From yellow to violet we have visual effect, heating effect, and chemical effect, all three; above the violet only chemical and heating effects, and so little of the heating effect that it is scarcely perceptible.

The prismatic spectrum is Newton's discovery of the composition of white light. White light consists of every variety of colour from red to violet. Here, now, we have Newton's prismatic spectrum produced by a prism. I will illustrate a little in regard to the nature of colour by putting something before the light which is like coloured glass; it is coloured gelatine. I will put in a plate of red gelatine which is carefully prepared of chemical materials, and see what that will do. Of all the light passing to it from violet to red it only lets through the red and orange, giving a mixed reddish colour.

Here is another plate of green gelatine. The green absorbs all the red, giving only green. Here is another plate absorbing something from each portion of the spectrum, taking away a great deal of the violet and giving a yellow or orange appearance to the light. Here is another absorbing out the green, leaving red, orange, and a very little faint green, and absorbing out all the violet.

When the spectrum is very carefully produced, far more perfectly than Newton knew how to show it, we have a homogeneous spectrum. It must be noticed that Newton did not understand what we call a homogeneous spectrum; he did not produce it, and does not point out in his writings the conditions for producing it. With an exceedingly fine line of light we can bring it out as in sunlight, like this upper picture, red, orange, yellow, green, blue, indigo, and violet, according to Newton's nomenclature. Newton never used a narrow beam of light, and so could not have had a homogeneous spectrum.

This is a diagram painted on glass and showing the colours as we know them. It would take two or three hours if I were to explain the subject of spectrum analysis to-night. We must tear ourselves away from it. I will just read out to you the wave lengths corresponding to the different positions in the sun's spectrum of certain dark lines commonly called "Fraunhofer's lines." I will take as a unit the one-hundred thousandth of a centimetre. A centimetre is ·4 of an inch; it is a rather small half an inch. I take the thousandth of a centimetre and the hundredth of that as a unit. At the red end of the spectrum the light in the neighbourhood of that black line "*A*" has for its wave length 7·6; "*B*" has 6·87; "*D*" has 5·89; the "frequency" for "*A*" is 3·9 times 100 million million; the frequency of "*D*" light is 5·1 times 100 million million per second.

Now what force is concerned in those vibrations as compared with sound at the rate of 400 vibrations per second; suppose for a moment the same matter was to move to and fro through the same range, but 400 million million times per second. The force required is as the square of the number expressing the frequency. Double frequency would require quadruple force for the vibration of the same body. Suppose I vibrate my hand again, as I did before. If I move it once per second a moderate force is required; for it to vibrate ten times per second 100 times as much force is required; for 400 vibrations per second 160,000 times as much force.

If I move my hand once per second through a space of a quarter of an inch a very small force is required; it would require very considerable force to move it ten times a second, even through so small a range; but think of the force required to move a tuning fork 400 times a second; compare that with the force required for a motion of 400 million million times a second. If the mass moved is the same, and the range of motion is the same, then the force would be one million million million million times as great as the force required to move the prongs of the tuning fork. It is as easy to understand that number as any number like 2, 3, or 4.

Consider gravely what that number means and what we are to infer from it. What force is there in space between my eye and that light? What forces are there in space between our eyes and the sun, and our eyes and the remotest visible star? There is matter and there is motion, but what magnitude of force may there be?

I move through this "luminiferous ether" as if it were nothing. But were there vibrations with such frequency in a medium of steel or brass, they would be measured by millions and millions and millions of tons action on a square inch of matter. There are no such forces in our air. Comets make a disturbance in the air, and perhaps the luminiferous ether is split up by the motion of a comet through it. So when we explain the nature of electricity, we explain it by a motion of the luminiferous ether. We cannot say that it is electricity. What can this luminiferous ether be? It is something that the planets move through with the greatest ease. It permeates our air; it is nearly in the same condition, so far as our means of judging are concerned, in our air and in the inter-planetary space. The air disturbs it but little; you may reduce air by air-pumps to the hundred-thousandth of its density, and you make little effect in the transmission of light through it. The luminiferous ether is an elastic solid. The nearest analogy I can give you is this jelly which you see.[1] The nearest analogy to the waves of light is the motion, which you can imagine, of this elastic jelly, with a ball of wood floating in the middle of it. Look there, when with my hand I vibrate the little red ball up and down, or when I turn it quickly round the vertical diameter, alternately in opposite directions;—that is the nearest representation I can give you of the vibrations of luminiferous ether.

Another illustration is Scottish shoemaker's wax or Burgundy pitch, but I know Scottish shoemaker's wax better. It is heavier than water, and absolutely answers my purpose. I take a large slab of the wax, place it in a glass jar filled with water, place a number of corks on the lower side and bullets on the upper side. It is brittle like the Trinidad pitch or Burgundy pitch which I have in my hand. You can see how hard it is, but if left to itself it flows like a fluid. The shoemaker's wax breaks with a brittle fracture, but it is viscous and gradually yields.

What we know of the luminiferous ether is that it has the rigidity of a solid and gradually yields. Whether or not it is brittle and cracks we cannot yet tell, but I believe the discoveries in electricity, and the motions of comets, and the marvellous spurts of light from them, tend to show cracks in the luminiferous ether—show a correspondence between the electric flash and the aurora borealis and cracks in the luminiferous ether. Do not take this as an assertion, it is hardly more than a vague scientific dream: but you may regard the existence of the luminiferous ether as a reality of science, that is, we have an all-pervading medium, an elastic solid, with a great degree of rigidity; its rigidity is so prodigious in proportion to its density that the vibrations of light in it have the frequencies I have mentioned, with the wave lengths I have mentioned.

The fundamental question as to whether or not luminiferous ether has gravity has not been answered. We have no knowledge that the luminiferous ether is attracted by gravity; it is sometimes called imponderable because some people vainly imagine that it has no weight. I call it matter with the same kind of rigidity that this elastic jelly has.

[1] A Lecture delivered at the Academy of Music, Philadelphia, under the auspices of the Franklin Institute, September 29, 1884, by Sir William Thomson, F.R.S., LL.D. (Continued from p. 94)

[1] Exhibiting a large bowl of clear jelly with a small red wooden ball embedded in the surface near the centre.

Here are two tourmalines; if you look through them toward the light, you see the white light all round, *i.e.* they are transparent. If I turn round one of these tourmalines the light is extinguished, it is absolutely black, as though the tourmalines were opaque. This is an illustration of what is called polarisation of light. I cannot speak to you about qualities of light without speaking of the polarisation of light. I want to show you a most beautiful effect of polarising light, before illlustrating a little further by means of this large mechanical illustration which you have in the bowl of jelly. Now I put in the lantern another instrument called a "Nicol prism." What you saw first were two plates of the crystal tourmaline which came from Brazil, I believe, having the property of letting light pass when both plates are placed in one particular direction as regards their axes of crystallisation, and extinguishing it when it passes through the first plate held in another direction. We have now an instrument which also gives rays of polarised light. A Nicol prism is a piece of Iceland spar, cut in two and turned, one part relatively to the other, in a very ingenious way, and put together again and cemented into one by Canada balsam. The Nicol prism takes advantage of the property which the spar has of double refraction, and produces the phenomenon which I now show you.

I turn one prism round in a certain direction and you get light, a maximum of light. I turn it through a right angle and you get blackness. I turn it one quarter round again and get maximum light; one quarter more, maximum blackness; one quarter more and bright light. We rarely have such a grand specimen of a Nicol prism as this.

There is another way of producing polarised light. I stand before that light and look at its reflection in a plate of glass on the table through one of the Nicol prisms, which I turn round, so. Now I must incline that piece of glass at a particular angle, rather more than 45°; I find a particular angle in which, if I look at it and then turn the prism round in the hand, the effect is absolutely to extinguish the light in one position and to give it maximum brightness in another position. I use the term "absolute" somewhat rashly. It is only a reduction to a very small quantity of light, not an absolute annulment as we have in the case of the two Nicol prisms used conjointly. Those of you who have never heard of this before would not know what I am talking about. As to the mechanics of the thing it could only be explained to you by a course of lectures in physical optics. The thing is this, vibrations of light must be in a definite direction relatively to the line in which the light travels.

Look at this diagram, the light goes from left to right; we have vibrations perpendicular to the line of transmission. There is a line up and down which is the line of vibration. Imagine here a source of light, violet light, and here in front of it is the line of propagation. Sound vibrations are to and fro; this is transverse to the line of propagation. Here is another, perpendicular to the diagram, still following the law of transverse vibration; here is another circular vibration. Imagine a long rope, you whirl one end of it and you send a screw-like motion running along; you can get the circular motion in one direction or in the opposite.

Plane polarised light is light with the vibrations all in a single plane, perpendicular to the plane through the ray which is technically called the "plane of polarisation." Circular polarised light consists of undulations of luminiferous ether having a circular motion. Elliptically polarised light is something between the two, not in a straight line, and not in a circular line; the course of vibration is an ellipse. Polarised light is light that performs its motions continually in one mode or direction. If in a straight line it is plane polarised light; if in a circular direction it is circularly polarised light; when elliptical it is elliptically polarised light.

With Iceland spar, one unpolarised ray of light divides on entering it into two rays of polarised light, by reason of its power of double refraction, and the vibrations are perpendicular to one another in the two emerging rays. Light is always polarised when it is reflected from a plate of unsilvered glass, or water, at a certain definite angle of 56° degrees for glass, or 52° for water, the angle being reckoned in each case from a perpendicular to the surface. The angle for water is the angle whose tangent is 1·4. I wish you to look at the polarisation with your own eyes. Light from glass at 56° and from water at 52° goes away vibrating perpendicularly to the plane of incidence and plane of reflection.

We can distinguish it without the aid of an instrument. There is a phenomenon well known in physical optics as "Haidinger's Brushes." The discoverer is well known in Philadelphia as a mineralogist, and the phenomenon I speak of goes by his name. Look at the sky in a direction of 90° from the sun, and you will see a yellow and blue cross, with the yellow toward the sun, and from the sun, spreading out like two fox's tails with blue between, and then two red brushes in the space at right angles to the blue. If you do not see it, it is because your eyes are not sensitive enough, but a little training will give them the needed sensitiveness.

If you cannot see it in this way try another method. Look into a pail of water with a black bottom; or take a clear glass dish of water, rest it on a black cloth and look down at the surface of the water on a day with a white cloudy sky (if there is such a thing ever to be seen in Philadelphia). You will see the white sky reflected in the basin of water at an angle of about 50°. Look at it with the head tipped to one side and then again with the head tipped to the other side, keeping your eyes on the water, and you will see Haidinger's brushes. Do not do it fast or you will make yourself giddy. The explanation of this is the refreshing of the sensibility of the retina. The Haidinger's brush is always there, but you do not see it because your eye is not sensitive enough. After once seeing it you always see it; it does not thrust itself inconveniently before you when you do not want to see it. You can readily see it in a piece of glass with dark cloth below it, or in a basin of water.

I am going to conclude by telling you how we know the wave lengths of light and how we know the frequency of the vibrations. We shall actually make a measurement of the wave length of the yellow light. I am going to show you the diffraction spectrum.

You see on the screen,[1] on each side of a central white bar of light, a set of bars of light variegated colours, the first one, on each side, showing blue or indigo colour about four inches from the central white bar and red about four inches farther, with vivid green between the blue and the red. That effect is produced by a grating with 400 lines to the centimetre, engraved on glass, which I now hold in my hand. The next grating has 3000 lines on a Paris inch. You see the central space and on each side a large number of spectra, blue at one end and red at the other. The fact that, in the first spectrum red is about twice as far from the centre as the blue, proves that a wave length of red light is double that of blue light.

I will now show you the operation of measuring the length of a wave of sodium light, that is a light like that marked "*D*" on the spectrum, a light produced by a spirit lamp with salt in it. The sodium vapour is heated up to several thousand degrees, when it becomes self luminous and gives such a light as we get by throwing salt upon a spirit lamp in the game of snap-dragon.

I hold in my hand a beautiful grating of glass silvered by Liebig's process with metallic silver, a grating with 6480 lines to the inch, belonging to my friend Prof. Barker, which he has kindly brought here for us this evening. You will see the brilliancy of colour as I turn the light reflected from the grating toward you, and pass the beam round the room. You have now seen directly with your own eyes these brilliant colours reflected from the grating, and you have also seen them thrown upon the screen from a grating placed in the lantern. With a grating of 17,000 lines—a much greater number of lines per inch than the other—you will see how much further from the central bright space the first spectrum is; how much more this grating changes the direction or diffraction of the beam of light. Here is the centre of the grating, and there is the first spectrum You will note that the violet light is least diffracted and the red light is most diffracted. This diffraction of light first proved to us definitely the reality of the undulatory theory of light.

You ask why does not light go round a corner as sound does. Light does go round a corner in these diffraction spectra; it is shown going round a corner, it passes through these bars and is turned round an angle of 30°. Light going round a corner by instruments adapted to show the result, and to measure the angles at which it is turned, is called the diffraction of light.

I can show you an instrument which will measure the wave lengths of light. Without proving the formula, let me tell it to you. A spirit lamp with salt sprinkled on the wick gives very nearly homogeneous light, that is to say, light all of one wave length, or all of the same period. I have a little grating which I take in my hand. I look through this grating and see that

[1] Showing the chromatic bands thrown upon the screen from a diffraction grating.

candle before me. Close behind it you see a blackened slip of wood with two white marks on it ten inches asunder. The line on which they are marked is placed perpendicular to the line at which I shall go from it. When I look at this salted spirit lamp I see a series of spectra of yellow light. As I am somewhat short-sighted I am making my eye see with this eyeglass and the natural lenses of the eye what a long-sighted person would make out without an eyeglass. On that screen you saw a succession of spectra. I now look direct at the candle and what do I see? I see a succession of five or six brilliantly coloured spectra on each side of the candle. But when I look at the salted spirit lamp, now I see ten spectra on one side and ten on the other, each of which is a monochromatic band of light.

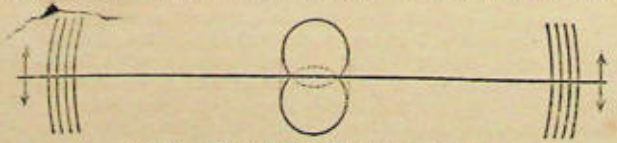
I will measure the wave lengths of light thus. I walk away to a considerable distance and look at the candle and marks. I see a set of spectra. The first white line is exactly behind the candle. I want the first spectrum to the right of that white line to fall exactly on the other white line, which is ten inches from the first. As I walk away from it I see it is now very near it; it is now on it. Now the distance from my eye is to be measured, and the problem is again to reduce feet to inches. The distance from the spectrum of the flame to my eye is thirty-four feet nine inches. Mr. President, how many inches is that? 417 inches, in round numbers 420 inches. Then we have the proportion, as 420 is to 10 so is the length from bar to bar of the grating to the wave length of sodium light. That is to say, as forty-two is to one. The distance from bar to bar is the four-hundredth of a centimetre: therefore the forty-second part of the four-hundredth of a centimetre is the required wave length, or the 16,800th of a centimetre is the wave length according to our simple, and easy, and hasty experiment. The true wave length of sodium light, according to the most accurate measurement, is about a 17,000th of a centimetre, which differs by scarcely more than 1 per cent. from our result!

The only apparatus you see is this little grating; it is a piece of glass with four-tenths of an inch ruled with 400 fine lines. Any of you who will take the trouble to buy one may measure the wave lengths of a candle flame himself. I hope some of you will be induced to make the experiment for yourselves.

If I put salt on the flame of a spirit lamp, what do I see through this grating? I see merely a sharply defined yellow light, constituting the spectrum of vaporised sodium, while from the candle flame I see an exquisitely coloured spectrum, far more beautiful than I showed you on the screen. I see in fact a series of spectrums on the two sides with the blue toward the candle flame, and the red further out. I cannot get one definite thing to measure from in the spectrum from the candle flame as I can with the flame of a spirit lamp with the salt thrown on it, which gives, as I have said, a simple yellow light. The highest blue light I see in the candle flame is now exactly on the line. Now measure to my eye, it is forty-four feet four inches, or 532 inches. The length of this wave then is the 532nd part of the four-hundredth of a centimetre, which would be the 21,280th of a centimetre, say the 21,000th of a centimetre. Then measure for the red, and you would find something like the 11,000th for the lowest of the red light.

Lastly, how do we know the frequency of vibration?

Why, by the velocity of light. How do we know that? We know it in a number of different ways, which I cannot explain now, because time forbids. Take the velocity of light. It is 187,000 British statute miles per second. But it is much better to take a kilometre for the unit. That is about six-tenths of a mile. The velocity is very accurately 300,000 kilometres per second; that is, 30,000,000,000 centimetres per second. Take the wave length as the 17,000th of a centimetre, and you find the frequency of the sodium light to be 510 million million per second. There, then, you find a calculation of the frequency from a simple observation which you can all make for yourselves.



Vibrating spherule embedded in an elastic solid.

Lastly, I must tell you about the colour of the blue sky which was illustrated by the spherule embedded in an elastic solid. I want to explain to you in two minutes the mode of vibrations. Take the simplest plane polarised light. Here is a spherule which is producing it in an elastic solid. Imagine the solid to extend miles horizontally and miles down, and imagine this spherule to vibrate up and down. It is quite clear that it will make transverse vibrations similarly in all horizontal directions. The plane of polarisation is defined as a plane perpendicular to the line of vibration. Thus, light produced by a molecule vibrating up and down, as this red globe in the jelly before you, is polarised in a horizontal plane, because the vibrations are vertical.

Here is another mode of vibrations. Let me twist this spherule in the jelly as I am doing it, and that will produce vibrations, also spreading out equally in all horizontal directions. When I twist this globe round, it draws the jelly round with it; twist it rapidly back, and the jelly flies back. By the inertia of the jelly the vibrations spread in all directions, and the lines of vibration are horizontal all through the jelly. Everywhere, miles away, that solid is placed in vibration. You do not see it, but you must understand that they are there. If it flies back it makes vibration, and we have waves of horizontal vibrations travelling out in all directions from the exciting molecule.

I am now causing the red globe to vibrate to and fro horizontally. That will cause vibrations to be produced which will be parallel to the line of motion at all places of the plane perpendicular to the range of the exciting molecule. What makes the blue sky? These are exactly the motions that make the blue light of the sky, which is due to spherules in the luminiferous ether, but little modified by the air. Think of the sun near the horizon; think of the light of the sun streaming through and giving you the azure blue and violet overhead. Think first of any one particle of the sun, and think of it moving in such a way as to give horizontal and vertical vibrations and what not of circular and elliptic vibrations.

You see the blue sky in high-pressure steam blown into the air; you see it in the experiment of Tyndall's blue sky, in which a delicate condensation of vapour gives rise to exactly the azure blue of the sky.

Now the motion of the luminiferous ether relatively to the spherule gives rise to the same effect as would an opposite motion impressed upon the spherule quite independently by an independent force. So you may think of the blue colour coming from the sky as being produced by to-and-fro vibrations of matter in the air, which vibrates much as this little globe vibrates embedded in the jelly.

The result in a general way is this: The light coming from the blue sky is polarised in a plane through the sun, but the blue light of the sky is complicated by a great number of circumstances, and one of them is this, that the air is illuminated not only by the sun but by the earth. If we could get the earth covered by a black cloth, then we could study the polarised light of the sky with simplicity, which we cannot do now. There are, in Nature, reflections from seas and rocks and hills and waters in an indefinitely complicated manner.

Let observers observe the blue sky not only in winter when the earth is covered with snow, but in summer when it is covered with dark green foliage. This will help to unravel the complicated phenomena in question. But the azure blue of the sky is light produced by the reaction on the vibrating ether of little spherules of water, of perhaps a fifty-thousandth or a hundred-thousandth of a centimetre diameter, or perhaps little motes, or lumps, or crystals of common salt, or particles of dust, or germs of vegetable or animal species wafted about in the air. Now what is the luminiferous ether? It is matter prodigiously less dense than air—millions and millions and millions of times less dense than air. We can form some sort of idea of its limitations. We believe it is a real thing, with great rigidity in comparison with its density, and it may be made to vibrate 400 million million times per second and yet with such rigidity as not to produce the slightest resistance to any body going through it.

Going back to the illustration of the shoemaker's wax: if a cork will in the course of a year push its way up through a plate of that wax when placed under water, and if a lead bullet will penetrate downwards to the bottom, what is the law of the resistance? It clearly depends on time. The cork slowly in the course of a year works its way up through two inches of that substance; give it one or two thousand years to do it and the resistance will be enormously less; thus the motion of a cork or bullet, at the rate of one inch in 2000 years, may be compared with that of the earth, moving at the rate of six times ninety-three million miles a year, or nineteen miles per second, through the lumi-

niferous ether: but when we have a thing elastic like jelly and yielding like pitch, surely we have a large and solid ground for our faith in the speculative hypothesis of an elastic luminiferous ether, which constitutes the wave theory of light.

SCIENTIFIC SERIALS

Bulletin de la Société de Géographie, Paris, 3 Trimestre, 1884.—The principal portion of this number is occupied by papers of M. Huber, who spent the years 1878 to 1882 in Arabia on a scientific mission on behalf of the Department of Public Instruction. In the first he introduces 145 inscriptions which he found in various parts of Central Arabia on rocks. The second article is the first instalment (accompanied by a map) of an account of his numerous and extensive journeys in the same region, from Palmyra and Bagdad in the north, to Kheiber in the south. A glance at the route map shows that he has explored the greater part of this region during his prolonged stay there.—M. Petitin, in his account of his journey in Indo-China, gives a lengthy description of the difficulties and dangers which the traveller encounters in this peninsula. He was selected by Admiral de la Grandière when Governor of Saigon to make a geological investigation of Cochin-China, Siam, Hainan, and Formosa, but the death of the governor and the appointment of another whose views were different cut M. Petitin's explorations short. He saw enough, however, to give a brief account of the geology of Cochin-China, and to give the intending traveller much advice as to his arrangements and preparations. He also urges his countrymen to extend their dominion in the Indo-Chinese peninsula, especially in Tonquin, where the Red River affords them an opening into the heart of China.—M. la Meslle's paper on the eastern provinces of Australia is little more than a lively account of a journey in Queensland, while the object of M. Simonin's article on the ports of Great Britain—especially London, Liverpool, and Glasgow—is not quite apparent, unless it be to urge his countrymen to go and do likewise with their ports.

Verhandlungen der Gesellschaft für Erokunde zu Berlin, Band xi., Nos. 6 and 7.—Herr Müller-Beeck, in the trade of Further India deals largely with trade routes into the Shan States and China. The Songkoi route into Yunnan he regards as one of great difficulty on account of the rapids. The delta also is constantly extending. Hanoi is now 110 mi'es from the sea; in the seventeenth century it was only half that distance. For half the year the upper part of the river is only navigable for boats of four tons, and when Manhao is reached, there is still a difficult land journey to Yunnan. The population also, he thinks, will form a grave obstacle to any regular trade by this channel.—Herr Buchta, in the Soudan and the Mahdi, deals purely with the political side of the Soudan question.—Prof. Seel-trang gives much interesting geographical and statistical information about the province of Santa Fé, in the Argentine Republic.—The usual notices of other societies and of new books conclude the number.

SOCIETIES AND ACADEMIES

LONDON

Linnean Society, November 20.—Prof. P. Martin Duncan, F.R.S., Vice-President, in the chair.—Mr. A. Roope Hunt was elected a Fellow.—Mr. F. B. Forbes drew attention to specimens of pods and seeds used by the Chinese in place of soap. He stated that for ordinary detergent purposes an impure earthy soda and a lye made from ashes are employed. The leaves of *Hibiscus syriacus* and *Ginko biloba* are occasionally used for cleansing the head. The most favourite substance, however, is the fruit of certain Leguminosæ (Fei-tsao-tow). The late Daniel Hanbury figures these seeds as a species of *Dialium*. Dr. Porter Smith says they are the product of the *Acacia concinna* (*Mimosa saponaria*, Roxb.). Dr. Breitschneider asserts, on the contrary, that they belong to *Gymnocladus chinensis*, originally described by Baillon from pods only. Specimens at Kew lately figured in the "Icones Plantarum," are young leaves, fruit, and flowers from Foochow; those now exhibited (by Mr. Forbes) are, however, much finer examples from Ningpo and Wahu. The pods are roasted and kneaded into small balls used for washing clothes, and the head in bathing, but, on account of their unpleasant smell, they are prohibited in the public baths. The pods of *Gleditschia sinensis*, Lamk. (Tsao-chio) are used for the same purposes as *Gymnocladus*, those shown at the meeting being from Pekin and Shanghai district. One appears to answer to Dr. Hance's new *G. xylocarpa*. Bentham refers a South China tree to *G. sinensis*. Lamarck founded his species on a tree growing in the Jardin des Plantes, raised from seeds sent by Père Incarville 200 years ago from Pekin. It is doubtful if the northern and southern plants are identical. The pods are broken into small bits soaked in boiling water until an oily substance is floated, when they are ready for use. Another saponaceous substance is derived from *Sapindus makarosi* (the *S. chinensis* or *Kelreuteria paniculata*, Lam.), specimens of which were shown from Ningpo.—Messrs. H. and J. Groves exhibited specimens of (1) *Chara connivens*, collected at Slapton, South Devon, the only known British station, for no trace of the plant is now to be found at Stokes Bay; (2) *Chara canescens*, obtained from a pool between Helston and the Lizard, West Cornwall, by Messrs. Guardia and Groves, and also at Little Sea, Studland, Dorset, by Mr. Mansell Pleydell.—Mr. Geo. Murray showed dried and moistened examples of an Algæ, *Glaucapsa*, found by Mr. Pryer in birds'-nest caves in North Borneo.—Mr. J. G. Baker read the following letter from Mr. W. Brockhurst, of Didsbury, dated November 17, 1884:—"On April 2 I had the pleasure of exhibiting to the Society a number of prepared specimens of the daffodil, which appeared to prove that double daffodil flowers might produce seeds, and I advanced some arguments, based upon the observations I had made, to show that they were spread over wide areas in a wild state of seeding. The specimens showed the seed-vessels filled with ovules, but this did not fully prove that ripe seeds capable of germination would be matured. I therefore carefully observed a number of flowers of double daffodils (*Narcissus telamonius-plenus*), and marked them as they went out of bloom, to prevent any mistakes. One of these produced a capsule containing nine shining black seeds, which were gathered on June 24, and at once sowed in a pot, and covered with a sheet of glass. Of these seeds four have already germinated, and show grass-like growths an inch above the soil. This therefore completes the proof."—Mr. W. T. Thiselton Dyer pointed out and made remarks on some sterile runners of *Mentha piperita*, and the remains of flowers of *Epilobium hirsutum*, both taken from a wreath found by Prof. Maspero in a tomb near Thebes, and supposed to be of the 20th or 26th dynasty; Mr. Dyer also exhibited fresh flowers of *Ipomœa purpureo-cærulea*.—Mr. Thos. Christy exhibited two specimens of *Lycaste Skinneri*, Lindl., one with two flowers on one stem, the other with an aborted lip adherent for the greater part of its length to the column. He also drew attention to samples of the tea (probably a species of *Ilex*) used largely in Bogota, but which is said to be deficient in flavour.—Mr. E. C. Stanford thereafter showed some of the products from seaweed, viz.:—Algin, the insoluble form of which (alginic acid) can be made into shirt-studs resembling horn, &c.; the soluble algin (or alginate of soda), which diminishes the brittleness of shellac, besides other uses.—A paper was read by Mr. E. M. Holmes on *Cinchona Ledgeriana* as a species. The author expressed the opinion that under the name of *C. Ledgeriana*, a number of varieties or forms, and probably some hybrids of *Cinchona Calisaya*, are now under cultivation in the British colonies. He believed that, if more attention were paid to the characters afforded by the bark of trees, taken in conjunction with the other botanical characters of flower and fruit, these varieties and hybrids would be more easily defined and recognised. He considers that the plant published under the name of *C. Ledgeriana* by Dr. Trimen was probably referable to Weddell's *Cinchona Calisaya*, var. *pallida*, as a horticultural form, for which the author proposed the name "*Trimeniana*."—A paper was read, notes on the habits of some Australian Hymenopterous Aculeata, by H. L. Roth. He states that the wasps of the genus *Pelopœus* (*P. lætus*) build their nests on the walls, ceilings, legs of chairs, under the table, in cupboards, vases, between pictures and the walls, on curtains, in all sorts of crevices in the house, and on the roof. No place is safe from their intrusion. When a cell is completed, the wasp goes in search of spiders, and, seizing these, packs their half-dead bodies in the cell, lays an egg, and closes the cell-top; thereafter rows of cells are added to the primary one and dealt with in the same fashion, generally finishing with a streaked coating of mud, thus to deceive as to the real contents beneath. These wasps are infested with Dipterous parasites. Of the Australian ants, *Formica rufinigro* is numerous, bold, and destructive. They destroy the web of certain caterpillars and wriggle them out, when they fall a prey to a host of attendant

warrior ants.—Mr. E. T. Druery read a paper on a singular mode of reproduction in *Athyrium filix-fœmina*, var. *clarissima*. In a previous paper the author had shown that prothallia-bearing antheridia and archegonia were developed on the apex of pear-shaped bodies with the larger end downwards, in the place usually occupied by sori. In the present paper he brought forward evidence to show that these pear-shaped bodies were not developed from sporangia, but from a previous formation of thread-like bodies, a few of which became thickened, and developed into the pear-shaped bodies previously mentioned, the others remaining starved and undeveloped.

Zoological Society, November 18.—Prof. W. H. Flower, F.R.S., President, in the chair.—A communication was read from Mr. J. G. F. Riedel, C.M.Z.S., containing comments on certain passages in Mr. H. O. Forbes's paper on Timor-Laut birds, read before the Society on June 17.—A communication was read from Mr. H. Pryer, C.M.Z.S., giving an account of a recent visit to the edible-birds'-nest caves of British North Borneo In illustration of this paper, Mr. Pryer sent specimens of the swift (*Collocalia fuciphaga*), of its nest and eggs, of the *Alga* on which the bird was supposed to feed, and of the bat which inhabited the same caves.—Mr. Sclater read an account of some skins of mammals from Somali-land, which belonged apparently to five species. Amongst these was an apparently new form of wild ass, which was proposed to be called *Equus asinus somalicus*.—Mr. F. E. Beddard read a paper on the anatomy of the Umbrette (*Scopus umbretta*). The author observed that, as regards its exact systematic position, which had been hitherto a matter of doubt, he was inclined to place this peculiar form as a type of a separate family, between the herons (Ardeidæ) and the storks (Ciconiidæ).—A second paper by Mr. Beddard contained the results of some recent investigations into the structure of *Echidna*, and related to the presence of a persistent umbilical vein in that animal.—Captain Shelley read a paper on some new or little-known species of East African birds. Three of these were described under the names *Muscicapa johnstoni*, *Pratincola axillaris*, and *Nectarinia kilimensis*. The collection, which contained altogether ninety-four specimens, referable to thirty-eight species, was the first-fruits of Mr. H. H. Johnston's expedition to Kilimanjaro.—A communication was read from Mr. J. H. Gurney, F.Z.S., on the geographical distribution of *Huhua nipalensis*, with remarks on this and other allied species of owls.

Chemical Society, November 20.—Dr. Perkin, F.R.S., in the chair.—The following gentlemen were elected Fellows:—F. Broughton, F. J. Down, L. Ehrmann, F. G. Holmes, J. Hulme, C. Thompson, W. F. Wigley.—The following papers were read:—On some new paraffins, by Khan B. B. Sobrabji. The author has prepared octane boiling at 278°, dicetyl melting at 70°, ethylcetyl and diheptyl.—On additive and condensation compounds of diketones with ketones, by F. R. Japp and N. H. J. Miller. The authors have studied the action of potash of various strengths on mixtures of phenanthraquinone and acetone. Additive compounds were obtained containing one molecule of the first substance to two of acetone, and another containing two molecules of phenanthraquinone to one of acetone. Condensation compounds were formed from the above additive compounds by the abstraction of the elements of water. The authors have also studied the action of potash upon mixtures of benzil with acetone and with acetophenone respectively, and have obtained acetobenzil and acetophenonebenzil.—On the vapour pressure of acetic acid, and on a new method of determining the vapour-pressures of liquids, by W. Ramsay and Sydney Young. The authors have used a species of still into which a thermometer dips, the bulb of which is covered with cotton-wool moistened with the liquid. On heating, the liquid evaporates from the cotton-wool without ebullition. Results obtained agree with those obtained in the ordinary way. Perfectly concordant and regular results have been obtained with acetic acid.—On the action of the halogens on the salts of trimethylsulphine, by L. Dobbin and Orme Masson. The authors conclude that all the haloid salts of trimethylsulphine combine directly with chlorine, bromine, iodine, and iodine monochloride. In no case is one halogen replaced by the other. The authors have partly investigated the action of the halogens on trimethylsulphine sulphate.—Note on the heats of dissolution of the sulphates of potassium and lithium, by S. U. Pickering. The salts do not seem to form isomeric modifications such as exist in the case of sodium sulphate.—On the application of iron sulphate in agriculture and its value as a plant food, by A. B. Griffiths. The author finds that half a hundredweight of sulphate of iron per acre increased the yield of beans from 28 bushels to 44 bushels, of turnips from 13 tons to 16½ tons, but little effect was produced on cereals.—Notes on the chemical alterations in green fodder during its conversion into ensilage, by C. Richardson. The author confirms the results obtained by Kinch and Kellner, that a considerable increase in the non-albuminoid nitrogen takes place in the conversion: no such change occurs during the ordinary drying of fodder. The author used maize in his experiments.—On the decomposition of silver fulminate by hydrochloric acid, by E. Divers and Michitada Kawakita. The authors have studied the action of dilute and strong hydrochloric acid on this salt. With dilute acid the principal products are hydroxyammonium chloride and formic acid; if the acid is strong, much ammonium chloride is produced. A small quantity of hydrocyanic acid is always formed. They could not obtain any oxalic acid by decomposing mercury fulminate with hydrogen sulphide in ether. They have also studied the action of hydrochloric acid on fulminurates.

PARIS

Academy of Sciences, November 24.—M. Rolland, President, in the chair.—Experiments with the chlorhydrate of cocaine (continued), by M. Vulpian. Further experiments made on snails (*Helix pomatia*) and fresh-water prawns (*Astacus fluviatilis*, F.) show that this anæsthetic is less efficacious in the case of invertebrate than vertebrate animals.—Note on the algebraic relations between hyperelliptic functions of the *n* order, by M. Brioschi.—On some reactions of the sulphuret of carbon, and on the solubility of this substance in water, by MM. G. Chancel and F. Parmentier.—Remarks by M. Daubrée on M. Nordenskjöld's "Voyage Round Europe and Asia," in connection with the French translation of that work presented to the Academy.—Note on the action of heat on electric piles, and on the law of Kopp and Wœstyne, by M. G. Lippmann.—Statistical note on cholera in the Paris hospitals since the outbreak of the epidemic on November 4 till the present time, by M. Emile Rivière. During this period 971 patients (579 men, 392 women) were treated in the various hospitals. Of these, 511 succumbed (302 men, 209 women), and 239 (129 men, 110 women) have so far been completely cured. The mortality has thus been 52·33 and 53·31 for men and women respectively. The working classes—rag-gatherers, seamstresses, washerwomen, masons, bricklayers, and shoemakers—have supplied the largest relative number of victims. These have almost invariably been persons of feeble constitution, subject to chronic disorders, exhausted by previous excesses, exposed to extreme physical destitution, or dwelling in the lowest slums of the French capital and its suburbs.—Remarks on the second instalment of the new map of Tunis prepared in the War Office on a scale of 1 : 200,000, by Col. Perrier. This instalment comprises six sheets, embracing the districts of Kef, Kairwan, Mahedia, Feriana, El Jem, and Sfax, based on surveys executed on the spot.—Presentation of the "Annals of the Ouro-Preto School of Mines," by the Emperor Dom Pedro II., with remarks by M. Daubrée.—On the condensation of the solar nebula on the hypothesis of Laplace, by M. Maurice Fouché.—Remarks on the nature of the curve known as Poinsot's erpolodie, by M. de Sparre.—On the involution of superior dimensions, by MM. J. S. and M. N. Vanecek.—Dynamo-electric machines: experimental confirmations of the two reactions, on the effective values of the inner resistance and of the inductor magnetism, by M. G. Cabanellas.—Action of water on the double salts, by M. F. M. Raoult.—On the composition of the gaseous products resulting from the combustion of pyrite, by M. Scheurer-Kestner.—New experiments on the rotation of crops in connection with the cultivation of beetroot, by M. P. P. Dehérain.—On the appearance and spread in France of the parasite of the beetroot known as *Heterodera Schachtii*, by M. Aimé Girard. To this parasite, the author thinks, is largely due the partial failure of this year's crop, which showed a deficit of 20 per cent. in the weight of the roots, besides a decrease in the yield of saccharine, which in some of the northern districts amounted to 12 or 14 per cent.—On the formation of vegetable acids in combination with potassa and lime bases, on the nitric substances and the nitrate of potassa developed in the saccharine plants, beetroot and maize, by M. H. Leplay.—On the characteristic smell and toxic effects of the products of fermentation produced by the comma-bacillus of cholera, by MM. W. Nicati and M. Rietsch.—On

cholera and cholemia, by M. W. Nicati. From the experiments recently made in the chemical laboratory of the Faculty of Sciences at Marseilles it seems established that biliary acids are relatively more abundant in the blood of the victims of cholera than in others. But the author is unable yet to decide whether in their case death is to be attributed to cholemia.—Note on infectious and parasitic pneumonic affections, by M. Germain Sée.—Experiments on the efficacy of disinfecting agents in the case of chicken cholera, by M. Colin.—On the virulence of the bubo accompanying soft chancre, by M. I. Straus.—On the luminous intensity of the spectral colours; influence of the state of the retina in determining light effects, by M. H. Parinaud.—On the appendices to the jaw of grinding insects, by M. Joannes Chatin.—On the floral polymorphism and the fertilisation of *Lychnis dioica*, L., by M. L. Crié.—Remarks on Dr. Ladislas Szajnocha's memoir on the Cephalopods of the Elobi Islands, West Coast of Africa, by M. Daubrée.

BERLIN

Meteorological Society, November 4.—Dr. Hellmann, following up an account of the most recent works in the department of meteorological literature, which he concluded with a full discussion of Mr. Blanford's rain-map of India, communicated his own observations regarding the rain conditions prevailing in Heligoland. The measurements there obtained had given an annual rainfall of 72·50 inches, an amount far surpassing that which had been observed at any of the neighbouring stations on the west coast of Schleswig and at the mouth of the Elbe. The speaker, having last summer made a tour of inspection, and convinced himself, from the instruments in use and their situation, of the accuracy of the registrations above referred to, explained the excessive rainfall in Heligoland by the circumstance that the steep coast, shooting up almost perpendicularly to about 164 feet above the level of the sea, forced the moist sea winds suddenly aloft, and so caused them to cool and condense both very rapidly and to a great extent. For the sake of testing the correctness of this explanation he had got another rain-gauge set up on the dunes at about 16 feet above sea-level, the registrations of which would next year be compared with those at the higher level. A second point in which the rain conditions of Heligoland deviated from those observed at the neighbouring stations on the coast respected the annual course of the rainfall. It was found that in North-West Germany the rainfall indicated a minimum in the middle of April and a maximum in August. In Heligoland, on the other hand, though indeed the minimum of rainfall occurred likewise in the middle of April, the maximum was attained in November. Dr. Hellmann sought an explanation of the postponement of the rain maximum in this latter case in the circumstance that in the yearly course of the temperature of the water and the atmosphere the difference between the two was greatest in November, the water at that time showing a temperature as much as 3°·6 F. warmer than that of the air.—Prof. Spörer gave a brief sketch of the present period of sun-spots. The spot periods being counted from minimum to minimum, the commencement of the present spot period was to be referred to 1878·8. So far as had been hitherto observed the present was distinguished from the two last spot periods by two peculiarities; first, that the maximum in the present period appeared to have occurred 0·4 of a year later than in the previous periods, and, second, that during the maximum the distribution of the solar eruptions showed an essentially different character from that usually obtaining. In the former periods it was observed during the maximum that the greatest concourse of spots surrounded with faculæ occurred in the median latitudes of the sun, that they were completely wanting towards the poles, became less numerous also towards the equator, and only at the equator itself did they again become somewhat more crowded. In the rotation of the sun those eruptions showed a heliographic displacement towards the equator, in contrast to the spots free from faculæ which, in the course of rotation, wandered towards the poles. During the minima of the spot periods the maximum of the eruptions was generally found in the neighbourhood of the equator. In the present period, again, the greatest concourse of eruptions surrounded with faculæ was found towards the equator during the maximum as well, a phenomenon usually occurring at the time of the minimum. The present, on the other hand, resembled former periods in the circumstance that it was only on rare occasions that the concourse of spots was alike on both hemispheres of the sun. In the majority of cases either the northern hemisphere presented a more copious display of spots than the southern, or the southern mustered them in larger numbers than the northern.

STOCKHOLM

Academy of Sciences, November 12.—Prof. Gyldén communicated the results of the Meridian Conference in Washington, according to the report of the Swedish delegate Count Lewenhaupt, and gave an account of his own paper "On the origin of comets."—Prof. Lindström exhibited a fossil scorpion recently found near Wisby in the Silurian formation of Gotland, and remarkable as the most ancient air-breathing land-animal at present discovered.—Prof. Retzius presented the last volume of his great work "Das Gehörorgan der Wirbelthiere," and made some remarks on its contents.—Prof. Nordenskjöld communicated a "Catalogue of the Meteorites in the Swedish Museum of Natural History," by Herr G. Lindström, Assistant Mineral Department.—Prof. Wittrock gave an account (1) of a paper by Dr. Johansson, of Upsala, "On Fungi from Iceland," and (2) of another paper by Dr. Alb. Nilsson "On the mechanical function of the sheaths of *Dianthus banaticus*, Heuff."—The Secretary presented the following papers:—On a quantity of the electrical potential, by Prof. Dahlander.—Sur la sommation des puissances semblables des n premiers nombres entiers, by Dr. C. O. Boije, of Gennäs.—On some recently-published mathematical papers from the seventeenth century by Bierens de Haan, by Dr. G. Enestrom.—On a proposition from the theory of the elliptic functions, by E. Phragmén.—On substituted cyanamides and melanins, by Dr. P. Claesson.—On *Mergus anatarius*, Eimbeck, found in Sweden, by G. Kolthoff.—On a new Isopod from the coast of Sweden, by Dr. C. Bowallius.—On minerals occurring at Vestra Silfberg, by Dr. Mats Weibull.—A catalogue of the phænogamous plants and ferns of Jemtland, by Dr. P. Olsson.

VIENNA

Imperial Academy of Sciences, October 23.—Report on his journeys in the Balkan Peninsula, by F. Toula.—The geological exploration of the Central Balkans and adjacent regions, by the same.

CONTENTS

	PAGE
The Cholera Bacillus	97
The Haytian Negroes. By Prof. A. H. Keane	98
Our Book Shelf:—	
Johow's "Hilfsbuch fur den Schiffbau"	100
Carr's "Synopsis of Elementary Results in Pure and Applied Mathematics"	100
Letters to the Editor:—	
Natural Science for Schools.—Walter A. Watts	101
Do Flying-Fish Fly?—Dr. John Rae, F.R.S.	101
The *Jeannette* Drift.—R. S. Newall	102
A Meteor Visible in the Daytime.—Rev. James Graves	102
Noon-Glow.—D. J. Rowan	102
Rosy Glow about the Moon.—Robert Leslie	102
Wild Fowl Decoy.—Sir Ralph Payne Gallwey, Bart.	102
Prehistoric Man.—Daniel Pidgeon	102
Fly-Maggots Feeding on Caterpillars.—J. H. A. Jenner; M. E. S.	103
The Forbes Memorial.—Prof. F. Jeffrey Bell	103
Thomas Wright, M.D., F.R.S.	103
Robert A. C. Godwin-Austen, F.R.S.	104
Charles Clouston	104
On the Autumnal Tints of Foliage. By H. C. Sorby	105
A Tornado Photographed. By Prof. Edward S. Holden. (*Illustrated*)	106
Meteorology of Magdeburg	106
On a Hydriform Phase of "Lymnocodium Sowerbii." By Alfred Gibbs Bourne	107
Notes	107
The Royal Society Anniversary	109
The Wave Theory of Light, II. By Sir William Thomson, F.R.S., LL.D. (*Illustrated*)	115
Scientific Serials	118
Societies and Academies	118

THURSDAY, DECEMBER 11, 1884

HEALTH LABORATORIES AS THE RESULT OF THE HEALTH EXHIBITION

MEN of science have thus far regarded the South Kensington Exhibitions of the last two years with very languid interest, if not with some suspicion. There has been throughout some show of scientific intent and much promise of serious result. Needless to say, however, that in regard to the Fisheries Exhibition, whatever may be in store for the future, very little of what was promised of solid or scientific result has thus far been definitely realised. That Exhibition achieved a certain success in technical interest and much was hoped in financial result, but there has been a remarkable reticence in respect to the surplus obtained and its proposed disposal. Little, if anything, has been announced in reply to the urgent requests that have been put forward for information on this subject as to the promotion of new knowledge which should aid the protection of the harvest of the sea, or help to give us information, of which we stand sadly in need, as to the best means of favouring the growth and hindering the destruction of the marine staple of food. So far the Marine Biological Association, which has been started by voluntary effort, has not received any promise of or share in the large sum of money which must now be standing to the credit of the Fisheries' Council. That body are in the happy position of having a continuing receipt as lessors of the buildings just vacated by the International Health Exhibition; they will receive a handsome sum for the next two years at least, and probably also in the succeeding years, from the Exhibitions already planned and in course of arrangement. They have a future before them rich in golden promise, and it is much to be hoped that they will not be unmindful of the new Marine Association. The Council of the International Health Exhibition have been more prompt in declaring the results of their work and in announcing some of its probable issues. Of this Exhibition also it was said, while its doors were open, that the element of display and of public attraction appeared to be much more prominent than did the scientific and solid objects which the great body of busy chemists, sanitarians, and engineers were summoned to assist by their work on the General Committees and on the juries. It will be found, however, by the statement which Mr. Ernest Hart makes in another column of the work done and the results achieved, that, although the serious side of the Exhibition was much less a subject of comment than its more entertaining features, the Council have steadily held the former in view and are likely still to do so in the proposed disposal of the surplus in promoting solid objects of national importance. In this Exhibition for the first time the Council went outside the ordinary routine of exhibits obtained from commercial or speculative sources, and at their own cost brought together and created departments of which the object was purely educational. Thus on the sanitary and unsanitary houses there appears to have been expended nearly 1000*l.*, and probably much more than that on the literature of the Exhibition, including a considerable series of hand-books by skilled persons, devoted to the popular exposition of public and private hygiene, and the reports of conferences and lectures. A library was brought together of sanitary and educational works—about five thousand in number. Although far from complete, it was in many departments, especially in those relating to civic, official, and foreign sanitation, more extensive than any that had yet been collected. Of this an excellent printed catalogue was prepared, which is of itself a useful book of reference. Besides this, and perhaps far more important, was the creation of two health laboratories, under the direction of Profs. Corfield and Cheyne. By special application to the French Government a full exhibit was also obtained, illustrating the nature of the work and showing the instruments employed by M. Pasteur and M. Mique in their respective institutes. It is well known that laboratories of this kind are especially important for the scientific study of the bacteriological problems which have to be worked out, and which form the basis of the most important public health researches of the present day. The scheme which was presented to the Council in the early days of its work for the formation of these laboratories contemplated the creation of temporary laboratories, which should be put in working order and should demonstrate the nature of the work carried on in such laboratories, and its close and immediate connection with the interests of the health of man, and with investigations of high commercial value to every department of agriculture, and with the study of the costly epizootics which affect the prosperity of the grazing interest and influence of the food-supply of the nation. These laboratories have been in every sense successful. We have already noticed with satisfaction the paragraph in the report which the Council presented on the closing day of the Exhibition, in which they referred to a proposition that had been laid before them for establishing these health laboratories on a permanent footing as the best possible application of the surplus. The amount of that surplus has not yet been determined, and it is premature to speculate upon it. There is reason to fear that it will be much less than has been publicly rumoured. We have seen it anticipated in print that it will amount to nearly 30,000*l.* On the other hand, we have it on good authority that it is not likely to exceed half that sum. However this may be, it is satisfactory that the address, of which we print a part, and which has a semi-official value, coming from a member of the Executive Council, with the Chairman of the Council presiding, adverts to this application of the surplus almost as though it were a settled matter. Mr. Ernest Hart may of course speak with some excessive hope, inasmuch as it is known that the first establishment of these laboratories was due to his efforts, and they were formed upon the scheme which he drew up for the purpose. The proposition for making them permanent proceeds comes also from him, and no doubt he has a paternal hopefulness which may be excessive. There is, however, evident reason for accepting this most desirable application of the funds as the most probable issue, seeing that the Duke of Buckingham so heartily indorsed it in his speech at the Society of Arts at the close of the address, and that Sir Frederick Abel, also a member of the Exhibition Council, and not likely to speak with other than official caution, stated that Mr. Hart's scheme had now obtained,

he believed, a pretty unanimous consensus of opinion in the Council. Outside, opinion has at once declared itself with strong approval of this application of the funds, and it is indeed evident that, if the Council can succeed in establishing health laboratories which shall find for the health students of this country establishments properly equipped such as those of Pasteur, Koch, and Miquel, the Exhibition will not have lived its short life in vain, but will leave behind it an institution not only of permanent value but of growing importance and of large promise. The Commissioners of 1851 will certainly see with great satisfaction this liberal intention of the Executive Council of the Health Exhibition to add to those laboratories which they have already provided one which is so greatly needed to complete the means of study and of education which South Kensington supplies in other departments of technical and biological research and teaching. They will probably make no difficulty—or, rather, they will have the strongest reason which a desire for national usefulness will give them to overcome any difficulty—in providing a suitable site for such laboratories. Even if the means which the surplus may provide should not be adequate for the establishment and endowment of such a laboratory, there is little doubt that, with this good beginning, so much may be effected as will afford the best possible reason and the largest inducement to societies such as the Royal Society, the British Medical Association, the British Association, and others to make grants to students conducting research in the laboratories. The Government can hardly refuse to make grants in aid of an institution which in any other country than this would be wholly supported by State funds—witness the health laboratories of France and Germany, which are liberally maintained by State endowments. In this country, however, we are accustomed to look to private enterprise, and the liberality of societies or committees, to furnish at least a large part of the funds required for scientific research or endowment, and it is satisfactory to know that the Council of the International Health Exhibition have favourably considered the proposition that they should take the first step in this useful direction. Every one interested in the promotion of real health-progress will trust that it will soon be an accomplished fact.

THE BUTTERFLIES OF EUROPE

The Butterflies of Europe. Described and Figured by Henry C. Lang, M.D., F.L.S., &c. Pp. 396, Super-Royal 8vo, with 77 Chromo-lithographic Plates. 1881–1884 in parts. (London: L. Reeve and Co., 1884.)

FOR some years past the writer of this notice has, almost annually, formed one of the members of that large class of Englishmen who, each year, spend a few weeks in the Alpine and sub-Alpine districts of Europe for "relaxation." The writer prefers to leave it to the taste and fancy of the individuals interested to define the meaning of the latter term. He has naturally met hosts of "foreigners" of different nationalities engaged in the same pursuit. Whatever may be the state of the weather or other conditions incidental to travelling of this kind, those *voyageurs* of Gallic origin succeed in amusing themselves after their own special fashion. The Teutonic element also succeeds, but in an entirely different manner. The Americans seem tolerably successful. They leave home to "do" Europe, and they "do" it, in their own businesslike fashion,—business and pleasure are carried out on the same principles. Then there comes the large class of our own countrymen and countrywomen. We must confess that, according to our observation, the majority of these do not bear the outward appearance of enjoyment (especially the male portion). There is something apparently wanting. They have left their business or profession behind them, and the void thus occasioned cannot be satisfactorily filled in. From these must, of course, be separated those who find enjoyment in the excitement of Alpine climbing, and some others. Amongst these others are those who may be seen with *vasculum* at back, or insect-net in hand (very frequently in ill-disguised clerical garb), enjoying *themselves* to an extent unknown to, and often not understandable by, their fellow-countrymen who have voluntarily placed themselves under the same conditions. Probably a still larger amount of Teutons may be observed provided in the same way. And only this year we found ourselves seated next to a New England divine and his wife, and overheard the latter read out to her husband an advertisement of a butterfly-book, with the remark, "That would just suit *you*."

In the foregoing notes we have tried to draw a picture which we (perhaps we are prejudiced) believe to be tolerably natural. The pursuit of some branch of natural history studies on our travels adds a zest to the other conditions of surpassing value. If pursued systematically, it can hardly be termed "relaxation," if taken to mean "doing nothing." But if the work be harder (and it often is very much harder) than ordinary occupations, it is often the one thing needed, both for health and enjoyment.

Of the bearers of the insect-net in the Alps the majority occupy themselves with butterflies and moths, and the majority of these again with butterflies only. To an Englishman accustomed only to his own meagre, and declining, butterfly fauna, the wealth and beauty of forms is marvellous. With the exception of a small, but useful, manual, published by Mr. W. F. Kirby more than twenty years ago, and which consists almost entirely of laconic descriptions without figures, there has been, up till now, no work in the English language that enables collectors of European (as opposed to British) butterflies to name their captures without the troublesome comparison of some noted collection. These therefore will thank Dr. Lang for having supplied the deficiency, and in a generally satisfactory manner. The author has adopted no new system of his own. He follows Staudinger's German Catalogue, describing (for the most part originally) and figuring those species that occur in Europe proper, and simply describing those that have not occurred in "Europe," but still form part of the "European Fauna" (a term becoming daily more difficult to define). We think there is evidence of a little too much dry routine in the text: the descriptions appear to be excellent, and there is always a notice of the larvæ when known, and tolerably copious geographical information as to distribution, but the class of readers who will mainly use the book would be more readily caught by a mixture of

popular matter, recalling to their minds some of the scenes in connection with their own captures, or serving as a stimulant for future expeditions. But after all it is the *plates* that will be most frequently consulted. Of these there are seventy-seven, mostly crowded with figures, and including a few of transformations. Without the recent adaptation of chromo-lithography, in a superior form, to natural history subjects, the publication of such a work as this (at the price) would have been impossible. The author estimates that there are more than 800 figures on these plates. It is impossible here to criticise them *seriatim*. Those subjects that appear the most difficult are often the best (perhaps more detail in the way of "stones" was used on them), and we are much pleased with the *Hesperidæ*, which, easy as they may look at first sight, must prove very troublesome of application. The "Blues" and "Coppers" (*Lycænidæ*) are fair, but naturally fail in effect where metallic colours are necessary. The worst, to our mind, are those of the *Satyridæ* (of which our "meadow-brown" is a familiar example), and yet they *look* the easiest: we think here there is evidence of trying to make too many species, with varying shades of practically the same colour, accommodate themselves to one "stone." The size is rather too large for a book to be used as a travelling companion, but we think it is rather intended for home study. Paper and type are very good (the former almost unnecessarily so). There is not much to find fault with in the way of uncorrected errors. This is satisfactory, because careless correction is the crying evil of the present day, even in works claiming a much higher scientific position than does this, and often shows up the amount of knowledge possessed by writers of the authors and works they quote. But such glaring errors as the following should not have escaped correction:—Page 47, "Illus. Mag." for "Illiger's Mag."; p. 61 (and elsewhere), "Wein" for "Wien"; p. 153, "Sellmann's" for "Silliman's"; p. 380, "Thurnberg" for "Thunberg"; and, as a crowning morsel, p. 379, "Aumer Kungen" for "Anmerkungen." In notices of some of the recent additions from Central Asia, the author uses indiscriminately (sometimes on the same page) "Samarcand" and "Maracand" as localities: we thought it was generally understood that the latter is only the ancient name of the former.

We have hitherto dealt with this work from a popular point of view. But there is also the scientific side of the question. The book will be of service as collectively giving good descriptions and figures of all known European species brought down to date, and thus avert the necessity of search through a multitude of scattered publications; and in this it will be useful to other than English readers.

On the title-page the author adopts a super-title—"Rhopalocera Europæ." This we think a pity in a work otherwise entirely in the English language.

R. McLACHLAN

ELEMENTARY MATHEMATICS

Lehrbuch der Elementaren Mathematik. V. Schlegel. Pp. 712. (Wolfenbüttel, 1878-1880.)

WE have not had the good fortune to meet with this work, but having now before us an elaborate notice of it by M. Houel in the *Bulletin des Sciences Mathématiques et Astronomiques*, December, 1882 (pp. 301-313), we have thought that a few passages from the notice would be acceptable to some of our readers, and lead them to a personal examination of the original treatise.

The writer's opening remarks have much truth in them:—"Nous sommes habitués depuis longtemps à considérer l'apparition d'un traité élémentaire de mathématiques comme un événement pédagogique ou commercial n'ayant rien de commun avec la science pure. Si l'on met à part quelques honorables exceptions, c'est toujours le même livre qui reparaît sous une couverture de couleur différente, avec quelques pages transposées, quelques propositions secondaires introduites ou supprimées, quelques démonstrations modifiées sinon perfectionnées, quelques développements de plus suivant les tendances des programmes officiels. Quant à la manière d'exposer les principes fondamentaux de la science, rien n'est changé. Les découvertes qu'on a faites dans les hautes mathématiques depuis un siècle et qui ont si admirablement éclairci les difficultés que présentaient encore les éléments d'algèbre semblent étrangères à nos auteurs, qui expliquent les imaginaires comme au temps de Bézout et de Lacroix, et présentent parfois à leurs lecteurs des notions géométriques en arrière de beaucoup sur celles qu'exposait Euclide il y a plus de deux mille ans. . . . En Angleterre, l'enseignement est resté ce qu'il était au temps de Barrow et de Simpson; heureusement le vieil Euclide a été choisi et fidèlement conservé à l'abri des prétendus perfectionnements des traités modernes."

M. Victor Schlegel is a pupil of H. Grassmann, and his present work is inspired by the bold views of the author of the "Ausdehnungslehre." It consists of four volumes devoted to arithmetic, algebra, plane and solid geometry, and plane and spherical trigonometry. Vol. i., "Arithmetik und Combinatorik" (182 pp.), treats of elementary algebra and of the theory of combinations. "Le tout est exposé avec une concision qui n'exclut pas la clarté, et avec une rigueur irréprochable." The reviewer's attention is especially directed to an analysis of vol. ii., "la partie vraiment originale de l'ouvrage." In 222 pages are laid down the principles of plane geometry, the ideas in which are those first introduced, we believe, by Grassmann. A full statement is given of the fundamental hypotheses, and the treatise consists of two sections. The first, "Geometry of Figures in Motion," naturally discusses the geometry of the straight line and of the plane; the second, "Geometry of Figures at Rest." A collection of 737 exercises closes the book. The following remark by M. Houël is deserving of a place here:—"La tendance de la nouvelle école à remplacer le raisonnement par le coup d'œil nous semble éminemment dangereuse. Le sentiment de la forme est un précieux auxiliaire, auquel les illustres inventeurs de la géométrie pure ont dû une grande partie de leurs découvertes: mais rien en mathématiques ne peut dispenser de la démonstration, d'autant plus que cette partie de la tâche est en général la plus aisée. Dans le cas actuel, la marche d'Euclide n'est pas plus longue, et ne laisse aucun doute dans l'esprit."

The third volume, Rectilineal (or Plane) Trigonometry, is founded, in like manner with the second, on a treatise on the subject published by Grassmann in 1865.

Approving in the main of this volume, we gather that the reviewer differs from the author on some points. M. Houël's views we have lately come across in "Remarques sur l'enseignement de la Trigonométrie" (a paper originally printed in the *Giornale di Matematiche*, t. xiii., 1875, and reproduced in the *Mémoires de la Société des Sciences Physiques et Naturelles de Bordeaux*, 2e série, tome v., 1882, pp. 197-209). He altogether approves of M. Schlegel's appendix, containing a table of *rational* right- and oblique-angled triangles "où l'on puiser d'excellents exercices de calcul numériques."

The fourth volume, devoted to Solid Geometry, is prefaced by an introduction in which the author discusses the most convenient methods for getting clear ideas of figures in space, viz., by the use of models in relief and by stereoscopic images (at the end are plates, corresponding, we presume, to Clerk Maxwell's stereograms, of polyhedra).

"Un auteur se disposant à écrire un traité classique ne saurait trouver une meilleure préparation que la lecture du livre de M. Schlegel, où il apercevrait tant d'horizons nouveaux, inconnus à la routine, et qui eux-mêmes peuvent conduire à des découvertes ultérieuses."

We must not omit to state that M. Houël objects to some of the ideas put forward; but the grounds on which he commends the "Lehrbuch" (in addition to others adduced above) are thus summed up:—"Quoi qu'il en soit, nous sommes si peu accoutumés à rencontrer dans les manuels de géométrie des idées neuves et hardies, que nous n'hésitons pas à saluer comme un heureux événement dans la littérature géométrique l'apparition de ce traité, où le disciple fidèle de Grassmann s'est fait le sagace interprète des idées du maître sur l'enseignement élémentaire."

OUR BOOK SHELF

The Edible Mollusca of Great Britain and Ireland. With Recipes for Cooking Them. By M. S. Lovell. (London: L. Reeve and Co., 1884.)

WE have received the second edition of this interesting, useful, and in some respects most amusing book. The primary object of the author is to call attention to the qualities and merits of many kinds of shell-fish which are as nutritious as others which are generally known, but which are rarely met with in our markets, or are only used locally for food, while the proper modes of cooking them are scarcely known. Accordingly all the known species of edible shell-fish on our coasts are here described in succession, with the various modes of cooking them. This alone would make the volume of great use at a time when we are going to the uttermost ends of the earth for the sources of our food-supply, and when public attention has been so powerfully drawn to our fisheries by the Exhibition of last year at Kensington. But when we add that the writer has collected from the most varying sources—from an "old M.S." to the Bridgewater Treatises, and from Athenæus to the latest book of travels that is having its little day,—a mass of curious lore about shell-fish, their uses, and the mode of catching them in various parts of the globe, their medicinal properties, the popular superstitions about them, &c., it will be perceived that this is much more than a work on natural history *plus* a cookery-book. If the title were not too suggestive of dulness for such an amusing volume, one would feel inclined to say that "Encyclopædia of the Edible Mollusks" would be a suitable title. And when we examine the formidable list of works "referred to or consulted" at the end, filling with mere titles thirteen pages, we cease to wonder at the out-of-the-way information contained in the volume. Of the nineteen sections in which the subject is treated, that on the *Ostreadæ* is, as might be expected, the longest, although that on the *Helicidæ*, which is also comparatively long, appears to us the most amusing. We hear of many infallible corn solvents, corn-destroyers, and the like, but the prescription of Master Ralph Blower, who wrote a certain "Rich Storehouse or Treasurie for the Diseased," possesses at least the merit of originality. Here it is. "Take black sope and snailes, of each a like quantitie, stampe them togither, and make plaister thereof, and spread it upon a piece of fine linnen cloth, or else upon a piece of white leather, and lay it upon the corne, and it will take it cleane away within seven dayes space." Master Blower who, by the way, wrote "for the benefit of the poorer sorts of people that are not of abilitie to goe to the Physicians," supplies the recipes for other cunning decoctions of snails, as do several other physicians who are quoted. Snail-water appears to have been considered a sovereign cure for consumption; but it may not be generally known that a large trade in snails is carried on for Covent Garden Market in the Lincolnshire Fens. They are sold at 6*d.* per quart, and it appears that they are still much used for consumptive patients and weakly children. Of all the many uses of snails in various parts of the globe, the strangest perhaps is that discovered by the London adulterator. They are much employed, the author assures us, in the manufacture of cream, being bruised in milk and boiled, and a *retired* milkman pronounced it the most successful imitation known! There are, we should say in conclusion, many beautifully coloured illustrations.

Forestry in the Mining Districts of the Ural Mountains in Eastern Russia. Compiled by John Croumbie Brown, LL.D., &c. (Edinburgh: Oliver and Boyd; London: Simpkin, Marshall, and Co., 1884.)

STILL another book on forestry by Dr. Brown, uniform in size and binding with those that have preceded it. We have before alluded to the readable character of Dr. Brown's books, and the one before us is no exception to those on "The Forests of England" and the "French Forest Ordinance of 1669"; indeed it is perhaps more popular in its style, which Dr. Brown is not entirely responsible for, as he states on his title-page that it is a compilation, and the free use of inverted commas shows it to be so to a great extent. Though the book may contain a very good description of the country under consideration and accounts of the several journeys made in Russia, we are bound to say that not more than half deals with forestry matters. Thus we have one chapter devoted to the journey from St. Petersburg to Moscow, including a description of the Nijni Novgorod Fair. Another chapter describes the "Mishaps and Difficulties Experienced in Travelling"; another "Metallurgy"; and another "Depressed Condition of Mining, Smelting, and Manufacturing Establishments." The chapters that deal with forestry in some form or another are on "Forest Exploitation in the Government of Ufa"; "Abuses in Connection with the Exploitation of Forests"; a short one on "Forests," &c.

It may be stated that Dr. Brown's several works on "Forestal Literature" were awarded a silver medal at the recent Forestry Exhibition in Edinburgh, a fact to which he draws attention at the commencement of the present volume.

Die pyrenäische Halbinsel. Von Dr. Moritz Willkomm. II. Abteilung: "Spanien." (Leipzig: G. Freytag, 1884.)

THIS forms one of a series of volumes on the countries of the world, and appears to be part of a German "Universal-Bibliothek" entitled "Das Wissen der

Gegenwart." It is clearly printed, has numerous illustrations, and the information, which is excellently arranged, is brought down to the latest date and is very full. The volume and the series are of a kind more numerous and popular in Germany than in England.

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 Prime Meridian Conference

IN *La Nature* of November 22 (p. 399) appears what is represented as information obtained at the meeting of the Academy of Sciences at Paris on November 17. It is stated that the proposal made by Prof. Janssen at the Meridian Congress at Washington, relative to the application of the decimal system to the measurement of angles and time, obtained a majority of 24 votes against 21, notwithstanding the "opposition *très-vive*" of the English and Americans. The vote to which reference is made was not on the merits of Prof. Janssen's proposal, but merely whether the opinion of the President that the Congress was not competent to entertain it, should be upheld or not. The decision being in favour of considering it, the proposal was accepted unanimously. On turning to the *Comptes Rendus* of the Academy I find it simply stated that M. Janssen observed that his proposition had been accepted almost unanimously, and without a vote in opposition.

La Nature further refers to the British delegates as having made the discussion on the prime meridian a question of "*amour-propre*," and as having converted to the British cause most of the representatives present. This statement is no less inaccurate and misleading than the former. As M. Janssen himself remarked at Washington, England did not make the proposal to adopt the meridian of Greenwich, and though the British delegates differed from their French colleagues as to the considerations which should govern the choice of a prime meridian for longitude, there was not a word said by them to justify what is stated by *La Nature*, and it is manifestly absurd to speak of the conversion of the representatives to the British cause, inasmuch as it is a perfectly well-known fact that almost every one of them came to Washington with instructions from their own Governments to vote for the Greenwich meridian. In justice to M. Janssen I wish to add that the *Comptes Rendus* makes no reference whatever to anything having been said by him on this subject.

It is greatly to be regretted that a journal professing to be scientific should have given a colour to the discussions which took place at Washington that forcibly suggests a deliberate intention of exciting national jealousies and animosities.

RICHARD STRACHEY,
Late Delegate at Washington

December 5

IT is to be regretted that the French delegates have declined to accept some of the resolutions of the Prime Meridian Conference, but it is to be hoped that their non-adherence is only temporary; at the same time it must be admitted that their contention that Greenwich is not a scientific starting-point for a universal meridian has much to be said for it; the zero of longitude ought certainly to be defined somewhere on the equator, and if it were to be hereafter so defined at a point on the equator having the same meridian as the Greenwich instrument it is probable that all difficulty would be removed. The French are known to attach importance to ideas, and doubtless do not like the apparent supremacy which would be conferred on Greenwich if it were made the actual centre of departure. The point in question lies somewhere in the Atlantic Ocean, and is therefore on perfectly neutral territory.

One of the great obstacles to the introduction of the French metrical system into this country lies in the forbidding and inconvenient nomenclature attached to it. If the long compound names were translated into short English monosyllables, such as *met*, *kim*, *mim*, &c., not only would their use be greatly advanced and facilitated, but the French nation would in time borrow back from us our nomenclature. Such words offend at first sight by their new and startling aspect, but this all wears off in an hour or two; they require however to be started by some one in authority. There is a strange and unreasonable prejudice in the present day against the introduction of new monosyllabic words without derivation, which happily for us did not prevail in the days of our early forefathers.

It is desirable that at future meetings of the Conference the question of astronomical nomenclature should be considered; the practice of using the same names for sidereal and mean time is extremely inconvenient. I have suggested that the sidereal hour should be called a *sid*, or *sider*, and the second a *cron*, so that sidereal time would be indicated by the letters *s*, *m*, and *c*. Some such change is greatly needed, and new names should also be assigned to minutes and seconds of arc.

LATIMER CLARK

London, December 1

The Electric Light for Lighthouses and Ships

THE application of the electric light to lighthouses and ships appears to me to be capable of considerable extension by a modification of the apparatus used. In lighthouses the practice is to have a fixed light in the lantern, with an apparatus either catoptric or dioptric, or a combination of both, for the purposes of bringing the rays of light from the arc into a parallel beam and sending them to the horizon. Sometimes, if not generally, this beam is cylindrical, and sweeps round at intervals of time as the combination of lenses and reflectors is rotated.

In the case of ships the head-light is an ordinary arc light, and searchers in use on men-of-war are arc lights set in the focus of a parabolic reflector, and pointed straight at the object it is wished to light up.

The arrangement that I would suggest as partly applicable to lighthouses and fully applicable to ships would be to use a fixed arc-light and large parabolic reflector in combination with a large, light, plane or suitably curved mirror to direct the beam of light, rendered parallel and cylindrical by the parabolic reflector, in any direction by means of this mirror only.

To apply this principle to a lighthouse, this light movable mirror would be placed in the lantern at an angle of something less than 45° with the vertical; the arc light and the fixed parabolic reflector would be placed below, centrally, in the tower; the light would then come from the parabolic reflector on the plane mirror, and so be sent in the required direction.

In using this mirror, where the light has to sweep over an angular area of less than 360°, I would use a to-and-fro motion, so that if the time of each sweep from side to side was 30 seconds of time, then any vessel in the middle line would have the light at this interval, but at any angular distance from the centre line the duration of the flashes would differ until, at the extreme range, two would be seen almost together, with almost 60 seconds interval between them and the next two, the sum of the time of two intervals always being the double of the fixed time for that light, and the difference between two intervals for all positions off the central line would enable the distance from the centre line to be determined by a vessel within the range of the light. An arrangement similar to this would answer for masthead lights for ships, the arc light and parabolic reflector being below deck, a light metal tube, terminating with a lantern to carry the plane mirror, going from the deck up to the required height in front of the foremast; the movement in azimuth of this mirror might be of the same kind as that mentioned for the lighthouse, but a much quicker motion from side to side, through 180° in about five seconds, would then give this time for all points in a straight line ahead, but vary at the sides in the manner already mentioned. As the light plane mirror has only to be moved, a clockwork arrangement would answer perfectly well for this purpose. In rough weather, when the vessel rolled, the light would have a tendency to vary too much in the vertical direction, but it would not be difficult to make the correction by a gravity counterpoise.

For war-ships such an arrangement, but on a more powerful

scale, would answer for a searcher, and the motions could be given by simple mechanical means or by means of electromotors worked from any point. Here the chief working parts of the apparatus would be fully protected, and this would be of the first importance, and the rapidity with which the light could be directed to any point or rendered quite invisible would be a great improvement on the present model, where all has to be exposed.

For forts requiring powerful searchers, and it is easy to see that they might be of great use here, this arrangement is suitable, particularly as the mark, being stationary, is more likely to be struck than in a ship; but the replacing of the plane mirror would be easily effected, and other part of the apparatus of course being quite protected, as in the case of ships.

In the case of a fort in a channel that it was desired to protect, the beam of light from a powerful fixed parabolic reflector could be so truly sent that it could be reflected from mirrors at a distance, as on the banks of the channel, so as to sweep across close above the level of the water and show the smallest object crossing the illuminated line.

It may be objected that in this second reflection there will be a loss of light, but that loss can be made very small, and there would be positive gain in using a large parabolic mirror in place of the necessarily small and imperfect ones in use in a lantern of a lighthouse or the deck of a vessel. Such a parabolic mirror could be made accurately in sections of very thin glass silvered at the back so as to retain its reflecting powers for an indefinite time; in the case of a lighthouse it might be placed at any point vertically below the lantern, even at the bottom if the tower had a well as large as the intended beam of light. The large mirror above may be also of thin glass silvered in a similar way and with such a slight curvature as might be required to enlarge the beam in any way, and more than one of these mirrors might be used if it was necessary to have a fixed light in one constant direction or for any other purpose. I am not sure if there would be any gain in the power to penetrate fog. In the case of a head-light, there would be certainly, from the collection of light into a beam instead of the naked arc; but whether a light such as the very small point that forms the arc including the incandescent carbon ceases to affect the eye in fog sooner than the same intrinsic light seen as a surface must only be settled by experiment on a proper scale.

Ealing, December 5 A. AINSLIE COMMON

Natural Science in Schools

IN the interesting discussion which has recently been carried on in your pages on the teaching of natural science in schools, not much has been said about the text-books which are, or should be, read. So long as the present system of teaching a single branch of natural science continues, and until the method recommended by Prof. Armstrong is adopted, it is clear that great care should be exercised in the choice of a good text-book on the particular subject selected. Even when it is found possible to teach science in the form of physiography, or *Naturkunde*, there will doubtless be many boys in the large schools who, having thus obtained a great amount of most valuable general knowledge and a wider view of the aims of science than is possible under the present system, will wish to carry on their studies in a particular direction. Taking chemistry, as the subject with which I am most familiar, and which at present is perhaps more widely taught than any other branch of science, it may be said that there should be no difficulty at all in selecting a suitable book. It is true that the number of text-book of chemistry is extremely large, and it is also true that there are a few books, written by men of wide knowledge and long experience in teaching, which are well adapted to the purpose in view. But it is, unfortunately, equally true that there are many text-books which are either untrustworthy or are badly arranged, or which contain little more than a bare collection of dry facts, and it is to be feared that some of these not unfrequently find their way into schools. Doubtless most teachers of chemistry will agree with Prof. Armstrong that the educational value of a course of instruction dealing merely with the methods of preparation and the properties of a number of elements and compounds is extremely small, because the faculty of reasoning from observation is not thereby developed. It will also, I think, be generally admitted that "it is of great importance that the meaning of the terms 'equivalent,' 'atomic weight,' 'molecular weight,' should be thoroughly grasped at an early stage." But it would perhaps be better that students should remain in complete ignorance of the meaning of these terms than that they should obtain such erroneous and illogical notions of atoms and molecules as are contained in some of the text-books. One of these books, which in 1880 had passed through no less than fifteen editions, and which appears therefore to be largely read, and which is advertised as being recommended by the head-masters of certain schools, contains the following remarkable statements:—

"Chemists *assume* that the elementary bodies are built up of infinitely small particles, which they call atoms; they further *assume* that these atoms, with few exceptions, are all of the same size. . . The exceptions are phosphorus and arsenic, whose atoms are believed to be half the usual size; and zinc, cadmium, and mercury, whose atoms are double the size." (The italics are the author's.) To the uninitiated it might appear strange to argue about the relative sizes of infinitely small particles.

Again:—"*All molecules are of the same size;* for the law of Ampère, which most chemists now accept, states that 'all gases and vapours contain the same number of molecules within the same volume.'"

Most of the errors contained in these statements are of course due to a misapprehension of the meaning of Avogadro's (Ampère's) law. It is not very easy to give an average student a clear conception of the fundamental generalisations and theories by means of which chemists have been able to determine the most probable relative atomic weights of the elements. To do this, it is first of all necessary to induce the student to think and reason for himself, and it seems to be much easier for most people to repeat a thing from memory than to understand it. But when the student's memory has already been stocked with such illogical statements as those quoted above, the difficulty is very greatly enhanced. SYDNEY YOUNG

University College, Bristol

The Edible Bird's-Nest

THE nature of the material from which the edible bird's-nest is formed has been long the subject of controversy. It is very gratifying to find from Mr. Layard's letter, published in last week's NATURE (p. 82), that a reconciliation of the various views is possible. Most writers support the theory that the substance is secreted in some way by the bird, though they differ as to the manner. Sir E. Horne, in a paper published in the *Phil. Trans.*, 1817, suggests certain gastric glands as the active ones. Bernstein, forty years later, points to the prominence in the nest-building season of certain salivary glands which form cushions by the sides of the bird's tongue, and suggests that these secrete the material. On the other hand, there are advocates of the view that the nest is constructed of certain vegetable matter found by the birds in the caves where the nests are built, and agglutinated by them by a buccal or salivary secretion.

Through the kindness of Prof Michael Foster I have been enabled to make some observations on the chemical nature of the material of the nests used for soup at the recent Health Exhibition, and from my experiments I have come to the conclusion that this is a substance resembling very closely the *mucin* described by Eichwald, Obolensky, and other writers, as forming the chief constituent of the mucous secretion of all animals and of the tissues of *Helix pomatia*, &c. It shows under the microscope scarcely any structure, but is laminated, shells splitting off easily in two directions. It contains here and there certain bodies resembling the cells of squamous epithelium. It is insoluble in either cold or warm water, but swells up in either, forming a gelatinous-looking mass; in both lime-water and baryta-water it is slowly dissolved, and the reactions of the solution differ very little from those described by the writers named as those of mucin. It resembles this body also in its behaviour when heated with acids, alkalies, and the different digestive ferments. The solution in lime-water contained a little debris, which proved to consist largely of pieces of feathers, with a little adherent amorphous matter. With the exception of certain microscopic particles among this, I could not get any evidence of the presence of vegetable matter in the nest substance. Indeed all the experiments I have described point certainly to the absence of anything but a glandular secretion.

Jos. R. GREEN

Physiological Laboratory, Cambridge, December 1

The so-called South Plant of Egyptian Art

THE identification of the original source of any conventionalised artistic form is always, I think, worth notice. It will probably interest many readers of NATURE to draw their attention to a short but instructive piece of work of this kind which Prof. Julius Lange has communicated to the Royal Academy of Copenhagen (*Bull.*, 1884, pp. 109-114). I am indebted to Mr. Liden, one of our garden staff at Kew, for a translation of the paper from the original Danish. I have freely condensed the details.

There is a well-known Egyptian symbol which represents both Northern and Southern Egypt. The northern symbol is admitted to represent the stem and head of the Papyrus. But the southern symbol has not hitherto been identified with any certainty. It has a lily-like form, and has been generally referred to the Lotus (*Nymphæa*), an identification which Prof. Lange thinks quite inadmissible, as the conventionalised treatment of this plant in Egyptian art is quite different.

The twin-symbol combining in a kind of knot the north and south plants is commonly found inscribed on the thrones of statues of Egyptian kings. In the later examples the south plant has the form of a flower with three divisions of the perianth depicted (implying that it was either five- or six-parted), and a definite flower-stalk. In one case Prof. Lange met with an example where the flower was separated from its stalk by some transverse carved lines.

Prof. Lange has, however, recently examined a diorite statue of King Chefren, which gives the symbol in a more primitive form. He finds that the supposed flower passes imperceptibly into the stalk, and that the apparent perianth segments are really distinct parts which are tied together by indications of ligatures. Without then arriving at any definite conclusion, he is content to point out the resemblance of the south symbol in this form to the palm-capitals of the Ptolemaic period. In these the leaves of the date are disposed round the body of the capital, and the junction of this with the column is indicated by transverse bands, the conventional representations of the ligatures which would hold the leaves together and in their places. As the date, according to Alphonse de Candolle ("L'Origine des Plantes cultivées," p. 240) has existed from prehistoric times in the dry and hot zone from Senegal to the basin of the Indus, between lat. 15° and 30°, a more characteristic plant as the symbol of Southern Egypt can hardly have been pitched upon.

W. T. THISELTON DYER

Earthworms

I SEE, in your issue of October 9 (vol. xxx. p. 570), an interesting communication entitled "A Gigantic Earthworm," in which the writer refers to worms of large size being fairly common in parts of Cape Colony. I may mention that here in Ceylon it is not an infrequent sight to see two or three of these big worms in the same day, after showers, though I would not pronounce them to be exactly common. I have seen some fully four feet in length, and about the thickness of one's little finger. They are of a pale slaty-bluish colour, and appear, on close examination, to have faint prismatic colours over parts of the body. These worms are seemingly not confined to particular soils or altitudes, as I have met with them at elevations of from 2000 to 4000 feet above the sea. Owing to their seeming inertness of body, the *leb-worms*—as I have frequently heard them called—soon fall an easy prey to swarms of small red and black ants, that attack the victim as it lies on the ground.

Passing from large to small, I may mention a curious earthworm that I found to be very common in North Borneo. The chief peculiarity about this worm is the size of its "cast," this being about four inches high by one inch and a half across the top, which is made cup-shaped or with a marked depression, for the purpose, I believe, of catching water. The stem—if I may apply the word—of the "cast" is about an inch in diameter, strongly built of rows of earthy matter laid circumferentially, widening towards the top into a lip that forms the side of the cup. Sometimes a leaf may have fallen on the "cast" in the course of erection, and this is at once built over, so that part of the "cast" may be seen above and part below. The worm itself is very small, and hard to secure. I have found the only method of catching them was to suddenly break off a fresh "cast," when one could get a glance of the worm as it rapidly withdrew into the ground. It is of a fleshy red colour, and about the thickness of the stem of a crow-quill pen, but I do not know how long, as I never succeeded in extracting a whole worm from its burrow. The "casts" are very numerous, and weigh, I should think, quite an ounce each, and are to be met with both in the forest—as well as in gardens—and cultivated land. I also found them close to the banks of rivers that were sufficiently near the sea to be considerably impregnated with salt, so that I conclude from this that salt water is not destructive, at least to this species.

FREDERICK LEWIS

Bogawantalawa, Ceylon, November 5

Injuries caused by Lightning in Africa

IT is a remarkable fact that in all the publications relating to Africa we so seldom come across accounts of injuries caused by lightning. Some travellers—those of the German Loango Expedition of 1873-76 for example—even distinctly report that, notwithstanding the extreme frequency of lightning in Africa, cases of damage inflicted by it are almost unheard of. During my own stay on the Congo, though I was eagerly on the look-out for instances of this kind, I did not succeed in authenticating a single case of injury due to the electric fluid. There was indeed a vague rumour among the natives of a man in some village having been struck dead and a "tshimbek" burnt down by lightning, but I could find no eye-witnesses of the fact; and all the time I was in Africa I never saw a tree or other object which showed any signs of having been struck by lightning. The only case of which I obtained any authentic report was that the coal-magazine of the French factory at Banana was burnt down in consequence of a lightning-stroke in March 1882. I have been recently informed, however, that just a year after the destruction of the French coal-magazine, the large gin-store of the Dutch factory at Banana was similarly destroyed, a flash of lightning having kindled a great fire there which lasted four days. As a result of these two accidents following so close on one another in the same locality, lightning-conductors are now being set up at Banana, and the International Association of the Congo has had conductors fixed on all the magazines at Vivi.

I find in Dr. Pogge's journals, which I am now preparing for publication, an instance, witnessed by that traveller himself, of a man being killed by lightning. As far as my own researches go, I find scarcely any literature concerning the use of lightning-rods or the frequency of accidents from lightning in the tropics; and if any of your readers would communicate to the columns of NATURE any information relating to this subject which they may have gained by a residence in those regions, they would render a great service to meteorological science.

Hamburg, November 29 VON DANCKELMAN

The Northernmost Extremity of Europe

YOUR correspondent, Mr. Mattieu Williams, says, on p. 54 that Tönsberg "is admitted by all as a high authority" on Norway. May I be permitted to ask who these "*all*" are? I knew this gentleman very well, and he never claimed the least *geographical* authority for a faulty and crude "Guide for Tourists," which is all that his work is. I beg to refer your correspondent to the preface, where the author himself says that, for reasons explained, it has many faults. To set Tönsberg up as a *geographical* authority would indeed be an insult to Norwegian geographers. Your correspondent further says that he saw with his own eyes, ten years ago, that Knivskjærodden jutted further north than the North Cape. Had I happened to meet him before he started on his excursion, I, then but a schoolboy, could have informed him of this startling fact. What I said was, that we had assumed it, but it had only been *proved* by measurements this summer. That was all. As regards the *height* of the promontories on the coast of Arctic Norway, I am sorry to have to repeat my contradiction that there is no single one which is higher than the North Cape. Your correspondent again quotes Tönsberg. If quoting this "high authority" at all, the statement should be correct. Your readers are informed that this guide-book says that Sværholtklubben "is *twenty-four* Norwegian (why *Norsk*? if Norwegian it should be *Norske*) feet higher than the North Cape." Tönsberg says nothing of the kind. What he says is simply that it is *upwards of* (*henved*) 1000 feet, and from this vague guess your correspondent evolves a fresh discovery and figures. Had he taken the trouble to consult the poorest of our geographies, he would have learned that the North Cape is *indisputably* the highest headland in Finmarken. His concluding statement that there are a dozen others is merely an imaginative one.

As a foreigner, I cannot refrain from remarking that it seems strange to me that, because a man has paid a few weeks' visit to Norway, and even "halted in front of the North Cape for half an hour," he can claim to have become an authority on all scientific and other matters connected with that country among a nation which can boast of such distinguished explorers and *savants* as the English. A NORWEGIAN

The Scandinavian Club

Our Future Clocks and Watches

IN connection with the indication of universal time by our future timepieces, I venture to suggest that the hours should be contained in one circle; but, instead of being numbered consecutively from 1 to 24, they might be arranged in Roman numerals, as at present, and if figured alternately would be almost, if not quite, as distinct as on the faces of our present style of clocks. Thus, the hours 2, 4, 6, &c., would be shown in figures, but the intermediate or odd hours, as 11, 13, 15, &c., would be more advantageously distinguished by an arrow-head or circular dot.

As regards the striking of the hours by our public and private clocks, they might strike up to twelve, as at present; the suggestion of your correspondent "R. B." (NATURE, vol. xxxi. p. 80), that they should not strike any number above six, appears to me as objectionable as if they struck up to twenty-four; but to distinguish between the afternoon and morning hours, the hours from thirteen to twenty-four might be distinguished by being preceded by two strokes in rapid succession either upon the bell which strikes the hours, or, preferably, upon a bell of a different tone. B. J. HOPKINS

Leyton, Essex

Singular Optical Phenomenon

ON the night of November 28, at about six in the evening, I went to the window to look at the moon, and saw, as it were, a *second* moon behind the other. The effect was so like what one sometimes experiences from suddenly going out of a very light room, or other causes, that at the time I fancied it was only a defect in my sight. On going into my son's room an hour afterwards he said: "If something is not gone wrong with my eyes, there are two moons out to night." On this I went out again, but saw only the one moon as usual. Later in the evening a young girl who had been meeting a friend at the Montreux train, said her friend had said the moon looked *queer* all the while she was in the train. The night previous a pretty severe shock of earthquake occurred in Geneva and Lausanne, and a few hours after we had observed the moon on the 28th, a very violent gale and snowstorm took place, and lasted for about six or eight hours. I am not scientific enough to know whether the "rosy glow," reported on November 28 by Mr. Leslie of Southampton, can have any connection with this, or whether my letter will interest your readers. X.

Vevey, Canton de Vaud, December 6

The Aurora Borealis

WITH the view of making the Norwegian catalogue of the aurora borealis, at which I am now working, as complete as possible, I take the liberty of asking meteorological societies which are in possession of journals supplied by those who have navigated *Norwegian waters*, to be good enough to place within my reach a copy of the observations which these journals contain respecting the aurora borealis seen near *the coasts of Norway or in their neighbourhood*. I should also be equally grateful for all information with regard to other unpublished observations of auroras of Norway, which may perhaps be found in the archives of meteorological institutes. SOPHUS TROMHOLT

The Meteorological Institute of Christiania, November 19

THE UNITED STATES FISH COMMISSION

IN the year 1871 the Congress of the United States had its attention directed to the alarming decrease in the abundance of its east coast food fishes, and appointed a Commission to investigate the matter, with the idea of preventing the decrease. Prof. Spencer F. Baird, then Assistant Secretary of the Smithsonian Institution, was appointed at the head of this Commission, and in the early summer of 1871, with a small but efficient corps of naturalists, he established himself upon the southern coast of New England at a place called Wood's Holl. Among the most noted of the members of that party were A. E. Verrill, S. J. Smith, and Sanderson Smith, all of whom have remained with the Commission every summer since its foundation. The first work of the Commission was to investigate the fauna, which then was comparatively unknown to science. In this way the food-supply of the food fishes and the food fishes near shore were carefully studied. During this one summer the fauna of this region was so carefully studied specifically that few new species have since been discovered. The main results were set forth in a very extensive report upon the invertebrate animals of Vineyard Sound by Profs. Verrill and Smith, and published in the first Fish Commission Report. In the summer of 1872 Eastport, Maine, was chosen as the station, and here the same systematic study was carried on with the addition of some dredging work done in shallow water with small boats. The summer of 1873 was spent at Portland, Maine; 1874 at Noank, Conn.; 1875 at Wood's Holl again; and 1876 being Centennial year, there was no summer station, but the energies of the Commission were exerted upon the Centennial Exhibition at Philadelphia. In 1877 a part of the year was spent at Halifax, Nova Scotia, arranging a fisheries treaty, and the remainder at Salem, Mass. The head-quarters for the summer of 1878 were at Gloucester, Mass. Up to this time, and, in fact, until 1880, the Fish Commission had carried on all its off-shore work in steamers placed at its disposal through the courtesy of the Coast Survey and Navy Department, but had owned no boat of its own with the exception of small sailing-boats and a steam-launch in which the shore work could be done. Thus under a decided disadvantage, it would hardly be expected that a great amount of work could be carefully done; but, notwithstanding this, a large part of the Gulf of Maine was very carefully explored, under the direction of the Fish Commission. During the years 1878 and 1879 the fishermen of Gloucester very materially aided the Commission in its work of investigating the fauna of the shallower water of New England by preserving such specimens of animals as they happened to meet on their fishing trips. Scores of animals new to the American waters were taken from the fishing-banks by these fishermen, and the importance of their work should not be under-estimated.

As yet the Fish Commission had done little practical work in its marine departments. It was for practical work that the Commission was established, and all its scientific work had some practical object in view. In the winter of 1878 and 1879 the Commission began important experiments upon the hatching of deep-water fish, but more especially cod. When America was first discovered, cod were found on all its shores in great abundance, and from this abundance the headland of Cape Cod received its name. As white men became more numerous on the shore and cities began to grow, the fish began gradually to decrease in number and be driven off into deep water because of the impure condition of the water. Now, in places where fifty years ago cod could be caught from any point of rocks, it is a rare thing indeed to catch this fish within several miles of shore. Men, who not many years ago could anchor a boat within a few rods of shore and catch fish in large quantities, are now obliged to visit the more remote ledges several miles from shore, and be satisfied with a light catch. Even in the deep water they are becoming scarcer. It was with the hopes of finding some remedy for this decrease that in 1878 and 1879 Prof. Baird began experiments upon artificially hatching these fish. Millions of eggs are laid where few come to maturity, the larger part being destroyed before they are hatched from the egg. Thus, if the eggs could be hatched and the

young placed in the water only when they are old enough to partially take care of themselves, the proportion that would arrive at maturity would be vastly increased. By constant work at hatching these fish it was thought that much practical good might result. Many difficulties stood in the way, the most important being that the eggs floated and clogged the overflow screen. After much experimenting this was overcome. It was found, however, that the place chosen, Gloucester, was by no means fitted for the work because of impure water and extreme cold; but the object of the present work was merely experimental, and it mattered little whether the fish which were hatched lived after being placed in the water. Several millions of young cod were thus successfully hatched and placed in the waters of Gloucester Harbour, but, because of the impurity of these waters, it was hardly expected that the fish would be heard of again. But early in the spring of 1882 reports began to be circulated that young cod-fish of the deep-sea species (*Gadus morrhua*) were abundant in Gloucester Harbour. Subsequent investigation proved this report to be true. Since the cod first left our coast they have not been found in the Massachusetts harbours in any abundance, but at this time, even in the impure docks of Gloucester Harbour, it was not infrequent for boys fishing for perch and flounders to catch young cod. Several generations were distinguishable, and as there is but one other place where a similar abundance is reported, there is every reason to believe that they are Fish Commission cod, and that the other school is but an offshoot of the original group which was placed in Gloucester Harbour. It is, of course, expected that they will migrate, in time, to purer, cooler waters outside. There are fishermen now who are making good catches of these cod in the harbour itself—a thing unprecedented in late years. Thus the experiments, though primarily successful, have met with an additional success which was not in the least expected. Gloucester not being naturally suited for hatching cod, the Commission has begun the building of extensive hatching-houses at Wood's Holl, where in a few years artificial hatching of deep-sea fish will be carried on extensively. While at Gloucester the members of the Commission made extensive inquiries into the statistics of American fisheries, and complete reports upon the results have been published in the Fish Commission publications.

The summer of 1879 was spent at another large fishing port, Provincetown, Mass., where additional studies of the fishing apparatus were carried on. In 1880 the Commission was at Newport, Rhode Island; 1881, 1882, 1883, and 1884 were spent at Wood's Holl, Mass., which has been chosen as the permanent summer station of the Commission, because of the many natural advantages offered by the location. At present extensive buildings are in progress at this station. A large hotel for the use of the Fish Commission *employés* is already built, and was for the first time occupied during the past summer. On one side of this hotel the new laboratory and hatching-station is being built. It will be a very large affair, the lower story being intended for use as a hatching-room, the upper for a laboratory in which the scientific work will be done. In the cellar there are some large stone-walled tanks which will have direct connection with the outside water. A steam pumping-station will supply water to the aquaria and hatching-tanks. In front of these buildings is a large breakwater wall which will serve the purpose of a wharf for the larger vessels, and will also form a harbour for the smaller boats. It is expected that actual operations in fish-hatching at this station will begin in the spring of 1886, and that after that time each year millions of young fish will be sent out from the station to all parts of the New England coast and placed in the water to take care of themselves. It is hoped by these means to at least make an appreciable difference in the number of cod after years of work, and in part make up for the decrease. In the laboratory not only the regular *employés* of the Fish Commission will be allowed to work, but in the future a limited number of general students will be admitted to a table in the laboratory. By special arrangement with several of the leading American colleges, two students from each will be allowed to work each year in the new laboratory. This will be a chance that will be eagerly sought after because of the great advantages for study offered at the station. Under these improved advantages, it is expected that much better work will be done in the future than has been done in the past, when all the work had to be carried on in an old shed-like building poorly fitted for the work.

In 1880 an appropriation was obtained from Congress for the purpose of building a steamer, which was to serve as a floating shad-hatching station to work in the Chesapeake. This was the first large steamer owned by the Commission, and was named the *Fish-Hawk*. Although intended for shad-hatching, at the end of each shad-hatching season she proceeded to the summer station to engage in dredging. On account of her shallow build she was not fitted for dredging, and the Fish Commission was greatly inconvenienced while she was used for this purpose. The remarkable results obtained by this steamer on the Gulf Stream slopes have long since become known to the scientific world. Several hundred species were found which were new to American waters.

It was not long before the Fish Commission became convinced of the necessity of having a new steamer in which they could go to sea at any time, and one which was perfectly adapted for deep-sea dredging. Accordingly, in 1883, the *Albatross*, a 1000-ton iron steamer, 234 feet long and drawing 12 feet of water, was launched and immediately began work. That she is very nearly perfect in all respects, both in build and outfit, has been proved by her two years of nearly steady work. She is without doubt the most perfect dredging-steamer ever owned by any Government, and she is achieving the most remarkable results.

In the spring of 1879 a new fish, the tile-fish (*Lopholatilus chamæleonticeps*), was found in abundance in the deep water south of New England, which promised to become an addition to our east coast food-supply. It was abundant and had a fine flavour. In the early spring of 1882 it was found dead in immense numbers on the surface just above the places where it was found in such abundance. In the official report it is estimated that there were at least 71,936,000 dead fish, of an average weight of ten pounds each, in an area of 5620 square statute miles. This estimate was arrived at by taking the largest trustworthy report of the numbers of dead fish given by the numerous captains and dividing it by 400, thus allowing that there was only one fish where 400 were reported to be. This wholesale destruction attracted much attention at the time, and the Fish Commission has since made a careful study of the subject, and although many trials have been made, not a single tile-fish has ever been taken. A few other species of animals have also disappeared from the same bank, and it is the theory that a cold wave of water from the inlying shallower region was driven across the warm bank inhabited by these fish by the strong northerly winds which prevailed at the time. The tile-fish being naturally a delicate fish, was killed by this sudden change of temperature, while less delicate animals survived. Whether they are entirely extinct or not cannot be told. Certain it is that, although many expeditions have been sent out and days spent in search of this fish, not a single specimen has been taken since that great mass of dead fish were found covering an immense area off the American shore. It is by far the most interesting problem as yet studied by the Fish Commission. An interesting history of this fish is given by Captain Collins in the Annual Report of the U.S. Commissioner of Fish and Fisheries for 1882, pp. 237-292, with a figure of the

fish and a map showing the position of the banks and the area covered by the dead fish.

In addition to this branch of the Fish Commission's work, it has been doing a very important service to the country by hatching shad and salmon, and partially re-stocking rivers with these fish. By introducing the German carp to America a work of great economic importance was achieved, and the large number of carp-ponds in America shows the popularity of this new fish. In connection with State Fish Commissions much work is being done, which is of great importance. In every State of the Union there is now a more or less important State Fish Commission, and nearly all have been started since the National Commission, which may be considered to be the father of them all. For several years naturalists of the Fish Commission have been studying the oyster problem, with the hope of in some way protecting them from their natural enemies and preventing their decrease. Under the direction of Mr. J. A. Ryder important experiments upon artificial oyster-farming have attained a marked degree of success, and within a comparatively few years it may be expected that oyster-culture in America will be revolutionised. There are at present experiments in progress upon the transplantation of certain desirable shell-fish from the east coast to the west coast of America. Owing to the extreme difference in character between the water of the two coasts, it is doubtful if these experiments will succeed.

For the purpose of studying the economic problems it is necessary that men be sent to different parts of the American coast, and these men are always instructed to study the fauna and make collections. These collections are all, after careful study by the Fish Commission naturalists, turned over to the United States National Museum, and in this way her zoological collections are vastly increased. The collections made by the Fish Commission steamers are of vast scientific importance, and they greatly add to the interest and value of the zoological branch of the National Museum collection. It is also the plan of the Fish Commission to distribute sets of duplicates from their collections to the different Museums of the country. Nearly 200 such sets have already been distributed, and special sets are made up for exchange with foreign Museums. It has been the policy of the Commission to carefully study American fisheries and the apparatus in use both in this country and abroad, and by this means find out the most improved apparatus and have it adopted in America. It was with this object in view that complete sets of American apparatus were sent to the Exhibitions held at Berlin and London, and that experts were sent to study the foreign exhibits. Already the effects of these studies are being felt in America, and American fishermen, having learned in the past to respect the Commission's advice, are beginning to adopt needed reforms in vessels and outfit. It is hoped that the American exhibits had some similar effect upon the fisheries of other nations.

The Fish Commission's work in its original conception was really the solution of practical economic problems, and it has in the main adhered to this idea. Hence its scientific work has been mainly upon animals which are in some way connected with such problems, the work in very deep-sea dredging being an exceptional but natural deviation from the rather uninteresting study of the shallow fishing-grounds to the rich field of deep-sea research. As this work can be carried on in addition to and without interfering with the regular work of the Commission, there is no chance for complaint. To the scientific world it is very important that this is the case. Dealing with the problems that it has, the natural history work of the Fish Commission has, of necessity, been mainly of a systematic character, dealing with species and their distribution more than with problems of anatomy, embryology, and histology. But there has been also much embryological work, that of Mr. Ryder upon certain economic fish and the oyster being of most importance. In addition to this natural history work, there has been the gathering together of complete collections of all apparatus used in connection with the fisheries, which have been placed in the National Museum. At some future time they will possess an immense scientific value.

The scientific and important practical results of the Commission's work are mainly set forth in the publications of the Fish Commission or the National Museum, but some of the monographs, and also synopses of species, which require better plates than the Government publications ordinarily contain, or need to be published in haste, are printed in some other publications. The Commission publishes an Annual Bulletin and an Annual Report. The former is printed in parts, a few pages at a time, and sent to scientific men as soon as published, and afterwards gathered into volumes. Four have been printed up to date, and they contain miscellaneous articles, many of considerable scientific importance. The Report is published annually, and contains the larger reports upon different questions and general monographs of groups of animals. There are nine volumes already published, and they cover the years of the Commission's work up to 1881. Many of the reports contain articles of great importance to the scientific world.

RALPH S. TARR

THE INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND

A GREAT amount of valuable scientific work, of a special character, is done by the various engineering institutions of the country; and much of the progress latterly made in the practical applications of science to mechanical operations, and also in the advancement of those sciences which bear most directly upon engineering work, is largely due to the growth of these institutions. The principal one—that of the Institution of Civil Engineers—may be regarded as the parent institution, not only by reason of its age, but also because of its high standing and the quality of its work. The Institution of Civil Engineers has contributed, in a very important degree, towards transforming engineering from the position of a "base mechanical" calling into one which ranks high among learned and scientific professions.

The great success and usefulness of the Institution of Civil Engineers has gradually led to its work becoming more and more differentiated, and to certain special branches of it being taken up by other institutions that have been formed for the purpose. We thus find the Institutions of Mechanical Engineers, Telegraph Engineers, Naval Architects (in which marine engineers are included), the Iron and Steel Institute, and others. All of these institutions are in a prosperous condition, and enrol a large number of new members every year. They have been most successful, without exception, both professionally and scientifically. While, on the one hand, they have benefited their members by collecting papers and providing opportunities of discussion upon points of vital interest to them in the pursuit of their various callings, they have also, on the other hand, carried scientific investigation forward in directions which would otherwise have been much neglected. The field of science—and particularly the inductive side of it—has been greatly extended by the able and thorough—though often unobtrusive—work which has been done by the engineering institutions.

It is not in the metropolis alone, however, that such institutions are now to be found. They supply too universal a want to admit of being centred in any one part of the country. We have just received from Glasgow the twenty-seventh annual volume of the *Transactions* of a well-known and excellent institution which exists in that city, viz. that of the Engineers and Shipbuilders in

Scotland. This Institution is not restricted to the marine or any other special branch of engineering, but includes among its members civil and mechanical engineers of all classes, metallurgists, marine engineers, and shipbuilders. Its published volumes of *Transactions* usually contain papers of a varied and instructive character, and very valuable communications from some of the most eminent Clyde engineers are to be found in them. The importance of this Institution may be judged of by the fact that the number of its members, associates, and graduates amounts to 581.

The volume of *Transactions* just issued contains papers and discussions upon the properties of the compound engine, the stability of ships, screw piles, the testing of turbines, cable tramways, and other subjects. There is also a Presidential Address, delivered by the President, Mr. James Reid, of the Springburn Locomotive Works. Mr. Reid reviews briefly many of the latest engineering achievements that have been recorded, or that are being attempted. He refers to railway operations in this country and abroad, tramways, steam-shipping, docks, harbours, canals, bridges, hydraulic and electrical machinery, gas, and smoke combustion. Where the range of subjects is so varied and extensive, the briefest references are usually of course all that are possible.

Mr. Reid points out, with regard to railway traffic, the beneficial results of lower fares and other increased facilities in not only wonderfully augmenting the volume of third-class traffic, but also in adding, upon the whole, to the receipts of the railway companies. "As the downward movement of classes is still continuing, the outcome will most likely be a general reduction of the number of classes to two—nominally first and third, but practically first and second." The railway companies in this country yet have a most useful work to do in circulating food-supplies. The Fish League have had refrigerator cars constructed, which are working between the Scotch ports and London; and this small commencement is capable of a very large and urgently-needed development. A new departure in locomotive practice has been taken by M. Anatole Mallet in France, and by Mr. F. W. Webb in England, by compounding the engines. The results thus obtained are stated to be very satisfactory, although the maximum economy that is practically possible can of course only be obtained by steam-jacketing the cylinder, or by the use of superheated steam.

The advances that have recently been made in steam-shipping are referred to. The fastest voyage made by any steamer prior to October 23, 1883, was that of the *Alaska*, in which she ran 2784 miles, between Queenstown and New York, in 6 days, 21 hours, and 40 minutes. Mr. Reid says that this is equivalent to a mean speed of 17 miles per hour; but he speaks of miles in connection with these figures as though he were dealing with ordinary statute miles. The figures given really relate, however, to knots, or nautical miles, so that the speed of the *Alaska* upon the voyage in question was at the rate of over 19½ miles per hour. Mr. Reid also says that at an average speed of 19¼ miles per hour the Atlantic might be traversed in six days. The average speed requisite for crossing the Atlantic in six days is about 19½ knots, or 22½ miles, per hour, a speed which nearly amounts to that of many ordinary railway trains.

The performance of the *Alaska*, which Mr. Reid refers to, has been much exceeded during the present year by two Atlantic liners, the *Oregon* and the *America*. The *Oregon* has crossed the Atlantic in less than 6 days, 10 hours, thus beating the *Alaska* by nearly half a day. The *Umbria* and *Etruria*, the new vessels of the Cunard Company, are expected to beat the *Oregon* by about as much as the latter beat the *Alaska*. The *Umbria* is said to have attained, upon the measured mile, a mean speed of 20¼ knots, or nearly 24 miles per hour. It is possible that she may succeed in crossing the Atlantic in six days.

Passing from the wonderful strides thus making in steam-shipping, the President calls attention to the chief of the large canal schemes which are now before the world, such as the Panama Canal—which the indomitable energy of M. de Lesseps appears likely to bring to successful completion—an independent canal across the Isthmus of Suez, and the Manchester Ship Canal. It is surprising, however, that, while referring to these various means for facilitating transit across the ocean, and also to the Channel Tunnel, Mr. Reid omits to notice the ship-railway scheme of the American engineer, Capt. J. B. Eads, C.E., which has now been for some time before the engineering world, and has received the approval of some of the most eminent authorities.

The principal papers contained in the volume of *Transactions* under notice are those upon the compound engine viewed in its economical aspect, by Mr. R. L. Weighton; upon the stability of ships at launching, by Mr. J. H. Biles; and on approximation to curves of stability from data for known ships, by Messrs. F. P. Purvis and B. Kindermann. Mr. Weighton's paper gives a clear and able explanation of some of those properties of the compound engine which affect its economical working; and while there is nothing novel or recondite in it, and it is somewhat amateurish in style, it is of value in keeping before the minds of engineers points of fundamental importance which it is well for them to think precisely and frequently about; and it did good service in causing one of the longest and most interesting discussions which took place during last year's meetings. We dissent entirely from an opinion expressed by one of the speakers, that "papers brought before an Institution of this kind should either expound some new theory, contain some novelty, or bring before them some important addition to the mechanical details of any machine." An exclusive striving after mere originality is not an unmixed good; besides which, one of the greatest advantages of such institutions as that of the Engineers and Shipbuilders in Scotland is that the members become familiarised by papers and discussions which are even of a commonplace type with what is already known and thought by the most capable men upon subjects that all engineers require to thoroughly master. It is not novel points nor original conceptions only which are of value to the rank and file of members; a still more potent cause of good is to be found in the educating and informing influence which is exerted by well-established scientific ideas and recorded experience being frequently discussed, and by the constant and ready reference to fundamental and accepted principles which this involves.

The paper on the stability of ships at launching is accompanied by curves for various types of steamer at launching-draught, and advocates constructing such curves, as a rule, before launching ships. It is well worth reading, as it, and the discussion upon it, show how diverse and inconsistent though, on the whole, vague are the views held by many shipbuilders, both upon the necessity for ascertaining the precise degree of stability possessed by a ship, and also as to the sufficiency of a given amount of stability for purposes of safety. The author is somewhat ambiguous and inaccurate in his definitions of such terms as "stability," "stiffness," &c., and inconsistent and loose in his use of them; but this appears to be a common fault with technical writers upon naval architecture, as was pointed out by Prof. Osborne Reynolds at the British Association meetings of last year. For instance it is stated in the paper under consideration that "the kind of stability which is required at launching is stiffness," and "the question of stability at launching appears therefore to reduce itself to one of stiffness,"—stiffness being represented by the metacentric height, which measures the force required to incline a given vessel through small angles from a position of rest in still water. Yet the author goes on to say that "our only safe guide is the

complete investigation of the stability of a ship at angles considerably beyond those to which the metacentric height is a fair measure of the stiffness." He also speaks of the "stability of a ship up to 60° of inclination." This is a strange although common misuse of the term "stability." Stability only exists at a position of stable equilibrium, and what is really meant by the above-quoted sentence is not stability at large angles of inclination, but *righting force*.

The other paper upon stability, which describes a method of approximation to curves of stability from data for known ships, is interesting in showing how some of the elements of stability vary in a ship with the ratios of draught of water to depth, and depth to breadth; but we cannot regard it as likely to be of much value in practice. The approximations obtained by applying the method are only reliable when the form of the vessel for which the curve of stability is required, and that of the one which is being used for estimating it from, are so related to each other that any section of the one may be obtained by projection from the corresponding one of the other. Differences in form are excessively numerous—almost universal indeed—among ships; and small discrepancies of such a kind often affect stability to an important degree. When vessels are found to belong to what is defined in the paper as a "type-form," the method is applicable, but where no true type-form can be discovered for a particular ship—and this is what usually happens in practice—the only reliable and also the readiest mode of approximation to a curve of stability is to compute by means of Amsler's integrator the true length of a small number of ordinates of the curve.

There are other papers of interest in this volume which are amply deserving of perusal, though we have not space for referring in detail to them. We may note, however, as an indication of the active and enlightened interest taken by Scotch engineers in scientific teaching, that the President of the Institution of Engineers and Shipbuilders in Scotland—in referring at one of the meetings to the endowment of the John Elder Chair of Naval Architecture in Glasgow University, which is filled by Prof. F. Elgar—said that "the Council had agreed, and were morally bound, to support the institution of a lectureship in anticipation of a Chair of Naval Architecture in the University." Mr. Reid further stated that "the Council had agreed to continue the lectureship in connection with the Chair," and he wished it to be known that the original intention was still to be carried out. This is a strong practical proof of the earnestness and wise liberality of Scottish engineers in the matter of scientific and technical education, and it is a policy which cannot fail to largely benefit the district in time to come. It is also one indication, out of many, of the advantages which may confidently be looked for by engineers and scientific men as the natural outcome of such institutions as those we have referred to.

THE EGGS OF MONOTREMES

SPEAKING at the anniversary meeting of the Royal Society in November 1883, Prof. Huxley said:—"It certainly was high time that British science should deal with a problem of the profoundest zoological interest, the materials for the solution of which abound in, and are at the same time confined to, those territories of the Greater Britain which lie on the other side of the globe." These words had reference to the series of investigations which Mr. Caldwell—the first Balfour Student—had then gone to Australia to prosecute with regard to the embryology of the lowest Mammalian forms, the Monotremes and Marsupials.

Somewhat less than a year later, and whilst the British Association was holding its meetings in Montreal, Prof. Moseley, the President of the Biological Section, was enabled to communicate the following brief but suggestive message telegraphed from Australia:—"Caldwell finds Monotremes oviparous; ovum meroblastic." Brief as was the message, it yet, as Prof. Moseley said, contained the most important scientific news which had been communicated to the Association in Canada.

Zoologists will now look forward with deep interest to the publication of Mr. Caldwell's more detailed account of his recent investigations, which have apparently enabled him to confirm so fully what has before been suspected, but never actually proved to be the case.

That Monotremes are oviparous has been maintained by various naturalists for now some sixty years: but up till the present time no sufficient evidence has been brought forward to place the matter beyond dispute, the chief difficulty in elucidating the problem lying in the fact that the two curious groups of animals which alone are placed in the Monotremata inhabit exclusively the Australian region, and hence have been but little studied in their natural habitat.

Though they are closely allied, yet the Ornithorhynchus and Echidna differ markedly from each other in external appearance—the one being adapted to the water, having its feet webbed, and its muzzle of that peculiar shape which has earned for it the name of Duck-billed Platypus, whilst the other is essentially a land animal, feeding on ants which it licks up by means of a long flexible tongue, and having its body covered with sharp spines, much as a hedgehog.

The question of how these animals reared their young, and in what condition the latter were born, has long been a matter of much dispute, and for information we are principally indebted to the memoirs of Home, Meckel, Geoffroy St. Hilaire, and perhaps most of all to Owen; whilst from time to time short notices are to be found in the *Proceedings* of the Zoological Society and the *Journal* of the Linnean Society.

In 1829 Geoffroy St. Hilaire laid a communication before the Royal Academy of Sciences in Paris, entitled "Considérations sur les œufs d'Ornithorinque formant de nouveaux documens pour la question de la classification des Monotrêmes."[1] Herein he stated his opinion that the Monotremes could no longer be admitted amongst the mammals, nor could they be classified with either birds, or reptiles, or fishes, but they must, though including only two groups of animals, be formed into a distinct fifth class among the Vertebrata, which would hence be divided, according to him, into Mammals, Monotremes, Birds, Reptiles, and Fishes.[2] The most interesting part of his paper, from our present point of view, however, consists of a letter which he quotes in full from Prof. Robert E. Grant of London, who describes in some detail the finding by a certain Mr. Holmes, whilst shooting on the banks of the River Hawksburgh in Australia, of a nest of eggs laid by an Ornithorhynchus; the animal was seen to hasten away from a sandy bank and plunge into the water. Examination of the bank led to the discovery of a small burrow, in which, on a rude nest made of twigs, were deposited nine eggs of a peculiar shape and size, which rendered them clearly distinguishable from those of any bird. The eggs, he says, are remarkable "par une forme régulière sphéroïdale oblongue, par une égale largeur à chaque bout; ils ont (mesure anglaise), en longeur de pouce, $1\frac{3}{8}$, et en largeur $0\frac{8}{8}$; la coquille est mince, fragile, légèrement transparente, et d'une couleur uniforme d'un blanc mat; sa surface extérieure, vue à la loupe, présente une texture d'un réseau admirablement réticulé; la matière calcaire a produit les parois blanches de ses innombrable et très-petites cellules, ce qui n'empêche pas que la surface n'en demeure à peu près polie.

[1] *Annales des Sciences Naturelles*, t. xviii. p. 162; also *Bulletin de la Société Philomathique*, t. viii. p. 95.

[2] The same idea is to be found also in Lamarck, *Philosophie Zoologique*, t. i. p. 145. Lamarck adds, further, "Ce ne sont point des mammifères; car ils sont sans mamelles, et très-vraisemblablement ovipares."

Un des œufs était cassé, et j'en ai examiné la surface interne, laquelle m'a paru être aussi formée par un dépôt de très-petits grains de la matière calcaire." He further states that the dimensions and form of these eggs remind him of those of many of the Saurian reptiles and Ophidians; whilst Jarrel, who examined them, came to the conclusion that they differed as much from the eggs of birds as from those of reptiles.

Fig. 1 is copied from a drawing which accompanies the paper of Geoffroy St. Hilaire, and represents its actual size and form.

Of the nine eggs which were discovered in the nest four were brought to England, and of these two found their way to the Manchester Museum, where, Prof. Williamson has kindly informed me—whilst he was curator, from 1835 to 1838—he distinctly remembers

FIG. 1.

their being placed and labelled as "eggs of Duck-billed Platypus."

In 1826 Meckel, of Halle, had published a monograph on *Ornithorhynchus paradoxus* (Leipzig, 1826), wherein he announced the discovery of mammary glands, rudimentary in condition, but still undoubtedly present, and serving for the nutrition of the young; Geoffroy St. Hilaire, who, as before said, was strongly of opinion that the Monotremes could not be included amongst the Mammalia, suggested that the nature of these glands had not been sufficiently studied, and that instead of being mammary they were very probably analogous to those spread out on the flanks of aquatic reptiles, and which served to lubricate the skin; if this were not the case, he further suggested a comparison between them and certain odoriferous glands existing in the neighbourhood of the mammary glands in shrews.[1]

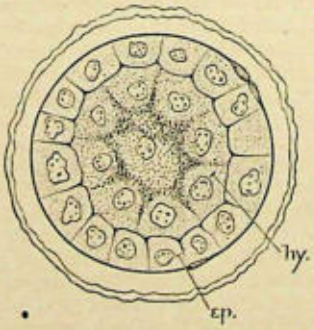


FIG. 2.

To these criticisms Meckel urged in reply the strong argument that they were only known to exist in female Monotremes, the males possessing no such structure, and later still Owen published his account of the "Mammary Glands of *Ornithorhynchus paradoxus*" (*Phil. Trans.* 1832). In this paper also he quotes the following passage from Meckel ("*Ornithorhynchi paradoxi* Anatome," p. 58):—"The difference between the bringing forth of living young and of eggs is really very small, and by no means of an essential nature: birds have accidentally hatched the eggs within the abdomen, and so produced a living fœtus—an occurrence which has been induced by direct experiment; and lastly the generation of the Marsupial animals is very similar to the oviparous mode." Meckel, Owen says, deems it "very probable that as the Ornithorhynchus approaches still nearer than the Marsupials to birds and reptiles, its mode of generation may be in a proportionate degree analogous."

Somewhat later Owen published an account of an Ornithorhynchus fœtus,[1] which measured only two inches in length. After describing its external appearance he says, "On the middle line of the upper mandible, and a little anterior to the nostrils, there is a minute fleshy eminence lodged in a slight depression. In the smaller specimen this is surrounded by a discontinuous margin of the *epidermis*, with which substance therefore, and probably (from the circumstance of its being shed) thickened or horny, the caruncle had been covered. It is a structure of which the upper mandible of the adult presents no trace, and is obviously analogous to the horny knob which is observed on the upper mandible in the fœtus of some *birds*. I do not, however, conceive that this structure is necessarily indicative of the mandible's having been applied, under the same circumstances, to overcome a resistance of precisely the same kind as that for which it is designed in the young *birds* which possess it. The shell-breaking knob is found in only a part of the class, and although the similar caruncle in the Ornithorhynchus affords a curious additional affinity to the *Aves*, yet as all

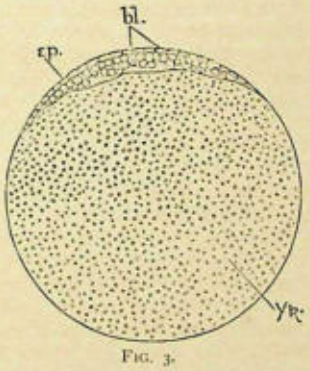


FIG. 3.

the known history of the ovum points strongly to its ovo-viviparous development (see also *Phil. Trans.*, 1834, p. 555), the balance of evidence is still in favour of this theory."

Later still (*Phil. Trans.*, 1865, p. 671) he published a paper on the "Marsupial pouches, mammary glands, and mammary fœtus of the *Echidna hystrix*," wherein he proved that the same caruncle was present in the Echidna fœtus, and further that this was carried about by the mother in a pouch (two being present in each individual, one on either side the middle ventral line), into which opened the mammary glands.

Owen adheres firmly to the opinion that the Monotremes are ovo-viviparous, in which opinion he is supported by the evidence of, amongst others, Sir E. Home (*Phil. Trans.*, 1802, p. 67), whose account is probably the earliest notice of any detail, which was published in England with regard to the internal anatomy of Ornithorhynchus.[2] Home says at the close of his paper, "this animal having no nipples and no regularly formed uterus, led me to examine the female organs in birds to see if there was any analogy between the oviducts in any of that class and the two membranous uteri of this animal;

[1] *Proc. Zool. Soc.*, 1833, pp. 28 and 91; also, "Memoir on the Abdominal Glands of Ornithorhynchus, falsely presumed to be mammary, but which secrete, not milk, but mucus, destined for the first nutriment of the young when newly hatched." *Gazette Médicale*, February 28, 1833; also, *Annales des Sciences Naturelles*, tom. ix. p. 457.

[1] *Trans. Zool. Soc.*, vol. i. p. 222; also *Proc. Zool. Soc.*, 1834, p. 43.

[2] For one of the earliest figures, see Shaw's *Naturalist's Miscellany*, vol. ix. 1799, and for figure of Echidna *vide op. cit.* vol. iii. 1792, under name of *Myrmecophaga aculeata*. Shaw says of Echidna, "It is also a most striking instance of that beautiful gradation so frequently seen in Nature, by which creatures of one tribe or genus approach to those of a very different one. It forms a connecting link between the very distant genera of Hystrix and Myrmecophaga; having the external aspect of the one with the mouth and peculiar generic characters of the other."

but none could be observed, nor would it be easy to explain how an egg could lie in the vagina to receive its shell, as the urine from the bladder must pass directly over it. Finding they had no resemblance to the oviducts in birds, I was led to compare them with the uteri of those lizards which form an egg that is afterwards deposited in a cavity corresponding to the uterus of other animals where it is hatched; which lizards may be therefore called ovo-viviparous, and I find a very close resemblance between them."

There has been, however, a certain amount of direct evidence brought forward beyond that which has been quoted from Geoffroy St. Hilaire's paper to prove that Monotremes are really oviparous, notwithstanding the fact that they nourish their young by means of mammary glands.

Thus a Dr. Nicholson (*Phil. Trans.*, 1865, p. 683), writing to Owen in 1865, informs him that a Platypus had been captured by workmen on the banks of the River Goulburn in Victoria, and had been placed for a night by the gold-receiver of the district, to whom it had been handed over, in a wooden case, and that whilst in confinement it had laid two eggs—white and soft, with no calcareous covering, and about the size of a crow's egg. Dr. Nicholson does not, however, appear to have taken the trouble to examine the eggs at all carefully, and his evidence is rejected by Owen as certainly insufficient to make him doubt that the Monotremes are ovo-viviparous.

Earlier still in Messrs. Lesson and Garnot's "Voyage de la Coquille" (*Zool. Journal*, vol. v.), it is stated that the colonists assured the travellers that Ornithorhynchus was oviparous, whilst a Mr. Murdoch, superintendent of the farms on Emu Plains, said that he himself had seen the eggs, that they were two in number, and the size of a hen's egg.

Again, Dr. Weatherhead (*Proc. Zool. Soc.*, 1832, p. 145) read, before the Zoological Society in 1832, extracts from a letter received by himself from Lieut. Maule in New South Wales, wherein the latter describes in some detail the finding and unearthing of an Ornithorhynchus burrow. The entrance to the latter, he says, is beneath the water, though, after some little distance, the passage rises, and, after a few yards have been traversed, it "branches into two others, which, describing each a circular course to the right and left, unite again in the nest itself, which is a roomy excavation lined with leaves and moss, and situated seldom more than twelve yards from the water or less than two feet below the surface of the earth: several of these nests were with difficulty discovered. No eggs were found in a perfect state, but pieces of a substance resembling egg-shell were picked out of the debris of the nest. In the insides of several Platypi which were shot were found eggs of the size of a musket-ball and downwards, imperfectly formed however, *i.e.* without the hard outer shell, which prevented their preservation."

Dr. Bennett also (*Proc. Zool. Soc.*, 1859, p. 213) investigated the structure of the Monotremes and examined the nest of Platypus, but failed to find traces of eggs.

Lastly, Mr. Patrick Hill, surgeon in the Royal Navy, published in *Trans. Linn. Soc.*, xiii. p. 621, information which had been brought to his notice concerning the Monotremes whilst studying their nature and habits in the district around Sydney. A female specimen was brought to him which had been taken directly from its nest, but which died very soon after being placed in confinement. On opening the body he discovered in the left ovary a round yellow ovum about the size of a small pea and two of smaller size, whilst no trace of ovisac was to be found in the right ovary;[1] but beyond his own investigations he brings forward the evidence of a certain Cookoogong, chief of the Boorah-Boorah tribes, who, as is quaintly remarked in Geoffroy St. Hilaire's article, "ne manquait ni de lumière ni de moralité." This native chief stated that it was a fact well known to their tribe that the animal lays two eggs, about the size, shape, and colour of those of a hen, and that the female sits a considerable time on her eggs in a nest which is always found among the reeds on the surface of the water; the native name for the Platypus, he added, was Mullingong.

The most important part of Mr. Caldwell's communication to the British Association was, however, contained in the two words "ovum meroblastic"; in other words, the ovum of a Monotreme contains, relatively to the pure protoplasm out of which the tissues of the animal will be formed, so much food-yelk that, when segmentation takes place, it is impossible for the egg to segment as a whole, and therefore the two kinds of protoplasm separate, and we find that the Monotreme embryo possesses a yelk-sac, by the gradual absorption of the contained material of which it is nourished during the early stages of development.

The presence of so large an amount of food-yelk thus renders it unnecessary that during this period the tissues of the embryo should enter into such a close relation with the maternal ones as is found to obtain in the rest of the Mammalia, though even amongst the higher members of the latter there are certain signs which point to a former period in their phylogenetic history when they also were possessed of a yelk-sac.

Figs. 2 and 3 represent respectively examples of holoblastic and meroblastic ova at very early stages, the one being that of a rabbit, the other that of a Sauropsidan, and it is to the latter that the ovum of Monotremes bears a close resemblance.

In both cases it is interesting, however, to observe that a structure is eventually formed known in birds and reptiles as the yelk-sac and in most mammals as the umbilical vesicle, the two being really homologous with each other.

Now that Mr. Caldwell has shown that in the lowest mammals a yelk-sac is present containing food-yelk instead of an umbilical vesicle as in the higher forms, it may be affirmed that the curious stages in the development of most Mammalia which result in the pinching off of the embryo and the formation of an umbilical vesicle are indications still remaining of the time when these animals were nourished during early stages, not directly by a close union with the maternal tissues, but by means of yelk-sacs: it affords evidence, in fact, that their ancestors were not viviparous, but oviparous, just as are the lowest mammals now known to us.

During late years various theories have been held concerning the origin of mammals: Balfour formed a hypothetical group—the Pentadactyloidei—in which he supposed the pentadactyle limb characteristic of all the higher vertebrates to have been established: from this he derives two groups—the one including the present existing Amphibia, the other being a hypothetical and somewhat generalised group, from which, though along divergent lines, were developed both Mammalia and Sauropsida. Thus, according to him, the two latter were branches from one common stem, but the Sauropsida could not be considered as the ancestor of the Mammalia.

Other scientific men have held that mammals were derived from Amphibia-like ancestors: with the present Amphibia they were supposed to agree in the presence of a holoblastic ovum, and in the important fact that in both groups two occipital condyles are present, whilst only one is typically found in the Reptilia.

It is interesting to notice that Cope has described, amongst the numerous extinct forms of reptiles which he has brought to light during the past few years, one, called by him the Theromorpha (*Proc. Am. Phil. Soc.*, vol. xix.

[1] See also Owen, "Anat. of Vert.," vol. iii. p. 676; also *Proc. Zool. Soc.*, 1834, p. 142.

p. 38), which he regards as intermediate between Reptilia and Mammalia. He says:—"The order Theromorpha approximates to the Mammalia more closely than any other division of Reptilia. This approximation is seen in the scapular arch and humerus, which nearly resemble those of the Monotremata, especially Echidna; and in the pelvic arch, which Owen has shown in the sub-order Anomodontia to resemble that of the mammals, and, as I have shown, especially that of Echidna. The tarsus is also more mammalian than in any other division of reptiles. In the genus Dimetrodon the coracoid is smaller than the epicoracoid, as in Monotremes. The pubis has the foramen for the internal femoral artery." Cope also appears to have found in the Theromorpha a spur attached to the hind foot, just as in the males of Monotremata.

In the skeletons of the latter, on the other hand, we find several prominent features in which, whilst they differ from the typical mammalian forms, they approximate more or less closely to the reptiles, whilst finally Mr. Caldwell's discovery with regard to the nature of the ovum has shown that Mammalia and Sauropsida are closely allied to each other—more intimately than has generally been allowed by naturalists.

In Monotremes we find, as it were, intermediate animals possessing the attributes of two classes: whilst on the one hand they have developed mammary glands, the distinctive feature of the higher group, on the other they lack that structure whereby the typical mammalian embryo receives nourishment before birth; and in correlation with this we find them agreeing with the lower class in the possession of a yelk-sac, whilst the contained food-yelk causes the ovum to assume the meroblastic type.

We may thus trace the line of descent through the Sauropsida directly to the Monotremes (doubtless through forms now extinct, as the Theromorpha of Cope); from these to Marsupials, which are indeed viviparous, but whose ova still possess a large yelk-sac, and whose embryos, as Mr. Caldwell (*Q.J.M.S.* October 1884) has just shown, enter into no close vascular connection with the maternal tissues; and from these to the higher mammals, whose much specialised structures for fœtal development differ now so widely from those of the lower vertebrates.

W. BALDWIN SPENCER

NOTES

LAST Thursday (December 4) the Chemical and Physical Society of University College, London, gave a scientific *soirée* in connection with the University College Society. Prof. T. G. Bonney delivered the annual address, and took as his subject "Serpentine Rock and its Origin." The lecture was illustrated by Wright and Newton's new oxy-hydrogen microscope. During the evening demonstrations were given on "Radiant Matter" by Mr. Rose Innes, "Absorption Spectra" by Mr. Schunck, and "Ozone" by Mr. E. E. Craves, in various parts of the building. In the library were exhibited by several gentlemen and manufacturers new scientific apparatus and chemical compounds. The physical and chemical laboratories were thrown open to visitors, and in them were shown new forms of apparatus for research. The meeting was numerously attended, and the committee are to be congratulated on the success of the evening.

THE ordinary general meeting of the members of the Parkes Museum was held on Thursday, December 4, Capt. Douglas Galton, C.B., F.R.S., in the chair. The meeting was held to consider the report of the Council for the tenth year and to elect officers. The report set forth the work done in connection with the Museum during the past year, which had included lectures by the Council of the Sanitary Assurance Association in addition to those arranged by the Council of the Museum. The accounts showed that there was urgent need for increased subscriptions if the Museum was to be continued, for the small invested capital had had to be made use of this year to meet the current expenses. The report was adopted on the motion of the Chairman, seconded by Mr. Rogers Field. Mr. Mark H. Judge, then proposed "That the report be printed for circulation, with a detailed statement of the financial position of the Museum, and that a special meeting of the members be convened within two months to consider the same." This was seconded by Mr. E. C. Robins, and carried unanimously. Sir R. Lloyd Lindsay, Prof. J. Marshall, F.R.S., and Mr. Alfred Waterhouse, A.R.A., were elected Vice-Presidents. Six new Members of Council were elected, and the meeting closed with a vote of thanks to the Chairman, proposed by Dr. J. C. Steele of Guy's Hospital.

WE have before us a most satisfactory report of the Manchester Public Free Libraries for 1883-84, showing increase everywhere. More than one and a quarter million of issues have been made to two and a half million of visitors to the libraries. Of these the boys have been provided with additional reading-rooms to themselves, which are reported as crowded every evening; the increased Sunday issues of books also are noted as being specially made to boys, and it cannot be doubted that a taste for reading thus early implanted will save them from half the temptations to which idle youth is subjected. While nearly 10,000 new books have been purchased, more than 10,000 have been started in new harness for fresh toil by the bookbinder; and few items can speak better of "something accomplished, something done," than 3325 volumes withdrawn from circulation, simply worn out. At one branch a new catalogue published, at another one preparing, and at a third two supplementary lists issued, keep the value and the availability of the books at the highest point.

AT the meeting of the Geologists' Association last Friday, Mr. R. Meldola gave a preliminary account of his investigation of the East Anglian earthquake of April 22, 1884, with special reference to the geology of the question. The extreme limits of the recorded disturbance were Brigg in Lincolnshire, Altrincham in Cheshire, Worcester, Bristol, Street (Somersetshire), Boulogne, and Ostend, giving in round numbers an area of 50,000 square miles. The focus of the disturbance appears to have been beneath the earth near the villages of Abberton and Peldon, between Colchester and Mersea Island, and there seems to have been total reflection of the shock at Wivenhoe on the River Colne, the tract of country to the north-east of this village, where great damage was sustained, being in "seismic shadow." The area of structural damage comprised about fifty or sixty square miles, the main axis being along a line five miles in length and extending in a S.W.-N.E. direction from Peldon to Wivenhoe. The evidence showing the propagation of the shock along the older rocks had been carefully considered, and the conclusion had been arrived at that such a spreading of the shock towards the west, north-west, south-west, and south-east had actually taken place, an additional argument in favour of the extension of the Palæozoic rocks beneath the south-east of England, as first suggested by the late Godwin-Austen in 1855, being thus furnished. It was pointed out that this extension of the disturbance along the older rocks was of a purely dynamical character, depending simply upon the superior elasticity of these formations. One phase of earthquake movement which the present disturbance appears to have revealed with special distinctness was the tendency of the shock to make itself felt along free margins such as coast-lines, river-valleys, lines of outcrop, &c. The general conclusion respecting the distribution of earthquakes in this country which the present investigation

had led to was that earthquakes having their focus in the east of England would be likely to extend much further west than those originating in the west would extend eastwards, this depending upon the geological structure of the country and being supported by the records of previous British earthquakes, of which a complete catalogue was in course of preparation. Mr. Meldola stated that the complete report, which was very voluminous, was nearly ready for publication.

WITH reference to the palæontological discovery of a fossil scorpion in the Upper Silurian formation of Gothland, recently made by Prof. G. Lindström of the Academy of Sciences, Stockholm, which has attracted considerable attention on the Continent, we have received the following communication from this *savant*:—"The discovery was made in the latest Upper Silurian layer. Only the thin chitinous coat has been preserved, all the soft membranes having decayed, and the body is compressed, owing to the pressure of the superincumbent layers. Like the scorpions existing at the present time, its body consists of the cephalothorax, seven abdominal membranes, and seven segments in the tail, of which the seventh is distinctly shaped into a poisonous sting. Both the great claws (*palpi*) still remain; the number of legs was eight, those of the left side being in perfect condition. They differ entirely from all known scorpions, fossil or living, by the joints being thick and heavy and the leg ending in a point instead of claws. There is a marked respiratory cavity (*stigma*) on the right side, from which I draw the conclusion that it was not only an air-breathing animal but an animal living on *terra firma*. Its whole construction points to this. It is the oldest known land-animal, the limits of our knowledge as to its existence during past ages having been extended from the Middle Devonian strata of Canada, where remains of Neuroptera have previously been found, to the uppermost strata of the Upper Silurian formations."

THE Mersey Tunnel is now completely arched in under the river with the exception of the inverts. It is interesting to geologists to know that, about three hundred yards from the Liverpool side, the upper part of the tunnel intersected the pre-Glacial bed of the river for a distance of about one hundred yards. This "gully" in the rock was filled with hard Boulder-Clay, with erratic boulders resting upon the hard denuded surface of the Triassic sandstone. As showing the importance of a knowledge of geology in engineering works, this pre-Glacial gully was, in opposition to the prevailing opinion, foreseen and predicted as one of the difficulties that would have to be encountered in the tunnel-works in a paper by Mr. Mellard Reade, entitled "The Buried Valley of the Mersey," published in the *Proceedings* of the Liverpool Geological Society in 1872. It is very satisfactory to know that this difficulty is now surmounted, and the stability of this important and interesting work placed beyond a doubt.

As we anticipated some weeks ago, M. Joseph Bertrand has been elected a Member of the Académie Française almost without opposition, having obtained twenty-five votes out of a total of twenty-six, the single dissentient voice having been given in favour of a poet who could hardly be termed a candidate. M. Bertrand's formal reception into the Academy will take place in the course of a few months, and M. Pasteur is to reply to the speech he will deliver on the occasion.

M. JANSSEN is at present engaged in drawing up for the Academy of Sciences a full report of his mission to the Prime Meridian Congress at Washington. He is also to deliver a lecture on the subject before the Geographical Society of Paris. The learned astronomer still adheres to his scheme of a neutral meridian.

MANY of our readers are aware that when Mr. Thiselton Dyer, more than ten years ago, introduced at South Kensington a system of instruction in botany based on the same principle as the instruction in animal morphology already introduced by Prof. Huxley, he intended to put together the results of his experience in the form of a hand-book for the use of other teachers. Pressure of other work prevented his carrying out his intention, but Mr. F. O. Bower, now Lecturer in Botany in the Normal School of Science, took the task in hand in conjunction with Dr. Sydney Vines, and we are glad to be able to announce that Messrs. Macmillan and Co. will publish a first instalment of the work immediately. When complete, according to the original scheme, the work is intended to contain a general introduction by Mr. Dyer, introductory chapters on methods and on the morphology of the cell by Dr. Vines, and then the description of a series of types representing the various groups of the vegetable kingdom. In each case a short general description will precede the directions for investigating the type in the laboratory. The instalment now promised will contain an explanatory preface by Mr. Dyer, the two introductory chapters by Dr. Vines, and the directions for laboratory work on vascular plants, as represented chiefly by the following types:—*Helianthus annuus*, *Ulmus campestris*, *Zea Mais*, *Pinus sylvestris*, *Selaginella Markensii*, *Lycopodium claratum*, *Aspidium Filix-mas*, and *Equisetum arvense*. It is hoped to publish the laboratory directions for the remaining types, and the short prefaces to each type, before very long. For the laboratory directions Mr. Bower is mainly responsible; the descriptive prefaces will be contributed by Mr. Dyer; but the whole work will have undergone the minute supervision of all the three authors concerned, and represent their united experience.

MESSRS. MACMILLAN AND CO. promise immediately an abridged edition, for popular use, of the "Life of Prof. J. Clerk Maxwell."

THE following are the lecture arrangements at the Royal Institution before Easter 1885:—Six lectures (adapted to a juvenile auditory) by Prof. Tyndall, on the Sources of Electricity, on December 27 and 30, 1884, January 1, 3, 6, and 8, 1885; five lectures by Prof. H. N. Moseley, on Colonial Animals, their Structure and Life-Histories, on Tuesdays, January 13 to February 10; four lectures by Dr. Arthur Gamgee, on Digestion, on Tuesdays, March 3 to 24; eleven lectures by Prof. Dewar, on the New Chemistry, on Thursdays, January 15 to March 26: three lectures by Dr. Waldstein, on Greek Sculpture from Pheidias to the Roman era, on Saturdays, January 17 to 31; three lectures by Mr. G. Johnstone Stoney, on the Scale on which Nature works, and the Character of some of her Operations, on Saturdays, February 7 to 21; and five lectures by Mr. Carl Armbruster, on the Life, Theory, and Works of Richard Wagner (with illustrations, vocal and instrumental), on Saturdays, February 28 to March 28. The Friday evening meetings will begin on January 16, when Prof. Tyndall will give a discourse on Living Contagia.

THE archæologist M. Saillard, well known through his indefatigable efforts for the preservation of dolmens, has discovered the workshop of a prehistoric armourer or smith on a steep rock by the sea on the south-west side of the peninsula of Quiberon (Brittany). It dates from the Stone Age. Polished lances, arrow-heads, axes, and other objects are represented in great numbers and in every stage of manufacture, so that the discovery is most interesting, inasmuch as the objects illustrate the workman's method and process. Amongst the objects is also a meteoric stone worked into an implement. The skeleton of the workman was also found, the skull being very well preserved.

DR. AUGUSTUS VOELCKER, F.R.S., died on Friday last, the 5th inst., at his residence, 39, Argyll Road, Kensington, in his sixty-second year. He was born at Frankfort-on-the-Maine,

received his chief education at the University of Gottingen, and in early life came to England. After that time he successively held the post of assistant to the late Prof. Johnston at Edinburgh, Professor of Chemistry in the Royal Agricultural College at Cirencester, and Professor of Chemistry to the Royal Agricultural Society of England, and was well known as the author of several works in theoretical and agricultural chemistry, such as the "Chemistry of Food" and the "Chemistry of Manure."

THE *Journal of Botany* for December contains a memoir of the late George Bentham, accompanied by an excellent photograph.

WE have received the prospectus of the Royal Agricultural College, Cirencester, issued during the past month. The course of instruction provided in technical and scientific subjects appears to be ample for the requirements of the agricultural students. We are glad to notice that external examiners are appointed for the final examination of students for the diploma, and also that a Board of Studies, in which are several professors otherwise unconnected with the College, exists. The number of students is steadily increasing, and among them are several Indian scholars sent by the Governments of Bengal and the North-West Provinces. The Governments of the Indian Presidencies also encourage some of their civil servants to pass through the College course when on leave of absence in this country.

ON the subject of agricultural education, a correspondent writes to the *Times* that a number of meetings have recently been held in Oxfordshire and Buckinghamshire with a view to the establishment of night classes during the winter for teaching the scientific principles of agriculture. There is, he says, a growing opinion among the more educated young men that agriculture requires something besides Commissions and inquiries and fair trade. It has been estimated that the annual waste from careless and unskilful methods of managing manure amounts to nearly five millions sterling. Add to this the want of knowledge in the purchase of artificial manures and their application, the waste of feeding-stuffs, the odd pieces and corners of fields that might grow other things beside rank weeds and couch-grass, and the waste of time in going to markets, auctions, and fairs. No reduction of rent or local taxation, or increased price of wheat, will, says this correspondent, do anything for men who make no effort to improve their industry by increased scientific knowledge. The natural history of the wire-worm, the leather-jacket, the dissolving of bones, the building up of plants, the judicious mixing of food, and many other things which farmers would be the better for knowing can never be acquired by what is called practical farming, and accordingly these classes are commended to the consideration of all who take an interest in the welfare and education of young men in rural districts.

THE additions to the Zoological Society's Gardens during the past week include a Yellow Baboon (*Cynocephalus babouin* ♂), a Chacma Baboon (*Cynocephalus porcarius* ♀) from the East Coast of Africa, presented by Capt. Edward Jones, R.N.R.; a Macaque Monkey (*Macacus cynomolgus* ♂) from India, presented by Mr. Geo. Airey; a Bittern (*Botaurus stellaris*), British, presented by Mr. Robert Page; a —— Otter (*Lutra* ——) from South America, a Cat Fish (*Amiurus catus*) from North America, deposited; two Rock Pipits (*Anthus obscurus*), British), a Passerine Owl (*Glaucidium passerinum*), a Crested Titmouse (*Parus cristatus*) from Siberia, purchased.

OUR ASTRONOMICAL COLUMN

WOLF'S COMET.—Herr Lehmann-Filhés of Berlin has made a first approximation to the amount of perturbation experienced by this comet at its near approach to the planet Jupiter in 1875, to which attention was directed in NATURE (vol. xxx. p. 615). He adopts the orbit determined by Prof. Krueger upon observations extending over an interval of forty-eight days, and applies the formulæ of the "Mécanique Céleste" (liv. ix. chap. ii.), which were first employed by Burckhardt in the case of the celebrated Lexell comet of 1770. The following are the elements deduced for perihelion passage in 1868, or the elements defining the orbit of the comet previous to its close approach to Jupiter; we annex Prof. Krueger's orbit for the present appearance for comparison:—

	Lehmann-Filhés, 1868	Krueger, 1884
Perihelion passage ...	Sept. 24·6 M.T. Berlin ...	Nov. 17·7922
	° ′ ″	° ′ ″
Perihelion	352 36 48	19 3 17
Ascending node	207 33 50	206 22 17
Inclination	27 36 49	25 15 10
Angle of excentricity ...	16 11 5	34 3 12
Log. semi-axis major ...	0·663970	0·552936
Mean daily motion ...	358″·14	525″·536

The longitudes in both orbits are reckoned from the mean equinox 1884·0.

Prof. Krueger writes modestly as to the degree of accuracy of his elements, which have been adopted by Herr Lehmann-Filhés, nevertheless they were founded upon a fairly-wide interval of observation as noted above. From the nature of the problem, however, the orbit for 1868 must be regarded as roughly indicating the kind of track which the comet was then following. And it is to be remarked that the perihelion distance corresponding to the assigned values of excentricity and semi-axis major is 3·327, which would account for such a comet not having been observed while moving in the orbit of 1868. Thus, as in several previous cases, the comet appears to have been brought within range of visibility from the earth by the powerful attraction of the planet Jupiter.

THE WASHBURN OBSERVATORY, WISCONSIN.—Vol. ii. of *Publications* of this Observatory has been issued. Its main feature consists in a reduction of the star-gauges of Sir William Herschel, published and unpublished, or 683 gauges published and 405 unpublished, Prof. Holden having been indebted for the latter to Lieut.-Col. Herschel, R.E., who forwarded to him a complete copy of a manuscript, by Miss Caroline Herschel, in which they are given, and who was at the further trouble of extracting from the Herschel papers in the library of the Royal Astronomical Society the dates of the various sweeps. Also of 500 counts of stars from the published charts of Prof. C. H. F. Peters, 983 counts from his unpublished charts and those of Watson and Chacornac, and 781 from those of Palisa. Prof. Holden states that he is now discussing these various gauges by a graphical process, and that they promise to lead to very interesting results, especially when they are supplemented by other star-gauges covering the same ground and made by a larger instrument. The volume further contains a list of 111 new double-stars and two new nebulæ, with observations of red or coloured stars between December 1881 and the end of 1883, in continuation of a list given in the first volume.

GEOGRAPHICAL NOTES

REPORTS have been received from M. Alfred Marche, who is travelling through the Philippine Archipelago on a scientific mission for the French Ministry of Public Instruction. During June and July last he explored the archipelago of Calamienes, situated to the south-west of Mindoro and to the north of Paluan (Paragua) Island. This archipelago is composed of three large islands, Busuanga, Calamienes or Culion, and Linacapan, and about thirty smaller ones. M. Marche first visited Culion, the inhabitants of which are Tagbannas, similar to those whom he observed in a previous journey to Paluan. These form the principal as well as the most ancient people of the peninsula, and it is probable that formerly they occupied a much larger area than they do now. A small number of them, more or less Christianised, have submitted and built a village, to which, however, they come as rarely as possible. The others are independent, and are fetish-worshippers. In Culion there is but a single Spaniard, the priest. After Culion, M. Marche visited the island of Busuanga, where there were formerly Chinese colonies engaged in collecting birds' nests, and in trepang and pearl-fishing, both industries which no longer exist. In spite of continual rains the traveller was able to make a large collection of plants and of woods of all kinds. In Busuanga he came

across the inhabitants of Agutayo, one of the Cuyos Islands. They left their home, where they could hardly get enough to bring them to Busuanga, to fish for trepang and for small prawns, which they dried in the sun, and then sold to Chinese and Indians. M. Marche was able to take measurements of a certain number of these Agutaino. He gives long and interesting ethnographical details of the Tagbannas of this island, on their marriage ceremonies, funeral rites, &c. M. Marche then went in succession to the islands of Penon, Coron, Magao-Puyao, and Dibatac. In the last he observed that the hills, which are almost disafforested by the natives, and which are about two hundred metres in height, surround fertile plains in the form of a horse-shoe, more or less closed, and in the centre a depression is observable. The whole has the appearance of a funnel, and it is suggested that this is an extinct volcanic region. In the same island of Dibatac, crocodiles and boa-constrictors are very numerous, and M. Marche was able to capture one of the latter, which had swallowed a calf several months old.

ON the 2nd inst. Mr. H. M. Stanley inaugurated the newly-formed Scottish Geographical Association in the Music Hall, Edinburgh. Lord Balfour of Burleigh presided. On the 4th Mr. Stanley formally opened the rooms of the Society, and on Saturday last he opened the Dundee branch of the Scottish Geographical Society in the Kinnaird Hall.

M. ROMANET DE CAILLAUD has communicated to the Geographical Society of Paris two papers on Tonquin. One refers to routes from the delta of the Red River into Yunnan, the other on the history of the Thai or Laos race in Tonquin and Southern Kwangsi. In the former he describes in detail five routes, two by river and three by land, into South-Western China. The only one of these of importance is that by the Songkoi, or Red River, and M. de Caillaud makes light of its difficulties, and insists that Paris is practically nearer to the Yunnan frontier than either Canton or Pekin. Paris is at the most, he says, fifty days' journey, while Canton is sixty, and Hankow, on the Yang-tse, eighty days. He also advocates this route for an invasion of China, and says that Lao-kai, on the upper Songkoi, is really for France the vulnerable point of that Empire. As has been already pointed out, discussion of the Songkoi route above Hong-hoa must for the most part be based on speculation, as only one European has travelled down or up the river from or to Manhao, and his journey was undertaken in circumstances which hardly admitted of accurate observation. A German geographer has recently expressed the opinion that one of the chief difficulties to be encountered in this route will be ethnological, and M. de Caillaud, in his second paper, traces briefly the fortunes of the principal race of the region—the Laos or Thai. This people has apparently had its day. At one time it dominated the whole Indo-Chinese peninsula, but now it is split up among a number of independent or semi-independent princelets, whose main business is war and piracy. Their various attempts to recover a portion of their old power have been repressed by the Annamites, assisted, when necessary, by the Chinese.

LIEUT. BOVE, of the Italian Navy, has written to Dr. Hyades of Paris a letter respecting his second expedition to Terra del Fuego. The first, he says, was to some extent scientific. He was ordered by the Argentine Government to study the south of Patagonia and Terra del Fuego from an economical point of view, and scientific observations were merely adjuncts. Nevertheless a scientific commission to investigate the geology, botany, zoology, and hydrography of these regions was sent with him. Lieut. Bove's official report is about to appear in Spanish in Buenos Ayres, and will be accompanied by those of the scientific men engaged. The *Bollettino* of the Italian Geographical Society will contain a paper on his journey in the interior of Terra del Fuego among the Ona. He started from Ouchonaya with an escort of twenty-four Fuegians of the mission, who proved very useful to him. After crossing the mountains behind this place, he descended into the valley which runs down to Admiralty Sound. He describes the interior of the island as magnificent, and much richer than Patagonia. The Ona were met with but twice, and their total number is estimated at from 300 to 400. The total number of Fuegians in the whole archipelago is stated, according to a careful census made by an English missionary, the Rev. Thomas Bridges, to be only 949 men, women, and children.

M. MICHEL VENUKOFF has addressed a note to the Geographical Society of Paris, referring to a new map of the island of Saghalin, prepared by M. Nikitine, the topographer. It differs from all the other maps of the island in some respects. It shows it to be considerably larger than had been previously believed. M. Reclus gives the area as 63,600 square kilometres. M. Strelbitsky 67,018, and Venukoff 73,529. Although the writer claims that his bases for calculation were necessarily more detailed and exact than those of his predecessors, he nevertheless considers his figures as approximate rather than final.

SCIENTIFIC ASPECTS AND ISSUES OF THE INTERNATIONAL HEALTH EXHIBITION[1]

[THE first Wednesday lecture at the Society of Arts was devoted to an address on this subject—in accordance with precedents—the Duke of Buckingham, Chairman of the Exhibition Council, taking the chair. The following are the parts of the address relating to the scientific departments of the Exhibition, and the proposal which the lecturer is understood to have laid before the Council for some time for the disposal of the surplus to such objects.]

There was only one exhibit in the food department to which I would specially call attention, it was that from the collections of the Science and Art Department and the Parkes Museum, illustrating the constituents of food and food values, and the connected exhibit by the Society of Public Analysts, of materials used as adulterants of articles of food; of adulterated articles of food commonly sold in this country; of adulterations which have been suppressed; of adulterations practised abroad, and mixtures generally protected by labelling. This latter was added in consequence of a suggestion made by the late Mr. Wigner, President of the Society of Analysts, at a late date in the progress of the Exhibition. I am afraid that it did not attract all the attention that it deserved. I trust, however, we shall be able to reserve it for continual public reference. Mr. Wigner, in communicating with me, pointed out that, although the Exhibition was most successfully arranged so as to display in a prominent manner all the articles connected with food, yet the public were only shown what is done by the most careful and respectable firms, whose names are a sufficient guarantee that only materials of the highest quality are used in the preparation of the goods which they show.

All who are connected with food produce know how, from time to time, the desire on the part of the consumer for cheap goods is the cause of the introduction of articles called "substitutes," which are offered to the manufacturer at one-third the price of the genuine material, and which frequently consist of some cheap and simple preparation, the very opposite in its chemical character to the article for which it is said to be an efficient substitute: several cases of this kind had recently been brought to Mr. Wigner's notice. For instance, he referred to an article to be used as a substitute for tartaric acid, the composition of which has been found to be acid sulphate of alumina in solution—a substance which, if introduced into the manufacture of bread or biscuits, is as objectionable as alum, and quite as much an adulterant. Bisulphate of potash is also sold under a name similar to tartaric acid, and is equally as worthless as sulphate of alumina. These are only two instances out of many, and serve as an additional argument to show the keen competition in trade, which causes the manufacturer to produce, and unscrupulous firms to sell, such articles under "Royal Letters Patent," or some other heading of this sort, to attract the notice of the consumer.

The public analyst, Mr. Wigner added, although, of course, he should be cognisant of these facts, has quite enough work for the remuneration paid to him, and in addition to this, there is the fact that the Sale of Foods and Drugs Act is so limited in its aim and scope as to practically prevent the analyst from testing anything but the common articles of food, such as bread and milk, unless they are sold under some recognised name. Let him once travel outside these lines, and a whole host of objections are raised. What is really wanted is more stringent legislation, similar in character to that at present in operation in the United States and Paris.

In the French Section were shown the monthly reports of the Municipal Laboratory, showing the complete and thorough manner in which the food-supply of that city is protected. Why cannot something of the same sort be done in London? What is wanted is a measure defining what is and what is not adulteration, and prohibiting the use of articles which are fre-

[1] Extracts from an Address delivered at the Society of Arts on Wednesday, November 26, by Mr. Ernest Hart, Member of the Executive Council.

quently employed at the present time, and the sale of which, while benefiting one class, seriously injures another, by substituting an inferior article for one of better quality.

Considerable good, it may be hoped, was done by the Health Exhibition by the exhibition of these so-called substitutes. The prominent display of this instructural series in a National Exhibition has, we trust, done something towards putting a stop to a trade which, while it enriches the unscrupulous trader, places the honest manufacturer in an awkward position.

How far it has fulfilled this intention is of course not yet apparent, but I shall certainly feel it a part of my duty in another capacity, as Chairman of the Parliamentary Bills Committee of the British Medical Association, to endeavour to keep the attention of our legislators to this important subject. It may be hoped that, when the political horizon is sufficiently cleared to enable Parliament to devote some time to interests of almost as important, if less strictly party, a character as those which are now occupying their attention, that it may be possible to secure for the people of England, or at least for the people of this metropolis as an example to other great towns, some of those better securities against the adulteration of food which this country was the first to set the example of creating by legislative action, but as to which it has at the present moment fallen behind some of those countries which followed us, such as France, Belgium, and America. It is within my knowledge, and in fact within my personal experience, that in all those countries our English legislation was originally the model which they set before them. In fact, in the case of several of these countries, I have had the opportunity of receiving the gentlemen who had been sent over by their various Governments, and of furnishing them in several instances with the opportunities of study and materials of which the respective Governments have availed themselves to create model laws respecting adulteration; I would refer here especially to the German code.

It is hardly to our credit that we have allowed ourselves to be distanced in a race in which we had so considerable a start, and in which the sole goal is the public benefit, and the maintenance of the public health. These are questions largely affecting the health of the whole nation, and especially affecting the welfare of the poor, who suffer most by the substitution of worthless, inferior, or adulterated articles in the fabrication of apparently cheap, but often very dear because worthless, articles of food.

Heating, Ventilation, and Smoke Abatement.—The testing of exhibits in Classes 24 and 25—Heating and Ventilating—were carried out on a considerable scale. Some 120 kitcheners—some burning solid fuel, and some gas—were tested. A large house was rented for conducting these trials, under conditions approximating to those which would be found in the actual use of the apparatus by the public, and a large number of tests of cooking joints, &c., in the kitcheners, &c., were made. The importance and necessity of exact testing, initiated by the Smoke Abatement Committee of 1881, and since carried on in a systematic manner by the National Smoke Abatement Institution, were fully recognised by the Executive Council of the Health Exhibition. The series of testings were conducted by the acting engineer to the Smoke Abatement Institution, Mr. D. K. Clark, and the jury of the Exhibition dealing with these exhibits included Prof. W. Chandler Roberts, Mr. Robert Harris, President of the Gas Institute, and other members of the Smoke Abatement Institution whose special knowledge peculiarly fitted them for the work.

The practical advantages of such testings have been manifested in the great interest taken by exhibitors in the work, their general desire to submit their manufactures for testing, the evidently accelerated course of improvement in design since the Smoke Abatement Committee first introduced the system of tests, and the advanced knowledge derived from the results of these tests.

At the Health Exhibition these beneficial influences were clearly traceable in the adoption of good ideas embodied in apparatus shown at the Smoke Abatement Exhibition in 1881, and brought into notice by the testing treatments adopted there, as well as in the rejection of plausible but impracticable methods of heating and ventilation which found place in the earlier exhibition. The detailed report of the tests of the apparatus shown at the Health Exhibition I trust will be published, for it will form a valuable addition to a continuous and advancing series of tests. The importance of this branch of my subject can hardly be exaggerated. We can follow, in the light of the knowledge derived from the result of the later tests, a regular and most encouraging course of improvements. For example, some of the exhibits shown at the Crystal Palace Exhibition last year, in the class of gas-cooking and heating-stoves, were proved to have a greater efficiency, by about 20 per cent., than those shown at the Smoke Abatement Exhibition in 1881; while at the Health Exhibition the efficiency proved by the tests was fully 25 per cent. greater than at the original Smoke Abatement Exhibition. Besides this increased efficiency, or improvement, to be measured by lower consumption of gas for equal work done, there has been an improvement hardly less important in numerous points of detail, affecting both the durability of the apparatus, and the facility with which it can be cleaned. These latter improvements, added to the lessened price of gas, and the reduced consumption of it in the newer forms of stove, cannot fail to tend towards the increased use of these cleanly conveniences and smokeless heating appliances for domestic purposes.

The testings at the Health Exhibition brought out the merits of a number of kitcheners and stoves very well adapted for using coke and "slack," or small coal, as well as improved patterns for using the ordinary lump coal, with lessened production of smoke. In regard to the advance made in smoke prevention from domestic fires, I may mention, on the authority of the testing engineer, that the highest average smoke shade proved by the tests of 1882 was 4·18 from kitcheners; and in the test at the Health Exhibition, the highest average was only 2·4; and from open grates the average density of the smoke was 3·0 in 1882, and at the Health Exhibition it was only 1·75. The importance of facilitating, by means of improved apparatus, the use of coke and the cheaper fuels now generally wasted is obvious, and I think I may fairly claim that this section of the Exhibition achieved a highly useful and successful result. In the bakeries department no less than five distinct systems of heating bakers' ovens, practically without the production of any smoke whatever, were shown—and not only shown, but were proved by an extended course of actual working—to be more or less well suited to the requirements of the trade. Varieties of machines for making dough by cleanly and expeditious methods were successfully worked throughout the period of the Exhibition, and it is but reasonable to assume that the exhibition of these machines, shown daily in satisfactory working, must have a great future influence in putting a stop to the laborious and filthy process of making dough by manual labour.

The Library.—The library sub-committee report with great satisfaction that the library has proved an unqualified success, and that it has attracted not only a large number of readers, but a considerable proportion of serious students.

Although no purchases of books have been made, upwards of 5000 works are now included in the collection, of which over 3000 relate to health subjects. The great majority are free gifts, a small proportion are on loan. They express a strong hope that a collection of books so useful as the nucleus for the formation of a special library will not be dispersed, but that the Executive Council will devise means to maintain the library on a permanent footing, as part of a memorial of this useful and successful national undertaking.

The library was altogether a novel feature in any exhibition of the kind, and its value was attested by the considerable number of serious students who availed themselves of its extensive resources, many of them being University students, who used this unwonted opportunity in preparing for examinations. The advantages to be derived from retaining the library as a permanent institution would be great. I put before you a copy of the catalogue, made entirely by Mr. Carl Thimm. This catalogue is in itself a publication of no small interest, being the most complete catalogue of sanitary literature with which I am acquainted (although of course it cannot be said to be complete in even an approximate sense, but must only be regarded as a very valuable nucleus for a larger library), in which the hygienic literature of foreign nations, and especially their official hygienic literature, is very largely and well represented.

The Sanitary and Insanitary Houses.—Of the sanitary and insanitary houses a special handbook has been published, which will be preserved among the literature of the Exhibition, and which constitutes a small epitome of the ordinary defects of existing houses, and the simple means by which such defects may in future be avoided. I shall not enter into any description of these houses, for they are already well known to most of you, and may, I yet hope, be further studied on some future occasion. But I wish to draw your attention to the very important conferences on the sanitary arrangement of houses which were held

by the Institute of British Architects in connection with this part of the Exhibition, and especially to that held in the last days of the Exhibition by the Guild of Plumbers. This I call your attention to because there is good reason to hope that out of this will spring an organisation, and I trust a legislation, which will, perhaps, do more towards the preservation of health and the saving of life than most of the much more pretentious forms of legislation which we must contemplate in the near future. The Exhibition will, in virtue of the organisation likely to follow from this conference, become the means of drawing together all those scattered forces which have for some time tended in the direction of a great improved regulation of the sanitary condition of our houses: a force, however, which, up to that moment, there seemed but little hope of being able so early and so practically to organise. I feel a peculiar interest in this subject, for I have now for several years, as Chairman of the National Health Society, and in connection with the Sanitary Section of the British Medical Association, occupied myself with collecting the facts and figures which demonstrate the urgent necessity of improved legislation for the safeguarding of the sanitary construction of our houses, and the improved education and registration of those builders and plumbers to whom we intrust that construction. I read on this occasion at the opening of the Congress a paper which I had prepared three years before, and which, in fact, I have in various forms presented to several professional and lay bodies, with the view of forming and gauging public opinion on the subject. I shall venture to put before you here now only the conclusions which I laid before this Conference, which practically and in principle received their approval, and which will thus, I hope, have an earlier chance of finding their way into the statute-book. They have the object of strengthening our statute law as to drainage and plumbing. I desire to enlist the aid of the Society of Arts in bringing into legal operation, as one result of the International Exhibition, the proposals which will be found in the Report of the Conference, of substituting sanitary for insanitary houses.

First as regards drainage itself:—

(1) Rural authorities should have the same powers as are now possessed by urban authorities. In the suburbs of towns, just outside the municipal boundaries, thousands of houses are springing up without any sanitary supervision whatever. The rural authority is, perhaps, unaware of the evil, or is, at any rate, careless about it until the houses are erected; and their opportunity of making by-laws which can control such houses is then lost.

(2) It would be well that the requirements of the Model By-Laws as to New Buildings issued by the Local Government Board should be incorporated in a Building Act which should be forthwith passed, and be of general application throughout the country.

(3) The plumbing and drainage of all buildings, public and private, should be executed in accordance with plans and specifications previously approved in writing by the local authority.

(4) No drainage-work should be allowed to be covered or concealed in any way, until it had been examined and passed by the surveyor.

(4A) The efficiency of all drains should be tested by the peppermint or some other test before they are passed; and it should be a rule that, wherever possible, drain-pipes should be kept from view only by boarding which can be readily removed.

(5) No new house should be allowed to be inhabited until it had been passed and certified by the surveyor, and a plan of the system of drainage should be appended in every case to the lease or other document for the letting of the house.

As regards the plumbers, I suggest that—

(6) The names and addresses of all plumbers should be registered by the local authority, and no plumber should be able to carry on his trade until he had been so registered, and had received a license from the local authority.

(7) Before the license is granted to him the plumber should attend personally at the office of the local authority, for examination as to his qualification as a plumber.

(8) Such licenses should be renewed from year to year, and their continuance should depend upon the good behaviour of, and the return of the work done by, the licensee.

(9) The names of all licensed plumbers should be publicly advertised once a year by the local authority.

The result of this Conference will live. Before long, I think we may promise ourselves, we shall see, as one result of this Exhibition, an active movement set on foot by which we shall henceforth be enabled to train skilled and educated workmen, and to ascertain by suitable tests their efficiency, and by which we shall be enabled to protect our artisans and ourselves from occupying houses which have been built with a total disregard or flagrant defiance of the first principles of sanitary construction, and of the conditions which we all know to be primarily essential to healthy occupation.

The Health Laboratories.—I pass to the laboratories. It did not at first, I think, appear evident to some of the members of our Council how close was the connection between the work to be carried on in these laboratories and the public health. Happily, however, that feeling soon gave way to one of acquiescence in the proposition which I made for the establishment of these laboratories, and, since, a closer examination of the subject has, I think, convinced every one that it is to establishments of research and of study, such as those over which Mr. Watson Cheyne and Prof. Corfield presided, that we must look for the most solid foundations for future progress in solving the highest problems connected with the preservation of health; and that no part of the Exhibition fulfilled a higher purpose, and to none can we look with more assured hope in the future, than to these departments of the Exhibition. A description of the laboratories appears in the official catalogue, and I shall not occupy your time with any description of them.

At the Hygienic Laboratory, in its chemical and physical departments, the public were not merely given the opportunity of seeing hygienic analyses of various kinds going on, and of having them explained to them either by Prof. Corfield or his assistants, individually or in the form of popular demonstrations—of which a considerable number were given, chiefly by the senior assistant, Mr. C. E. Cassall, during the time the Exhibition was open—but they also had the opportunity of seeing the ordinary working of such a laboratory, from the fact that Prof. Corfield was able to utilise this laboratory for his students. A class of about forty teachers, selected by the Science and Art Department from schools in all parts of the country, attended a course of lectures given by him at the Normal School of Science, and at the same time worked in batches in the hygienic laboratory at the Health Exhibition, and thus the public were enabled to form an idea of what such a laboratory is in full working order; and, indeed, during the whole time that the Exhibition was open after the above-mentioned class had dispersed, there were pupils who worked in the laboratory.

In a complete hygienic laboratory there should be a separate part set aside for physical experiments relating to hygienic appliances; but in this laboratory there was barely space for the chemical work to be carried on, and even the microscopical work could only be prosecuted to a limited extent, insomuch that the class of teachers went through their course of microscopy relating to hygiene in the physical laboratory at the Normal School, and the absence of physical appliances was replaced, as far as it could be, by demonstrations given by Prof. Corfield at the sanitary and insanitary houses.

As regards the Biological Laboratory, it is sufficient for my purpose to-night to remind you that in it Mr. Cheyne, the worthy pupil of Sir Joseph Lister, who acted as chairman of the Laboratory Sub-Committee, showed by practical working, and by collections such as had never before been seen in this country with the same completeness, the refined methods of research and of teaching by which we are enabled to study the life-history and the habits, the development and the means of arresting the development, of those minute organisms which modern science has shown to be prime factors in the causation of a great proportion of the most fatal diseases which afflict our flocks and herds, which decimate mankind, and which attack those plants and animals which constitute the staple of our food-supplies. Mr. Cheyne's demonstrations were eagerly followed by health students from all parts of the kingdom. A certain number of tables were set apart for study and research, and these were fully occupied from the first to the last days that the Exhibition was open. In Dr. Corfield's laboratory was collected the apparatus for that kind of instruction in the chemical and physical examination of soil, air, water, food, clothing, and materials of house construction, which are essential elements in the education of that great army of medical officers of health who are appointed now under existing Acts of Parliament to watch over the health interests of the community. It is very well known, however, that a large majority of those gentlemen have not this necessary instruction, and that at the present moment there does not exist in this country any adequate means for giving such instruction. There are in England 1102 medical

officers of health, and 996 inspectors of nuisances, all of whom are expected to get their information and to acquire the technical knowledge of which they stand daily in need as best they can; and it is well known that a large proportion of them are very imperfectly equipped with the necessary knowledge, and indeed can hardly be said to possess even the rudiments of systematic technical education in subjects in which they are presumed to be experts, and which they are called upon to decide in matters largely affecting the pockets of the community and intimately concerning its health. In order to illustrate the importance of the establishment in this country on a permanent footing of such laboratories as those which were shown in temporary working at the Exhibition, I shall ask leave now to refer you to an exhibit which was made in the French Court, illustrating the work done by M. Pasteur in a similar laboratory to that of which I am now advocating the permanent establishment, as the best possible sequel of this great Exhibition.

M. Pasteur is the scientific director of the École Normale supérieure in Paris, a school especially designed to supply professors in literature and science to the *lycées* or higher schools of France. He is not, however, called upon to undertake teaching, but is expected to devote all his time to his researches. In a word, in consideration of the considerable national services which he has rendered, an exceptional position has been accorded to him. He receives a professorial salary of 400*l*. a year. M. Pasteur is also the head of l'École des Hautes Études, of which Mr. Chamberlain is the sub-director. In this laboratory he receives some pupils. He possesses further a laboratory at the École Normale, where M. Roux is his coadjutor, and where are admitted some students who are generally persons already known for their studies. He has entire freedom of the choice of students of the laboratory of l'École des Hautes Études, as well as those of persons who work in his private laboratory at the École Normale. About 800*l*. a year are allowed for this laboratory by the Minister of Public Instruction, and for the last few years, 30,000 francs from the Minister of Commerce and Agriculture. These grants are renewed yearly.

The principal researches of M. Pasteur have related to—

(1) *Wine*, in which he demonstrated that, in order to avoid the transformation of alcohol into acid, it is necessary to destroy the germs remaining in wines which are poor in alcohol, by heating them up to 55°-60° Centigrade. He has also studied the action of oxygen and light on wine, and has demonstrated that it is to this action, *i.e.* to the oxidation of the materials of wine, that we are to attribute the development of the bouquet of wine, *i.e.* the flavour which it acquires with age. In order that this may yield a product appreciated by amateurs, it is necessary that it should proceed slowly. He has further demonstrated that the ferment of wine exists on the surface of the grape when it has ripened. He has demonstrated the useful and precise indications which the areometer furnishes, in order to appreciate during fermentation the state of the *mout* of the grape.

(2) *Beer*.—After having demonstrated that brewers employ, generally, a ferment containing, among others, injurious germs, M. Pasteur indicates the following means for obtaining a pure ferment. A small quantity of pure yeast is prepared according to the exact rules of the laboratory. This is introduced into a large copper pan, three-quarters filled with the wort of beer, which has been first carried to the boiling-point, and then cooled before the introduction of the yeast. The vessel only communicates with the external air by a long tube of copper, many times bent, in such a way as to permit the gases to escape without external germs being able to enter. When the wort has been developed, it is drawn off by a tap placed in the lower part of the apparatus, and which is previously purified with the flame of a spirit lamp. The wort of the beer is put to ferment in a large white-metal vat, resting on a plank, and closed by a movable cover, this movable lid dropping into a groove which is kept full of water. As the wort arrives in a boiling state in this vessel, it destroys any germs which may exist there. When it is cooled, and the cooling may be rapidly aided by the use of external cooling water, the yeast is introduced through an opening in the lid. The aeration of the fluid is obtained by two tubes curved downwards, by one of which carbonic acid escapes, and by the other the air enters after being previously filtered through a layer of cotton wool rolled round a cylindrical cage on metal wires which cap the extremity by which the air enters. This apparatus, like the foregoing one, reproduces exactly the conditions which are found to be necessary in the laboratory to prevent the introduction of external germs. The aëration by these two tubes is sufficient, for the carbonic oxide being heavier than air, they are placed in such a way as to form a siphon; moreover, during the fermentation, the wort is certainly kept in movement by the ebullition of the gas which escapes, so that the aeration, although less active than in some of the technical apparatus previously in use by brewers, is more than sufficient. By employing this procedure, secondary fermentations are no longer to be feared, and the spoiling of beer by secondary fermentation is almost entirely put an end to.

(3) A third and profoundly interesting series of researches, which have had a great influence on agriculture, carried on by M. Pasteur, are those relating to *charbon*—the malignant pustule or black quarter of cattle and sheep. M. Pasteur has demonstrated that animals of the ovine and bovine species may be prevented from contracting the disease of *charbon* by inoculating them with attenuated germs, obtained by artificial cultivation of the specific minute organism which is ascertained to exist in the case of *charbon*, and to be the efficient cause of the disease. This attenuated preventive material for inoculation is obtained by the aid of what are known as cultivations of the germs made in special liquids. After the first inoculation with the highly attenuated virus, Pasteur has shown that the second inoculation may be made with a product of medium virulence, and that the animals thus twice vaccinated were unsusceptible of contracting the disease. Pasteur has further demonstrated that the bacterium of *charbon* is capable of retaining its vitality for several years in the earth, and that, when brought to the surface by earth-worms, it is capable of infecting the animals which eat the grass polluted by its contact, especially if the grasses or plants so eaten be hard, and such as to cause abrasions in the mouth and digestive tube.

(4) *Silkworm Disease*.—M. Pasteur, after having assured himself that normally, and in good health, silkworms never contain, at any moment of their life, the bacteria or corpuscles seen for the first time by Guérin Menneville, demonstrated that the eggs of the worms, even when only slightly attacked, contained a great number of these corpuscles or bacteria, which developed in considerable quantities when the animal underwent its metamorphoses, and finally destroyed it. Since its droppings polluted the leaves of the mulberry on which the silkworm feeds, and as healthy animals thus devoured them, and contracted the same disease, a single infected silkworm was capable of destroying a whole school of worms, and preventing the subsequent cultures from being developed.

M. Pasteur then laid down the rule that, in order to avoid the silkworm disease, it was necessary to employ for breeding. With this view he devised the following procedure:—When the female has laid its eggs it is at once destroyed. If a single corpuscle is found in its tissues, when crushed in water, the eggs are immediately burned. In the same way the several eggs of each hatching are carefully examined. If no corpuscles are discovered, the whole brood is preserved for culture; if any are found, the whole are immediately destroyed. Since that time the silkworm breeders have followed the rules of M. Pasteur. The implements for the purpose of recognising the diseased worms consist of a microscope, two objectives, one with low power, and one with high power, magnifying about 400 times, and a small porcelain mortar for crushing the tissues of the worm or its eggs, some glass slides, and a flask of distilled water. By this application of scientific research to the silkworm industry the silkworm disease has been almost wholly put an end to. Nearly all the silkworm growers, whether masters or servants, have learnt, by the aid of a very cheap little handbook, prepared by M. Pasteur, to recognise diseased worms or eggs from healthy eggs or worms, and thus a great industry, which was threatened with extinction, has been saved from the fate which threatened it.

(5) *Fowl Cholera*.—After having demonstrated that this affection is caused by a micrococcus, M. Pasteur showed that if this micrococcus is cultivated in the manner which he indicates, and the micro-organism thus obtained inoculated in a fowl, the fowls so vaccinated become proof against fowl cholera, even when they are placed in the midst of other infected fowls. These researches have a special and suggestive scientific interest, for he has shown that if you filter through plaster the liquid taken from one of the external foci of the disease in a fowl affected with fowl-cholera, the filtered liquid thus inoculated will not give a healthy fowl the specific disease, but render it somnolent

and inert for some hours, so that it may be concluded that the micro-organism secretes a material to which must be attributed the lesions which are observed in fowls suffering from fowl cholera.

Some idea may be obtained of the commercial value of the work done by M. Pasteur in his laboratories from the following facts and figures, which I have on good authority:—In three departments of the centre of France, after the silkworm disease had attacked the factories, the product yielded a value of less than 1,500,000 francs. Since the regulations laid down by Pasteur have been applied, the average value per annum, calculated on five years, in those departments has risen to more than 22,000,000 francs.

As to wine, there was a known loss of wine to the extent of 1,700,000 francs in four departments. Since heating on Pasteur's method has been applied, there has been saved of this loss at least 1,500,000 francs; the difference of 200,000 francs being alleged to be due to the carelessness or ignorance of small proprietors, who are unwilling to heat their wine. As there are in France about forty-five departments that make wine, the saving may thus approximately be estimated. I should add that there are twelve departments that make silk.

In respect to anthrax, the following was the official statement indicating the ravages made by this disease in France and foreign countries, and the reduction of mortality effected by these inoculations:—

	Sheep		Oxen		Horses
1881					
France	62,050	...	5977	...	142
Foreign countries...	12,500	...	1254	...	100
Total	74,550	...	7231	...	242
1882					
France	270,040	...	35,654	...	1825
Foreign countries...	36,830	...	6,169	...	200
Total	306,870	...	41,823	...	2025
1883					
France	268,205	...	26,453	...	371
Other countries ...	84,825	...	5,777	.	975
Total	353,330	...	32,230	...	1346

The average mortality reduced by these inoculations in the proportion of 10 to 1 for sheep, and 15 to 1 for oxen, cows, and horses.[1]

Meteorological Laboratory.—The corresponding exhibit was that of the meteorological laboratory by M. Miquel, corresponding to which I hope to see a permanent meteorological station established as a sequel to the Exhibition. The work of M. Miquel has been summarised in the following words by Dr. Vivian Poore:—The observatory for Montsouris was established, in 1871, by the influence of M. Dumas, who was then President of the Municipal Council of the city of Paris. In 1873, M. Marié Davy was appointed director of the observatory by M. Thiers. The work of the observatory is as follows:—

(1) Meteorology proper, and its application to agriculture and hygiene. This department is under the control of M. Léon Descroix.

(2) Chemical analysis of the air and rain, under the control of M. Albert Lévy.

(3) The microscopic study of the organic matters held in suspension in the air and rain. This is under the control of M. P. Miquel.

In 1870, the municipality decided to have the above meteorological observations, in their relation to hygiene, made in different parts of the city. The chemical analyses and microscopical examinations are made—

(1) On drinking waters.

(2) On the waters infiltrating the soil.

(3) On the emanations from the soil and sewers.

(4) On the air of different localities estimations are made. A. (air), ozone, carbonic acid, ammonia, organic nitrogen; and similar analyses are made of the soil-water, &c. Every year the *Annuaire de Montsouris* is published, a work full of information, and which is now in its thirteenth volume.

The laboratory of Mr. Cheyne at the International Health Exhibition was largely fitted up by the aid of Dr. Koch, and of Dr. Koch's laboratory at Berlin. Mr. Cheyne has furnished me with the following outline:—

Dr. Koch's laboratory is subsidised by the Government. It consists of director, library, biological department under Dr. Koch and several assistants, and a chemical department. All expenses of investigation are paid. Koch's salary is only 300*l*. Other salaries I do not know. When appointed, Koch first set to work to improve methods of cultivating and studying bacteria, and to devise new methods, and the result has been a precision and simplicity in this sort of work quite beyond all expectation. His further researches have been devoted to the study of the cause of disease in man and how to prevent it. Either by himself, or under his direction, the causes and means of prevention of tuberculosis, consumption, erysipelas, osteomyelitis, and glanders have been absolutely demonstrated, while a large amount of work has been done in respect to the causation and prevention of typhoid fever, cholera, diphtheria, and other affections. His researches on disinfectants and the best mode of disinfection are classical, and are still being carried on. This work is being rapidly extended to other diseases, while important researches are going on relating to water, air, and soil.

The Anthropometric Laboratory at the Health Exhibition was designed by Mr. Galton, to show the feasibility of performing, at a small cost, an extended series of measurements of the human faculties, and of testing the demand that there might at present be for having such measurements made. The ulterior object he had in view was to familiarise the public with the facility and need of periodically recording facts which test the progress of individual growth and development, whether it is proceeding normally or otherwise; and if it should be abnormal, to call attention to the existence of hurtful influences, and to demand inquiry into their nature, and whether they may not be removable. The experience of the laboratory showed emphatically, first, that about seventeen different measurements of each person, including height, weight, strength, breathing capacity, eyesight, judgment of eye, hearing powers, &c., could be accurately performed at a cost of less than 3*d*., by means of a well-organised method of work; secondly, it showed that the public greatly valued the opportunity of having themselves measured and appraised in so minute a manner, inasmuch as the door of the laboratory was besieged all day long by a crowd of applicants for admission, far more numerous than could be accommodated in its small area, 36 feet long by 6 feet wide. As it was, measurements were made of between nine and ten thousand persons, yielding data that are now being discussed, and which have considerable statistical value. The methods and appliances used and suggested by the experience of this laboratory have been very recently described by Mr. Galton at the Anthropological Institute. It is therefore not necessary here to go into details. It may be taken as established that there need not be the slightest difficulty in periodically measuring with much completeness and keeping a register of the development of every boy and girl in large schools, at the cost of a very few pence per head per annum, on the supposition that the process was methodically conducted by a paid expert, with the willing and gratuitous assistance of the masters and attendants. The power of a system of periodical measurements and tabulated returns upon the well- or ill-being of the growing portion of our race is of unquestionable value, and it would seem that common-sense considerations must insure its being ultimately called into action. Now that there are signs of much awakening to the importance of such records, a central institution becomes especially desirable, where the best patterns of instruments should be kept, where instruction in their use might be obtained, where the methods of tabulation, and of quickly getting useful results out of the data, might be learnt, and where the fullest information of all kinds on anthropometry would be stored. It must not for a moment be supposed that anthropometry is a simple and thoroughly understood art. On the contrary, it continually grows, new methods being discovered from time to time of measuring faculties that had before escaped measurement. There can be little doubt that the progress of the useful art of knowing one's self all round, and of knowing others accurately, of reducing what has hitherto been too much a matter of estimate to quantitative measurement, would be very largely aided by the establishment of an anthropometric laboratory in a national hygienic institution.

Proposed Disposal of Surplus.—That which I look forward to, then, as the best possible sequel to this Ex-

[1] In the last thirty years there has been an increase of life-duration of from 39·9 to 41·9 years, an increase of 5 per cent. human duration of life. The annual economy of life, on the least favourable calculation, during the last five years, has been equal to a saving of 36,000 lives per annum. The money saving on the last five years has been calculated, on good basis, by Capt. Galton, to be in London alone nearly half a million of money per annum.

hibition, is the establishment of these laboratories, so vastly important to the prevention of disease and the maintenance of our population in health, and of the library on a permanent footing and under suitable direction. The whole subject is one on which I can only venture to express, thus far, my individual opinion, although I have the satisfaction of knowing that the views which I have thus put forward have met with considerable approval among many of my colleagues, to whom I have submitted them *in limine* for future consideration by the Executive Council, who may possibly approve of them, and in that case may feel it their duty to submit them to his Royal Highness the President, with whom will rest the ultimate decision as to the disposal of any parts of the surplus. The rumour that such a project was about to be submitted to the Council, has awakened the liveliest interest and satisfaction amongst the authorities of the leading sanitary associations in this country, and I am glad to know that the authorities of the Parkes Museum, of the Sanitary Institute, of the Social Science Association, of the Society of Medical Officers of Health, and of the National Health Society, have each, on their own individual motion, taken the opportunity of expressing, by resolutions and memorials, their strong sense of the great national value which they consider would attach to the accomplishment of this design. Should this proposition prove acceptable to the authorities, there is no doubt that the opinion of the great body of persons interested in the sanitary progress of this country, thus early expressed by the official representatives of every form of sanitary progress, would declare itself strongly in favour of an institution from which considerable results might be anticipated in the furtherance of health education, and of our knowledge of all that relates to the prevention of disease. It is further hoped that an Institute of Public Health, founded on this basis, might prove a home and centre with which these numerous voluntary organisations now working for the public health might connect themselves, by some well co-ordinated and accepted plan; that it might be a centre where their members would be able to meet; where libraries, class-rooms, and meeting-rooms might be made to serve a valuable purpose in bringing these various societies into closer relation. There is reason to hope that many of the great scientific associations which now foster the progress of science by grants to individual workers, would heartily welcome the establishment in this country of what it so greatly stands in need—a place of higher education and research in sanitary science, such, as I have already pointed out, as have been recently created in France and Germany. England has been first in sanitation; it is here that have been solved—so far as they have as yet been solved—many of the greatest problems of sanitary science; but we must acknowledge that, during the last decade, each of these countries has made progress in the higher departments of sanitary education and sanitary research, in which we can hardly be said to have held an equal place. This reproach we may now find the means of wiping away, and I earnestly trust that this may prove to be a sequel of the International Health Exhibition, than which no higher memorial could have been hoped for or expected.

The Lesson of the Exhibition as to Open-air Recreation and the Electric Lighting of Public Parks.—Let me conclude by reference to another aspect of the teaching of the Exhibition, less scientific, but yet of peculiar public importance. It was often said by the public scorner—a person from whose judgments and criticisms we have commonly much to learn—when walking through the crowded course of the Exhibition devoted to food and all that concerns the construction and decoration of the dwelling: "This is a Health Exhibition—where is the health?" and the popular answer was, "Outside in the gardens." That answer also I accept. I think you will agree with me that the practical demonstration which this Exhibition afforded of the eagerness of the English people to resort to healthful means of outdoor amusement was in itself a valuable result and an important experience. The gardens, illuminated by the electric light and enlivened by music, were undoubtedly a great attraction to the Exhibition, and I would be quite willing to agree with any one who might say that they were the greatest attraction. Allow me to add that I look upon this not merely as a means, but itself an end. It is no small thing to have acquired the conviction that our open spaces may be, and should be, much more largely devoted to the open-air recreation of the people than they are at the present moment. I say this now, without any intention of entering upon that large question, but with the specific desire to repeat (for it is only by repeating often that one can gain access to the minds of the majority who are all-powerful in such questions) that it appears to me to be no small disgrace to this great metropolis that, in the very centre of its crowded districts, within an arrow's flight of the houses probably of most of us who are here, there lie great open spaces, such as Hyde Park (but what I say refers also to Victoria Park), which at night are dreary desolate areas of darkness, which are unlighted, which are dangerous to cross, which are unused in the evenings for any wholesome or moral purpose, which are often scenes for the display of some of the worst vices incidental to the lowest dregs of the population of the great city. Why should we not learn from the success of the music and the lighting of the gardens of the Health Exhibition, that our great parks should all be lighted by the electric light at night, and that throughout the spring and summer months the military bands should play there, and should make those places, which are now not only useless but scandals to the metropolis, the sites of healthful and innocent recreation? I have inquired from a good source what would be the cost of lighting Hyde Park by the electric light; and I am not speaking without data when I say that I believe that Hyde Park could be adequately lighted with the electric light, so that it might add to the resources of health and enjoyment for the teeming population surrounding it, at an annual expenditure of about 5000*l*. I do not know what impression this will make upon you. I confess that to me such an expenditure seems trifling in consideration of the sum of human happiness and enjoyment, and, I may add, also of health, which such a devotion of municipal or public money would afford to the people of this city. Nor is it likely that, the example once set, it would end here. Our eastern population have a right to the enjoyment of their parks in the evenings that could be conceded to the west. This lesson also, then, the Exhibition seems to me to teach, and how greatly we might all rejoice if it should ultimately prove that the lighting by electric light of our public parks, and the introduction of music as a part to enliven and attract the people, and to add to the success of the innocent recreation, the health and the happiness of our working population should form also one of the possible sequels of this Exhibition.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—Prof. Roy was on Thursday last admitted to the degree of M.A. *honoris causâ*. The Public Orator in presenting him spoke as follows:—

Dignissime Domine, domine Procancellarie, et tota Academia,—Quis nescit Athenas illas Caledonicas, cum aliarum artium, tum praesertim studiorum medicorum praeclaram esse sedem. Academiae tam illustris alumnum, Pathologiae Professorem primum nobis nuperrime datum, hodie senatus totius nomine salutamus, ipsum senatorum nostrorum ordini libenter adiungimus. Neque vero una tantum doctrinae sedes Professorem nostrum sibi vindicat; scilicet Germaniae ipsius Academiae celeberrimae hunc virum inter alumnos suos numerant. Ne inter Cantabrigienses quidem prorsus hospes est, qui non modo Physiologiae praeceptoris nostri optimi experimentis aliquamdiu interfuerit, sed etiam ipse de Physiologiae arcanis praelectiones quasdam inter nosmetipsos habuerit. Idem quondam (ut ad remotiora transeamus) Ottomannorum inter milites arti medicae deditus, in ipsa Epiro, prope Pindi montes, prope Dodonae antiquae diu desertum oraculum, velut ἰατρόμαντις aliqui, consulentibus respondebat. Ad eundem postea Respublica Argentina, morbo gravi et inexplicabili oppressa, velut ad oraculum aliquod misit, cuius responsis obsecuta peste illa dira sese protinus liberavit. Inter antiquos quidem victimarum in visceribus rerum futurarum praesagia quaerebantur; hic autem, non vanus haruspex, ex ipsis morbis quos alii reformidant, ex ipsa Morte quae aliis tacet, veritatem ipsam audacter extorquet,—adeo ut Catonis verbis profiteri possit:

me non oracula certum
sed mors certa facit.[1]

Vobis praesento Medicinae Doctorem Edinensem, Pathologiae Professorem Cantabrigiensem, CAROLUM SMART ROY.

[1] Lucan, "Pharsalia," ix. 582.

SOCIETIES AND ACADEMIES

LONDON

Physical Society, November 22.—Prof. Guthrie, President, in the chair.—Mr. James Bewsher was elected a member of the Society.—The following notes were read by Mr. R. T. Glazebrook, M.A., F.R.S. :—On the permanence of some standards of electrical resistance. The author has had occasion to compare with ten standard B.A. units a coil which had been tested by Lord Rayleigh in 1882, the coil then being two years old. He found that its resistance was 0·98335 B.A. units at 14°·05 C., while Lord Rayleigh found the value 0·98330 B.A. units. Thus, either the coil and the standards have changed by exactly the same amount, which is improbable, for they are wires of different thickness, or they have all remained permanent.—On the effect of moisture in modifying the refraction of plane-polarised light by glass. The author described some experiments he had been engaged in lately at the Cavendish Laboratory. Plane-polarised light is made to fall on a plate or a wedge of glass at various angles, and the position of the plane of polarisation determined. It is found that this depends greatly on the hygrometric condition of the air in the neighbourhood of the glass. If moist air be blown on to perfectly clean glass, the plane of polarisation of the emergent light is displaced from its normal position in one direction, while, if dry air be blown, it is displaced in the opposite direction. At an angle of incidence of 60° the difference between the two positions is from 6′ to 8′. If, however, the glass be not perfectly clean, the effect of moisture is *at first* the same as that of dry air, though on stopping the draught an opposite effect is observed. The author assigns as the cause of this the heating of the surface, which, as Magnus discovered, is produced by a draught of moist air. He finds, on repeating Magnus's experiment, that the heating is not produced if the glass be clean, and he shows by an independent experiment that slight local heating does produce an effect on the plane of polarisation in the same direction as that due to the dry air.—Mr. Glazebrook also exhibited a spectrophotometer described by him in a paper read before the Cambridge Philosophical Society (*Proc. Phil. Soc.* vol. iv. part vi.), and made by the Cambridge Scientific Instrument Company from his design.—A note on a point in the theory of pendent drops, by Mr. A. M. Worthington, was read by the Secretary, Mr. Walter Baily. This was a note upon a paper recently communicated by the author to the Royal Society upon the measurement of the surface-tension of a liquid from the observations of the forms assumed by pendent drops. By making a measurement of a horizontal section of such a drop, and of the angle made by the tangent plane to the surface at the line where the section meets the surface with the horizontal, and knowing the density of the liquid, sufficient data are obtained to determine its surface-tension. Prof. Perry remarking upon this paper gave an account of some researches upon the subject, in which some years since he had assisted Sir William Thomson. On the usually accepted theory of surface-tension based upon the behaviour of liquids in capillary tubes, at every point of the surface of a liquid the equation

$$kp = \frac{1}{R} + \frac{1}{R'}$$

must hold where p is the pressure at that point or the difference of pressure on the two sides of the surface, R and R' the two principal radii of curvature, and k a constant. In the case of a drop whose surface is one of revolution about the vertical, the contour may be drawn from the equation. This was done, and theoretical drawings were made of a number of drops. These have since been compared by Sir W. Thomson with enlarged photographs of actual drops, and the results are highly satisfactory. This law no longer holds in the case of a drop at its "critical point," or that point when it is about to fall, since here dynamical action comes in.—Mr. Baily also read a paper by the same author on a new capillary multiplier. This is an apparatus for the measurement of surface-tension, and is a modification of one used by M. Despretz. From one extremity of the arm of a balance is suspended a roll of platinum foil, consisting of a strip 50 cm. long and 5 cm. or 6 cm. broad, rolled up, the successive convolutions being prevented from touching by rolling up with the foil a number of small pieces of hard glass tubing about 2 mm. diameter, which occupy the upper part of the helix, and preserve the form of the lower. The coil is cleaned by igniting it in a Bunsen flame, and then suspended with its lower end in the liquid to be examined. The increase in weight corrected for the part of the coil immersed is due to the fluid rising between the convolutions. From this the surface-tension is readily calculated.—Mr. Hilger described a new solar eye-piece. In Prof. Pickering's eye-piece there are two rectangular prisms of glass of slightly different refractive indices. The light of the sun undergoes partial reflection at the surface separating the two prisms, the ratio of the reflected to the incident light diminishing with the difference between the refractive indices. It is found, however, that such a prism under a high power always gives a double image, due to the two glass surfaces, it being practically impossible, even under enormous pressure, to bring them into true contact. To obviate this Mr. Hilger makes the second prism of Canada balsam, which gives the most satisfactory results, the image being pure and single.

VIENNA

Imperial Academy of Sciences, November 6.—On the fossil flora of the breccia of Hoetting, by C. von Ettingshausen.—On resorcin-blue, by P. Weselsky and R. Benedikt.—Carcinological notes, by K. Kœlbel.—On a reduced organ in *Campanula persicifolia* and in other species of Campanula, by E. Heinricher.—A new method of combating Phylloxera, by G. Henshel (sealed packet).—Contribution to the anatomy of the male organs of generation, by E. Finger.—On the bodies formed from hydroquinones by melting soda, by L. von Barth and T. Schreder.—On the temperature of the Austrian Alpine countries (part 1), by E. Hann.—On oxyphosphinic acids, by W. Fossek.—On the length of the year of Sirius, by Th. von Oppolzer.—On the figure of light-waves in the magnetic field, by E. von Fleischl.—On diluvial man from the caves of Stramberg (Moravia), by T. N. Woldrich.

CONTENTS

	PAGE
Health Laboratories as the Result of the Health Exhibition	121
The Butterflies of Europe. By R. McLachlan, F.R.S.	122
Elementary Mathematics	123
Our Book Shelf :—	
Lovell's "Edible Mollusca of Great Britain and Ireland"	124
Brown's "Forestry in the Mining Districts of the Ural Mountains in Eastern Russia"	124
Willkomm's "Pyrenäische Halbinsel"	124
Letters to the Editor :—	
The Prime Meridian Conference.—Gen. Richard Strachey, F.R.S. ; Latimer Clark	125
The Electric Light for Lighthouses and Ships.—A. Ainslie Common	125
Natural Science in Schools.—Prof. Sydney Young	126
The Edible Bird's-Nest.—Jos. R. Green	126
The so-called South Plant of Egyptian Art.—W. T. Thiselton Dyer, F.R.S.	127
Earthworms.—Frederick Lewis	127
Injuries caused by Lightning in Africa.—Dr. von Danckelman	127
The Northernmost Extremity of Europe.—A Norwegian	127
Our Future Clocks and Watches.—B. J. Hopkins	128
Singular Optical Phenomenon.—X.	128
The Aurora Borealis.—Dr. Sophus Tromholt	128
The United States Fish Commission. By Ralph S. Tarr	128
The Institution of Engineers and Shipbuilders in Scotland	130
The Eggs of Monotremes. By W. Baldwin Spencer. (*Illustrated*)	132
Notes	135
Our Astronomical Column :—	
Wolf's Comet	137
The Washburn Observatory, Wisconsin	137
Geographical Notes	137
Scientific Aspects and Issues of the International Health Exhibition. By Ernest Hart	138
University and Educational Intelligence	143
Societies and Academies	144

THURSDAY, DECEMBER 18, 1884

A TEACHING UNIVERSITY FOR LONDON

A MOVEMENT, which first began to shape itself into form at the Educational Conference at the Health Exhibition, made its first formal public appearance at the house of the Society of Arts on Monday afternoon. The crowd of well-known and much-occupied men with which the room was filled was at least an earnest of something more than a discussion of a mere speculative project; and the speeches made, though revealing, as might be expected, a considerable diversity in point of view, were listened to with a closeness of attention which indicated a pretty confident belief that the movement was not likely to evaporate in mere debate.

Lord Reay opened the proceedings with an address, which was admirably conceived both in tone and matter. If subsequent speakers scarcely can have been said to have carried on the discussion on the same level, this may be attributed to the fact that the report submitted to the meeting for adoption by Lord Justice Fry embodied an amount of detailed suggestion which the meeting was naturally not in any way prepared to assimilate without a good deal of consideration.

Every one knows that we have in London a body bearing the title of a University. Every one, at least who has looked into the matter, knows equally the immense services which this institution has rendered in raising the standard of middle class education. But a University all the same, in any intelligible sense, it is not. It is essentially nothing more than a Government Department for giving, after examination, academic certificates. Nor, as Professor Lankester very properly pointed out, is it, any more than the Home Office for example, an institution which, because its head-quarters happen to be in London, is locally identified with the metropolis in the same sense in which the Universities of Oxford and Cambridge are identified with the places in which their work is carried on. The operations of the University of London are, in point of fact, more wide-reaching than those of any other Government office, and are, indeed, co-extensive with the Empire itself.

In one aspect the whole movement may be regarded as an outcome of the nascent municipal feeling in the life of the metropolis. The Examining University, for reasons stated above, does not, and in its present form never can, satisfy the reasonable desire that the metropolis should possess that academic crown which is worn by every other great capital in the world. The disembodied spirit of what might be brooding over gloomy examination halls may strike a wholesome terror into the hearts of candidates, and sustain a certain feeling of emancipation in the hearts of candidates; but it cannot, and does not, excite any enthusiasm in either. Nor has the cold officialism of Burlington Gardens ever treated with more than a lofty disdain the more humanly organised institutions which furnish the victims who pour into its portals.

The movement to constitute a Teaching University is undoubtedly in some degree due to a reaction against this state of things. Those whose business "is to teach, know now-a-days that a great deal depends on the way teaching is done. It is here that the educational bodies of the metropolis feel their isolation. There is no central authority to gather their representatives into its fold and smooth away the individual difficulties in the way of common action and "bringing into harmonious cooperation the dual business of examination and teaching. Life is getting appreciably shorter now; the thread of existence has more knots though its length remains the same. The time that can be given to education out of an ordinary existence cannot be indefinitely expanded. Method must be brought in to economise labour in instruction. This is a very different thing to cramming; it is on the contrary a scientific mode of directing the educational attack in the most effective way. Here the rulers of the University have shown themselves most deficient in sympathy; they have turned an obdurately deaf ear to the entreaties which have been repeatedly addressed to them by the Convocation of the University to get "touch" with the teaching bodies. And, what is perhaps even still more irritating, though, as remarked at the meeting, for the most part, laymen in education, they still issue in a purely *doctrinaire* spirit directions which of course from the nature of the case have the binding force of edicts at the actual seats of education. Dr. Carpenter, with an official optimism excusable enough in one who has devoted a lifetime to loyal and honest work, contended, it is true, that the university was blameless in this respect. But those who are familiar with the other side of the shield know how far this is from being the feeling in teaching institutions. Manchester has already broken away from the rule of Burlington Gardens, and it can scarcely be doubted that had the University of London shown a more conciliatory attitude with regard to the formation of Boards of Studies, the present movement would in all probability have taken a very different shape.

It is proposed, then, alongside of the existing examinations to have a Teaching University. This it is also intended should examine and grant degrees. It may be thought that this is going too far, and that it is not desirable that the one thing should become a mere mechanical reflection of the other. But the risk is small; the principle is now-a-days accepted by all who have really studied the matter, that teachings and examinings must be in the hands of the same persons; but this does not imply that the same individuals should control both. Nor, it must be admitted, is this merely a matter of interest to the teaching bodies. The imperfect educational discipline to which a large proportion of the candidates who frequent the examination rooms of the university have been subjected, leads to an inordinate amount of rejections. This creates the misconception in the public mind, that the examinations are unreasonably severe. The real fact is that the candidates are badly prepared. In this way the want of cooperation between teachers and examiners becomes indirectly a real obstacle to educational progress.

So far we have endeavoured to give our readers an account as distinct as we have been able to gather of the forces which have initiated this movement, and the aims which are desired by it. We cordially sympathize with both, and it is because we do so that we must now indulge in a little criticism on the scheme as put forward by Lord Reay's committee. In the first place, we found it difficult

to believe that the creation of a new university with full powers in the metropolis is ever likely to come within the bounds of political possibility. It is not that the Government will be inaccessible, but that it will be difficult to persuade general public opinion of the necessity of such a course. We believe that it will in the end be necessary eventually to come to terms with the existing university. The fact that eleven members of its Senate have joined the movement, shows that that body at any rate contains a powerful element discontented with its present asphyxiation by red tape. What, however, we do hope to see is the federation of our scattered educational bodies in London into Faculties, which would be practically universities in all but the name, and the representatives of which should have a leading voice in the management of the Central University. The only speakers who really evinced at the meeting a clear idea of their own policy, were the representatives of the Medical profession. Prof. Marshall showed with singular lucidity that the altered character of medical education has made the continued isolation of the smaller medical schools a practical impossibility. Not merely has technical instruction gone beyond the capacity of the junior members of the medical staff who are usually told off for it, but the appliances required are too costly for all but the wealthier schools to provide efficiently, and the teachers are themselves wanted for the more minute and careful clinical instruction which is now everywhere demanded.

The Medical Schools will therefore combine, perhaps, into some four great groups, for purposes of education and the organisation of laboratories, just as the small colleges at Oxford and Cambridge have combined for purposes of intra-collegiate lecturing. Once federation has begun, the foundation of a medical faculty for London is only a question of time. This will come about, probably, whatever the fate of the more general movement. But such a faculty would undoubtedly be found to be politically a body to whose just claims in direct medical education the University of London would find it impossible to lend a deaf ear.

The faculty of law may also shape itself into existence, though, it must be admitted, the elements of its form are, at present, very dim and shadowy.

To balance these we want a faculty of literature and science, and the materials for these are to be found in a federation of University and King's Colleges, as suggested by Prof. Lankester. If the representatives of such a faculty were allowed a proper share in the councils of the existing University, it is not obvious why such a federation should be intrusted with a separate degree-giving power.

We now come to what appears to us the weak point in the scheme. A university may impart knowledge: it may test its quality when imparted; but that which has ever been the peculiar glory of university life, is to enlarge its bounds. But except a few well-expressed sentences which fell from Lord Reay, and a sentence put into the conclusion of the report very much with the air of an afterthought, this very important matter does not seem to have received very much attention. Now the most melancholy feature about such elements of university organisation as already exist in London, is its displayed incapacity to retain its best men. There is an obvious dearth of such posts as would satisfy their legitimate ambition. No sooner amongst us does a man rise to the first rank at any seat of education, than sooner or later he is drafted off to one of the universities in the provinces. To take the first instances that come to hand: Cambridge has robbed us of Michael Foster, and Oxford of Burdon Sanderson, while the greatest biological teacher of the day is driven from England by ill-health after a life toilsomely spent in the lowest order of teaching—drudgery. What is absolutely essential to add lustre and distinction to the work of a Metropolitan University is a body of University Professors who would take charge of the higher studies, which never can be properly cared for by bodies sedulously occupied with the very serious business of the higher education. What we hope then some day to see is the University of London equipped with a proper staff of Regius Professors, who themselves would be at the least an invaluable bond of union between its own too abstract isolation and the living reality of the actual teaching bodies.

Although we could have wished for greater insistence on this—as it seems to us—most vital point, we cannot but entertain the highest hopes of the usefulness of the present movement. It has some of the notes of healthy organic development; it has at least spontaneity and individual activity, which have always been the foundations of political achievement amongst us. At the worst, mere effervescence is better than stagnation, and we think there is more in this movement than effervescence. In any case we cannot too warmly tender our expression of acknowledgment to public men like Lord Reay and Sir George Young, who have spared neither pains nor labour in the purely patriotic labour of giving our own too inarticulate murmurings definite form and expression.

THE POLYZOA OF THE "CHALLENGER" EXPEDITION

The Zoology of the Voyage of H.M.S. "Challenger." Part XXX. "Report on the Polyzoa—the Cheilostomata." By George Busk, F.R.S., V.P.L.S., &c. (Published by Order of Her Majesty's Government, 1884.)

THE description of the Polyzoa collected during the expedition of the *Challenger* was undertaken by Mr. Busk, and the first part of his Report, comprising the Cheilostomatous forms, or those in which the mouth of the zoœcium or cell is provided with a movable lid which shuts down over the polypide when retracted, has just been published.

The investigation of this important part of the *Challenger* collections could not have been placed in better hands. As an authority on the zoology of the Polyzoa, Mr. Busk stands pre-eminent; and the present admirable Report of 216 pages and 36 plates bears testimony to a laborious and conscientious investigation, the value of which as a contribution to our knowledge of the multitude of forms associated under the name of Polyzoa cannot be over-estimated.

The number of species of Cheilostomatous Polyzoa in the *Challenger* collection is 286, and when these came into Mr. Busk's hands he found no less than 180 of them

new. In one genus alone, that of the *Retepora*, the number of known species has been raised by the dredgings of the *Challenger* from 31 to between 50 and 60.

The determination and definition of species in a collection so large as that of the *Challenger* Polyzoa, and in a group of organisms in which the differences are far from being always strikingly obvious, cannot but be a work of great labour. The critical examination of the species in such a genus as *Retepora*, for instance, which is represented in the *Challenger* collection by 23 species, and *Cellepora*, which is represented by no fewer than 31, requires no ordinary patience, and the author must be congratulated on having so far brought to a conclusion labours which, in order to be conscientiously performed, must be often wearisome and monotonous.

Among the most important contributions of the Report to the systematic zoology of the Polyzoa is the revision which it contains of *Adeona* and allied genera. A critical comparison of the species of *Adeona* with species belonging to other genera which had been hitherto placed among the *Escharidæ* has necessitated the founding of a new family, *Adeonea*, in order to include the whole in a single natural group. This family has several peculiarities, among which the most interesting is the possession by all the species of three different kinds of cells, which the author terms zoœcial, oœcial, and avicularian. Oœcia of the ordinary type are entirely absent, and their function appears to be performed by special cells which differ in form from the others. When decalcified these oœcial cells appear as thick-walled sacs, containing in most cases an ovoid mass, which resembles the contents of an ordinary oœcium, and like these is almost certainly embryonal. Mr. Busk has further made the important observation that in some of them there is lodged instead of this mass a polypide similar to those inhabiting the zoœcial cells, and he concludes that the embryonal mass is derived from a polypide, which it finally replaces.

Among other peculiarities of the Adeoneæ is one which, notwithstanding its apparent triviality, derives importance from its constancy. This consists in the universal presence of a projecting point at each end of the base in the avicularian mandibles both large and small. In doubtful fragments this character alone will often indicate the affinities of the species.

The descriptions of the new species are throughout the work drawn up with that care and precision which characterise all Mr. Busk's zoological writings, while the absence of redundant description and the exclusion of characters not necessary for the diagnosis, give to his definitions a conciseness which will be appreciated as it deserves by all who require to consult the Report.

In a large proportion of the diagnoses the author has had recourse to the chitinous elements of the skeleton. These are the so-termed opercula or oral valves, and the chitinous parts of the avicularia and vibracula; and a very large number of accurately-executed outlines are given in order to show the various forms assumed by these elements in the different species. The employment of the chitinous elements in the classification and descriptive zoology of the Polyzoa is due entirely to Mr. Busk, who has convinced himself that "their value for these purposes cannot be over-rated, while their importance extends far beyond the mere distinction of genera and species."

The descriptions of the species are of course necessarily confined to the hard parts, whether calcareous or chitinous, for, except in living examples, it is rarely possible to determine any facts of importance regarding the soft parts of the colony. The author, however, gives two highly instructive figures of the avicularia of *Bicellaria pectogemma*, in which the muscular apparatus and other soft parts of these curious and still enigmatical bodies are clearly and beautifully represented. In one of his figures of *Carbasea moseleyi* also—a form in which the calcareous walls are quite transparent—there is a very interesting view of the polypides in the interior of their cells.

The distribution of the species, geographical and bathymetrical, finds a prominent place in the Report. An instructive map is appended in which the oceans traversed by the *Challenger* are divided into seven regions, three being to the north and four to the south of the equator, each including 90° of longitude. In each of these regions the stations from which any species of Polyzoa were obtained are indicated.

The bathymetrical range varies within wide limits. The greatest depth which yielded any species to the dredge was 3125 fathoms, in the North Pacific region. From this vast depth four species were procured, and between it and quite shallow water a great number of stations of very various depths are recorded.

One of the most unexpected facts brought out in the Report is the very wide bathymetrical range enjoyed by certain species. Thus *Cribrilina monoceras* is one of the four species brought up from 3125 fathoms in the North Pacific, while the same species was obtained from 1325 fathoms in the South Pacific, from 69 fathoms in the South Indian or Kerguelen region, from 55 fathoms in the South Atlantic, and from 35 fathoms in the Australian region.

This striking difference in the depths inhabited by one and the same species is, however, exceptional; and so is the wide range of geographical distribution which is here presented by a species occurring at great depths. The study of the bathymetrical distribution of the *Challenger* Polyzoa shows that "the extent of geographical distribution is to a considerable degree correlative with the bathymetrical, the wider geographical distribution being in most instances coincident with the shallower depths."

To this law another striking exception is afforded by the beautiful genus *Catenicella*, a genus very rich in species, which, though from comparatively shallow water, are almost exclusively confined to the Australian region.

The thirty-six beautiful plates which illustrate the Report are all that could be desired. Clearly and faithfully drawn, they place in the hands of the zoologist facilities for the determination of the species which, with the descriptions in the letterpress, leave no excuse for erroneous diagnosis.

Though the Report is confined to the species obtained during the expedition of the *Challenger*, the number of these is so large, and the descriptions and figures so exact, that the work will possess a classical value, and be found indispensable by every student of the Polyzoa.

G. J. A.

OUR BOOK SHELF

On the Healthy Manufacture of Bread. A Memoir on the System of Dr. Dauglish. By Benjamin Ward Richardson, M.D., F.R.S. (London: Baillière, Tyndall, and Cox, 1884.)

THIS pamphlet is another of Dr. Richardson's labours in the cause of public health. It deals mainly, as the title implies, with healthy bread, and especially with the system of the late Dr. Dauglish of Malvern for baking what is now generally known as aërated bread. The advantages of the aërated process are stated by the author to be that the destructive influence of fermentation is prevented. There is no chemical decomposition of the flour whatever, and therefore no loss of material, while the rising of the dough is just as effectively carried out. The aërated bread contains, therefore, all the gluten and all the albuminous food of the wheat, out of which the living tissues are constructed, as well as the food which ministers to the animal warmth and vital activity. Moreover, much labour to the baker is spared, and the kneading by hand is wholly dispensed with—a matter of some consideration to delicate or fastidious persons. The gradual steps by which the process has been worked out, from the incubation of the idea in the brain of Dr. Dauglish to the modern aërated process of baking are fully traced by Dr. Richardson, who describes also the different effects of fermentation and aëration on the different qualities of flour, the economic and sanitary advantages of the new system to the workmen (by no means the least important part of the subject, as those who recollect Mr. Lakeman's report on the London bakeries, and who read Chapter IX. of this little work, will acknowledge), and the public advantages of the aërated bread in relation to health. An appendix contains a brief memoir of Dr. Dauglish.

Proceedings of the Edinburgh Mathematical Society. Second Session, 1883-84.

OUR readers have seen from time to time in our "Society" Notices the titles of papers read before this young but from the outset vigorous body, and must have often wished for a more intimate acquaintance with their contents (as the odoriferous steam issuing from the cookshop tempts the hungry "Arab" to enter and feed). We are glad to find, from the volume before us, that the Society is in a position to print its *Proceedings*, for we now know how interesting the papers are. They are not, like some other papers nearer home, caviare to the general, but they deal with matters which come home to every mathematical teacher. Mr. Mackay writes on the circles associated with the triangle, viewed from their centres of similitude; Mr. Muir, on the condensation of a special continuant; Dr. Macfarlane, on voting; Prof. Chrystal, on an application of matrices to spherical geometry, on a problem in partition of numbers, &c. Mr. Allardice furnishes some useful notes on spherical geometry and trigonometry; Mr. Browning, some illustrations of harmonic section; Mr. Barclay, notes on the teaching of elementary geometry (abstract only), and Mr. Traill, proofs of the theorems as far as "Euclid" i. 32, from first principles. Other papers are: a good concise account of Pascal's "Essais pour les Coniques" by Mr. Macdonald; the hypothesis of Le Bel and Van't Hoff, by Prof. Crum Brown; on the representation of the physical properties of substances by means of surfaces, by Mr. Peddie; and a joint account of the problem "La Tour d'Hanoi" (one of displacements), by Messrs. Allardice and Fraser. With these *Proceedings* are bound up Prof. Tait's introductory address on Listing's "Topologie," which, our readers will remember, has been published in the *Philosophical Magazine* (January 1884, pp. 30-46, with plates), and Mr. Muir's Presidential Address entitled "The Promotion of Research; with Special Reference to the Present State of the Scottish Universities and Secondary Schools" (delivered February 8, 1884).

Elementary Text-Book of Trigonometry. By R. H. Pinkerton, B.A. (London: Blackie and Son, 1884.)

THIS elementary text-book of 176 pages contains all the essentials for obtaining a knowledge of trigonometry proper. It might be used either by those who desire merely a thorough grounding in the elements, or, as a first book, by those who intend to take a full analytical course. The arrangement is good, the text well written, and the examples, worked and unworked, are numerous and judiciously chosen. The introductory chapter on the measurement of angles is particularly commendable. We should prefer, however, not to write "$\pi/3$ radians" but "$\pi/3$ radian," reading it "*pi*-thirds of a radian." It may be suggested also to a writer who has the courage to introduce reforms, whether the time has not come for dispensing with the so-called *tablogsines, tablogcosines*, &c., and using only logsines, logcosines, &c. *Tabular* log functions are, according to our experience, well-meant aids which only hinder.

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.*]

Iridescent Clouds

ON Thursday evening, December 11, about fifteen minutes after sunset, in the south-west direction as seen from the Royal Observatory here, were two rather large clouds about 10° or 12° high, and below them several much smaller ones, all of them of the most brilliantly iridescent colours and nothing but bright colour, of a kind I do not remember to have seen before, though they were not improbably like some described by several of NATURE's correspondents last year.

The principal cloud, some 5° or 6° long and 2° or 3° across, exhibited a diagonal band of glowing green, passing through blue into exquisite violet on either side, while it was fringed nearly all round by dull red.

The second largest cloud, a little below and rather to the eastward of the first, exhibited all the same colours in similar diagonal bands, but unconformably with the places of the bands of the first produced down to it; though both may have had their bands at right angles to a ray from the sun long since set, but directed on their centres. The sky behind them and all around was singularly dark and sombre, so that these iridescent clouds, in the brightness and richness of their colouring, reminded one more of mother-of-pearl inlaid in a black tea-tray than any ordinary sunset sky.

The smaller clouds of the same kind lower down gradually lost the central green band and passed into yellow and orange, but were still phenomenally bright specks of luminous material on the dark general background. All this towards the south-west; while west and north-west the sky was nearly clear, and exhibited, in a sunset-illumined sky "proper," a fairly fine but quite ordinary set of thin cirro-stratus rolls of cloud, warmly coloured on one side and cold-gray shaded on the other, like any corporeal body in the same exposure.

Lower down still on the horizon was a heavy cumulo-stratus cloud, which the west wind presently brought up to eclipse the green and blue iridescent clouds, proving that they were higher than it, though not so high as the dark cirrus haze to the south-west that had served so well to set forth their brilliant and unusual colouring. C. PIAZZI SMYTH

Edinburgh, December 13

A STRIKING phenomena, apparently a new phase of the cloud-glows, was widely witnessed here on the 13th, and I myself noticed it, though on a much less scale, and in the north

east, on the 11th. About 3.30 p.m. the upper edge of a dark, very lofty haze cloud, stretching almost straight from alt. 15° in the south-south-west, to about alt. 20° in the north-west, was fringed with prismatic colours, in parts thrice repeated, separating the dark haze cloud from a bright white haze, like that often seen of late near the sun, which itself was nearly setting. The luminous haze was widest, about 5°, above the sun, and was also, but far more faintly fringed, with a hazy blue sky above. It lasted until 4.20, but at 4.10 the dull cloud was a deep violet, and the bright haze a steel blue. They both seemed to disappear in the dusk, but the bright glow reappeared about 4.40 p.m.

On both occasions the phenomenon lasted long after sunset, and the cloud was quite distinct from the feathery cirri on which, if near the sun, one so often sees prismatic effects. On the 11th the two small oblong clouds affected had the colours in regular bands, in one round a dark, in the other round a bright centre, reminding one of Newton's rings. J. EDMUND CLARK

York, December 15

The "New" Volcanic Island off Iceland

KNOWING the interest which, from their association with the later years of the Gare-fowl's existence, I have long taken in the islets lying off the south-west point of Iceland, Prof. Lütken has most kindly sent me a copy of the Copenhagen newspaper *Dagbladet* for the 7th of this month, containing an article by Capt. C. Normann of the Danish Royal Navy, in command of the ship *Fylla*, during her recent scientific voyage to Greenland, a distinguished officer and an eminent authority in Arctic matters. The article is long—too long for my powers of translation—but, with the friendly help of a Danish young gentleman of this University, I have mastered it, and find it exceedingly entertaining. It treats of the island which, as already announced in these columns (vol. xxxi. p. 37) and elsewhere, is said to have been lately thrust up, as other islands have before been known to be upthrust (at least temporarily) in that volcanic neighbourhood. According to the statement of Mr. Consul Paterson (*loc. cit.*) it is said to have been first observed by the lighthouse-keeper at Reykjanes on July 29; and it would seem that news of its apparition speedily reached Reykjavik; but unfortunately, says Capt. Normann, there was then no ship there available to make search for it. Rather less than a month later, however, the *Dupleix* and *Romanche*, of the French navy, arrived at that port, and the commander of the former, animated with the laudable desire to determine the position of the new island, and if possible to effect a landing upon it, resolved to do so in the course of his homeward voyage, and, with that intent, set out after a short delay. To the surprise of all at Reykjavik, he, as he subsequently informed the French Consul there, could find no trace of the object of his search on August 24. On the departure of the *Dupleix*, however, the commander of the *Romanche* dispatched two of his officers, equipped with proper instruments, by land to Reykjanes, thence to take the bearings of the new island. On August 26 they undoubtedly saw an island corresponding in position with what they expected to see, and reported accordingly to Reykjavik, where Capt. Normann's *Fylla* had arrived on the 25th, on her homeward voyage. The Danish commander, equally enthusiastic in the cause of scientific discovery, accordingly left Reykjavik early on the morning of the 27th, and soon after mid-day his ship was off Reykjanes, whence he pursued a course along the northern side of the bank from which the Fowlskerries emerge, seeing nothing of the new island, it is true, but that time the weather was thick. However, he passed cautiously (as well became a navigator in water liable to volcanic upthrusts) along the whole range, and even beyond the furthest of the emerged skerries—the Geirfugladrángr or Grenadeerhuen, when it began to grow dark, and also to blow. Next morning he turned back, running still along the northern side of the bank. It was clear and beautiful weather, and the rock just named, as well as Eldey or Melsækken, the innermost of the range, stood out in bright sunshine. Breakers marked the position of the old Geirfuglasker, which sank beneath the waves in 1830, and the neighbouring coast of Iceland, as well as the inland fells, was plainly visible, but nothing in the shape of a "new" island was to be seen. So he came back to about midway between the Meal-sack and Reykjanes—the lead giving a depth of eighty fathoms of water. Thence, thinking that after all there might be some mistake in the reported position of the island, he put his ship's head about, and ran along the southern side of the bank. But again was he disappointed, for no new island met the anxious gaze of all on board.

It remains to be said that a day or two later the *Romanche* came to the same spot, but alas, nothing new was to be found—not even a pumice-stone by which, as Capt. Normann remarks, all decent volcanic islands are expected to indicate their position, even when submerged. Still, the form of the "new" island went on gratifying the vision of the lighthouse-keeper at Reykjanes; and, as Mr. Paterson has told us (*loc. cit*) it was seen by him through a telescope on September 9. I do not for a moment doubt that both he and previously the officers of the *Romanche* saw what was pointed out to them as the "new" island; but, from all that has been said before, and from my own knowledge of the locality, gained during a two months' stay at Kykjuvogr and the neighbourhood in 1858, neither do I doubt that Capt. Normann is perfectly right in asserting that the supposed "new" island is a very old friend of mine—the Geirfugladrángr or Grenadeerhuen before mentioned—the outermost of the emerged Fowlskerries, and our best thanks should be given to that gallant and scientific officer for dispelling the mystery. ALFRED NEWTON

December 14

Overpressure in Schools

I HAVE carefully read Dr. Gladstone's article on over-pressure. Over-pressure is due more to the action of inspectors and teachers than to the requirements of the Code; *e.g.* a teacher in my district has a first class in an infant school, the children being all about six years of age. Owing to the unusual brightness of the children and their regular attendance, the teacher has had no difficulty in training her class in the three R's for first standard work, which, under ordinary circumstances, they could not do until they were a year older and in a higher class. What is the result? An inspector visits that school, finds the children can do much more than is required by the Code, and, without reflecting *how* this has been accomplished, he gives a good report for that class. The following week he visits another school in the same neighbourhood and examines a similar class; these children, he finds, are not so far advanced as those examined the previous week, and therefore he makes a less favourable report, thinking that the teaching-powers are not so good, although the children have really been quite as well taught, and are fully up to the requirements of the Code. When the report comes to the latter school, the teacher cannot understand how it is that the class has not gained the report it deserved, until by and by she hears indirectly what has been accomplished at the school previously examined. Then she says, "If they can do it at that school, we can do it here." Hence *over-pressure*. If inspectors did not examine beyond the Code, teachers would not train children for a higher standard than the Code requires.

Dr. Gladstone says, "Teachers used to be paid partly from the Government grant, and thus had a pecuniary incentive to press forward the feeble so as to insure a pass." That is quite true, but teachers will be found in the future to be quite as anxious as they were in the past as to the results of the examinations. They know quite well that now the salaries are fixed, and do not depend on results, it would be said directly that they did not take the same interest in their work as formerly if perchance the schools passed a less favourable examination, and on this point they are keenly sensitive.

Dr. Gladstone advocates "varied and appropriate occupations in infant schools." It is no doubt very monotonous for little children to be kept closely to the study of the three R's, but there are very few who really like the Kinder Garten as taught in our infant schools, unless it be the Kinder Garten games: it is *not* play, but hard work for such little ones to do. It is impossible for the work to be taught successfully when a teacher has too large a class under her control; in Belgium an assistant mistress has a class of fifty children with a pupil teacher to help her, and then no doubt Kinder Garten can really be carried out with beneficial results to the children, but in the London Board schools, where an assistant teacher has seventy or eighty or even more in her class *without help*, how is it possible to obtain good results? If Kinder Garten is to be taught with success there ought to be a Kinder Garten mistress appointed by the Board to teach it to the children, and I think there are very few teachers who would not agree in this. Of course it would entail extra expense, but it would be an expense more beneficial to the

children than some that are indulged in. These I believe to be the views of nearly all teachers as well as those of myself, who am but a SCHOOL TEACHER

December 8

The Tokio Earthquake of October 15, 1884

AT 4h. 21m. 54s. a.m. the inhabitants of Tokio were awakened by a sudden and violent earthquake. In Yokohama, which lies about sixteen miles south-west by south from Tokio, the disturbance was noted at 4h. 21m. 38s., that is to say, sixteen seconds before it was felt in Tokio. The chief source of error in these time-records—if error exists—will probably be due to observers at different stations having noted time at different portions of the disturbance, the length of which, as determined by the sensations of those who made the records, was about one minute, but, as recorded by a seismograph, between five and six minutes. At the commencement of the disturbance four complete waves were described in three seconds, but at the end of the disturbance the motion became so slow that each wave occupied from two to three seconds. From a record taken by Mr. K. Sekiya, a gentleman whose especial duty it is to attend to the earthquake phenomena of this country, it would appear that the maximum range of motion may have reached 42 mm. The maximum acceleration per second per second was about 500 mm., that is to say, the intensity of the earthquake or its destructive power was similar to that which would be experienced by a building standing on a carriage which was suddenly caused to move with a velocity of about one foot and a half per second, or if, such a carriage having gradually acquired such a velocity, it had been suddenly arrested. The result of the earthquake was to overturn a few chimneys in Yokohama and to crack one or two in Tokio.

Our last severe earthquake was on February 22, 1880. On that occasion in Yokohama very many buildings lost their chimneys and were unroofed, whilst in Tokio the damage was chiefly confined to loosening tiles and shaking down plaster. Had our buildings in Japan been constructed like those in England, it is probable that this last shake would have caused about the same amount of damage as that which was so recently caused by the late disturbance in Essex. From the observations on direction, coupled with what has been said about time, it seems that the earthquake had its origin in Yedo Bay, at or about the same point as that which was determined for its severe predecessor.

It may here be remarked that nearly all the heavier earthquakes which are felt in Tokio and Yokohama practically have had a common centrum. They are not large earthquakes as measured by the area shaken, but they are severe because we are near to their origin.

The earthquake of 1880, according to a record furnished by one of Palmieri's instruments, had an intensity of 78°, whilst the recent earthquake, the actual intensity of which, as deduced by its destructive effect, was much less, is given as 95°.

These intensities measured in degrees really indicate the height to which a certain quantity of mercury in a bent tube was caused to wash—the height of the "wash" being measured by the turning of a pulley connected by a string to a small weight floating on the surface of the mercury. It would seem evident that the magnitude of the records obtained in this manner must among other things depend upon the duration of the earthquake, the period of its waves, and the depth of the mercury contained in the tube. For reasons such as these, records like those just given cannot be regarded as anything more than roughly approximative.

In connection with the remarks made on the amplitude it may be stated that the seismograph by which the record was taken was situated on soft soil in the flat portion of Tokio. This amplitude, had it been recorded on the hard ground of a hill, probably would not have exceeded 25 mm.

One of the most remarkable points connected with this disturbance were the changes in level as observed by the displacement of specially arranged pendulums, which took place before the shock, and again about six hours afterwards.

J. MILNE

Large Meteor

ONE of the largest meteors that I have seen for some years appeared at 7h. 15m. 15s. this evening. It began as a speck, north of Vega, at about 4° greater altitude than that star. The course was perpendicularly down, only disappearing by passing below the horizon. It was 2° east of Vega on descending to the altitude of that star, and by that time had increased to fully a quarter the apparent size of the moon, and this size it maintained whilst above the horizon. The colour was an intense blue, and there was left a streak of orange-red elongated separate stars in its track, and this streak was about 1° in length, although the separate stars of which it consisted disappeared almost as rapidly as they were formed. The stars, like the meteor, increased in size and brilliancy from a mere point, and instantly vanished on attaining their maximum brightness. Each moved perpendicularly down for the length of about half a degree, and left a continuous momentary streak. None of these stars were seen within half a degree of the meteor, and their ignition was confined to the centre of the meteor's path. Their size was tolerably equal, being about that of a second-magnitude star. The speed of the meteor was unusually slow, it being visible for nearly six seconds. The shape was circular in front and cuneate behind (bluntly conical). Its brilliancy was great, considering the presence of a nearly full moon.

Shirenewton Hall, near Chepstow, E. J. LOWE

December 4

The Cost of Anthropometric Measurements

ALLOW me to correct an absurd typographical blunder in the account of my anthropometric laboratory at the Healtheries, which appears in Mr. Ernest Hart's lecture at the Society of Arts. It originally occurred in the *Journal* of the Society of Arts, whence it was copied into your columns (p. 142) last week. The effect of the error to which I refer is to make the statement that the cost of measuring each person at the laboratory in seventeen different ways was 3*l*., whereas it should have been 3*d*. The subsequent argument, based on the extreme cheapness of the process, becomes in consequence unintelligible. I write myself to make the correction, because the part of Mr. Ernest Hart's address which refers to the anthropometric laboratory was written for him, at his request, by myself. I regret I had not an opportunity of revising it in proof.

FRANCIS GALTON

The Northernmost Extremity of Europe

As "a Norwegian" now fully admits that the pretended discovery of Capt. Störensen is no discovery at all, but an elementary fact well known and long known to Norwegian geographers, I need not discuss that question any further, but I must protest against his reference to Sönsberg's "Norge," which is the joint production of some of the most eminent men in Norway. Sönsberg is the *editor* and *publisher*.

Amongst the writers who have co-operated to produce the national "Handbook" are the following:—Lieut.-Col. Broch, Chief of the Geographical Survey of Norway (he is the largest contributor, and the writer of the words I quoted), Prof. H. Mohn, Prof. T. Kjerulf, Prof. Rasch, Prof. L. K. Daa, Sorenskriver, H. Thoresen, J. B. Halvorsen (the well-known writer), Beaureauchef Kjer, and Secretary Mohn, Th. Bœck (Royal plenipotentiary), J. N. Prahm, Capt. Scharffenberg, E. Mohn, Lieut. Flood, Capt. Overgaard (the Inspector of Forests), Hörbye, Lieut. Langeberg, and Mr. Langeberg, K. Lassen, Dr. Kahrs, Lieut. Solem, O. T. Olsen, Capt. Bang, Capt. Haffner, and Sörenskriver Nannestad.

All these names are given in the preface, and the contributors of each carefully specified. This was known to "A Norwegian" when he wrote his last letter, for he refers to that same preface, and yet asserts that Sönsberg "never claimed the least *geographical* authority for a faulty and crude guide to tourists" (his own italics). That preface is written for the express purpose of claiming such authority and thanking the authors. It makes special claim in a special paragraph of the *geographical* authority of the "head of the Geographical Survey," Lieut.-Col. Broch, whose name, Sönsberg says, "offers a sufficient guarantee of correctness."

The anonymous "Norwegian," in further disparagement of the book, states that in this preface "the author himself says that for reasons explained it has many faults." I will quote this very damaging confession. It is as follows:—"A few errors and misprints will be found here and there." A list of them is given. After this the flippant misrepresentation of my pretensions in the last paragraph of the letter is not surprising, and demands no further notice.

I make this protest, knowing that NATURE is largely read by

well-educated Norwegians (who all read English as a matter of course). They cannot fail to be indignant if such unjust treatment of a national work, which genuine Norwegians understand and appreciate, is allowed to pass unrefuted. Beside which, Englishmen in search of available and reliable information concerning Norway might be grossly misled.

W. MATTIEU WILLIAMS

APOSPORY IN FERNS

A PARAGRAPH in the report in NATURE (p. 119) of the meeting of the Linnean Society for November 20 last contained what is, to the best of my belief, the first publication of one of the most interesting botanical observations which has been made for some time. As it is quite possible that this brief record may escape the notice of a good many botanists, I venture to give the matter a little more prominence.

At the meeting referred to, Mr. E. T. Druery made a second communication (the first did not, I think, receive any record) upon a singular mode of reproduction in *Athyrium Filix-fœmina*, var. *clarissima*. In this fern the sporangia do not follow their ordinary course of development, but, assuming a more vegetative character, develop more or less well-defined prothallia, which, according to Mr. Druery's observations, ultimately bear archegonia and antheridia. From these adventitious prothallia the production of seedling ferns of a new generation has been observed to take place in a perfectly normal way.

Mr. Druery very kindly offered at the meeting to supply me with some of his material. This reached me on November 29, and I immediately placed it in the hands of my friend Mr. F. O. Bower, who was engaged in other research connected with the vascular cryptogams in the Jodrell Laboratory of the Royal Gardens. Although in the material sent me the abnormal development of the sporangia had not proceeded very far, Mr. Bower obtained evidence which, as far as it went, was entirely confirmatory of the correctness of Mr. Druery's observations. With appropriate cultural treatment prothalliform bodies have already made their appearance, but have not yet reached the stage at which archegonia and antheridia are developed. They are, however, furnished with root-hairs.

This is, however, not all. Mr. Bower placed himself in communication with Mr. Druery, and paid a visit to his collection of ferns. By the kindness of this gentleman he was allowed to bring away specimens of another fern (*Polystichum angulare*, var. *pulcherrima*) which altogether eclipses the *Athyrium*, remarkable as that is. In the *Polystichum* the apex of the pinnules grows out into an irregular prothallium, upon which Mr. Bower with little difficulty was able to demonstrate at Kew the existence of characteristic archegonia and antheridia. In this case the production of the prothallium is not even associated locally with the sporangia, but it appears as a direct vegetative outgrowth of the normal spore-bearing plant. The oophore is a mere vegetative process of the sporophore, a suppression of the alternation of the two generations which exceeds even that which obtains in the flowering plant.

Mr. Druery's discovery, for which I have borrowed Mr. Bower's convenient term Apospory, is the direct converse of the Apogamy in the fern, discovered by Prof. Farlow. In this the sporophore is a vegetative outgrowth from the oophore. The parallel phenomena in the life-history of the moss have been known for some time. But this point and all detailed observations at present available will be dealt with in the communication which Mr. Bower will make at the meeting of the Linnean Society this (Thursday) evening. While every merit must be attributed to Mr. Druery for the first observations of this important fact, he has with great liberality allowed Mr. Bower free liberty to discuss the histological and theoretical points involved.

The obvious possibilities of discovery with regard to the reproduction of ferns may now be regarded as exhausted. It may be interesting to give the dates of the different steps:—

1597	Gerarde	Observed seedling plants near parents.
1648	Cæsius	Sporangia.
1669	Cole	Spores.
1686	Ray	Hygroscopic movements of sporangia.
1715	Morison	Raised seedlings from spores.
1788	Ehrhart	Prothallium.
1789	Lindsay	Germination of spores.
1827	Kaulfuss	Development of prothallium.
1844	Nageli	Antheridia.
1846	Suminski	Archegonia.
1874	Farlow	Apogamy.
1884	Druery	Apospory.

Royal Gardens, Kew W. T. THISELTON DYER

MODERN ENGLISH MATHEMATICS[1]

YOU will remember that two years ago it was announced from this chair that the Council had settled the conditions under which the De Morgan Medal should be given, and that the first award would be made at the anniversary meeting of 1884.

I have now to make the announcement that the Council has decided that the first medal should be given to Prof. Cayley, in acknowledgment of his work in the theory of invariants.

As this is the first award of the medal, I may remind you of its origin. Soon after the death of De Morgan, some of his admirers started a subscription for the double purpose of having a bust executed and founding a medal to be given in his memory. The *bust* now adorns the library of the London University, where also his valuable collection of books is preserved. The *medal* was offered to the Mathematical Society, and its Council accepted the honourable duty of determining its award. There is a peculiar fitness in the medal being thus connected with our Society; for this Society was founded with the active co-operation of De Morgan by a number of his advanced students, among whom his talented son George, who died soon afterwards, took the lead. De Morgan himself was the first President, and our *Proceedings* begin with a very characteristic opening speech by him.

The medal is to be given for eminent original work in mathematics, and no more fitting memorial than this could in my opinion be devised for a man who spent his whole life in carefully preparing the foundation for such work by his teaching and his writings.

De Morgan was pre-eminently a teacher. His most original work does not so much increase our stock of mathematical knowledge, but is concerned with mathematical reasoning, and with exact reasoning in general.

In the opening speech referred to, De Morgan himself divides exact science into two branches, *the analysis of the necessary laws of thought*, and *the analysis of the necessary matter of thought*. His own work belongs to the former. He was a logician much more than a mathematician in the ordinary sense of the word, and when reading his mathematical works I have always had the feeling that he studied mathematics not so much for its own sake as on account of the logic contained and exemplified in it. I once made this remark in the Professors' Common Room of University College, when an old colleague of his turned round and said, "You are quite right, he told me so himself."

In this work De Morgan did not stand alone. We may almost take him as a type of his period. It has often struck me as a noteworthy fact that in England, after the long pause in mathematical activity, the work taken first in hand was investigation into the very bases

[1] An address delivered by Prof. Henrici, F.R.S., at the annual meeting of the London Mathematical Society (November 13), on the occasion of presenting the De Morgan Memorial Medal to Prof. Cayley, F.R.S.

of mathematics and more particularly into mathematical reasoning. These investigations became partly a mathematical analysis of logic itself and partly a logical analysis of the laws followed by the symbols and operations used in mathematics. De Morgan worked in both directions; we have his "Formal Logic" and his "Double Algebra." Operations were studied quite independently of the meaning given to the symbols. Originally the symbols stood for concrete things, and each operation had its concrete meaning. At present symbols are sometimes used without giving them any meaning whatsoever, and without defining them at all, and then the operations for combining these symbols are arbitrarily defined, with the sole restriction that they do not contradict each other.

Each new set of operations thus establishes a calculus. If afterwards any entities can be found which can be combined by operations answering the characteristics of the operations used in the new calculus, then the latter may be employed for a theory of those entities, and its results will allow of an interpretation. These entities themselves may be anything, concrete things, or logical concepts, or ordinary algebraical quantities.

Thus the ground was already prepared for greatly extending the realm of algebra and the scope and power of algebraical operations, when the genius of Prof. Cayley conceived the idea of invariants [1] which has given rise to that marvellous growth of our science which has suddenly brought England again far to the front.

It was known from Gauss's investigations that for quadratic expressions a certain combination of its constants, its determinant, exists, which has the following property.

If the quadratic expression be transformed into another by a linear substitution, then the determinant of the transformed expression is obtained from that of the original expression by multiplying it by a factor which depends solely on the substitution used.

Afterwards Eisenstein discovered that a similar theorem holds for a cubic expression of one variable. These isolated facts suggested to Cayley that combinations of constants having this property must exist for all algebraical expressions. The problem was how to find these.

The manner in which this has been solved I need not restate here, but I wish to call your attention to the fact that the symbolic methods worked out by the school of mathematicians referred to have been of the greatest use in the development of the theory of invariants, which could scarcely have been brought to its present perfection without it.

It would be an impertinence for me to say much either in praise of Prof. Cayley's work or in justification of the Council's choice. Prof. Cayley has invented and worked out the theory of invariants, and in steady life-long work connected it with nearly every branch of mathematics, enriching everything he touches, and everywhere throwing open new vistas of future work.

The Council of the Mathematical Society in selecting Prof. Cayley as the first recipient of the De Morgan Medal, and thus doing homage to his genius, did so not so much with the idea that it could add honour to his name as that they might add honour to the medal by connecting his great name with it, and thus increase its value for all future recipients. And it is befitting that a body like the London Mathematical Society should give formal expression to the reverence and admiration in which it holds the greatest among its members.

[1] Prof. Cayley, when returning thanks, distinctly waived the claim of priority in favour of the late Prof. Boole. See also Salmon's "Higher Algebra," p. 294.

PHYSICAL GEOGRAPHY OF THE MALAYAN PENINSULA

As some remarks of mine on the mountain system of the Malayan peninsula have already appeared in NATURE, perhaps the following summary of the results of ten months' explorations in the State of Perak will be interesting.

The State of Perak is comprised between the sea (Straits of Malacca) and the main central chain which runs along the centre of the peninsula. Its boundaries are, roughly: north, the River Krian; south, River Bernam; west, the ocean; east, the main central chain. The geology may be briefly described as consisting of—

(1) An immense granite formation, rising into extremely sharp and precipitous parallel ridges having nearly a meridional direction. This granite passes frequently into slates and schists. The prevailing colour is blue.

(2) A Palæozoic formation of slates, mottled sandstones, and clays, forming outliers or detached portions. It is found most abundantly at the foot of the ranges, whence it usually dips away conformably to the slopes of the hills and mountains. It has evidently been subject to great denudation.

(3) Limestone in detached outliers, or isolated hills of precipitous character, showing much denudation. It is stratified or crystalline. No fossils have been found yet, but is probably of Palæozoic age. From its wide extension throughout Perak, where it crops out in so many places, it may have once covered the whole of the granite and Palæozoic clays.

(4) Drifts and alluvium from the ancient streams and river beds. These are formed of the material from all the preceding deposits. All the tin deposits of the country are in these drifts. The ore occurs in a manner very similar to the alluvial gold in Australia, that is to say, in "leads," which are the ancient or modern river beds.

Above these alluvial deposits there is the usual alluvial surface soil, for the most part supporting a very dense vegetation.

The tin deposits hitherto found are all stream tin. No lodes have yet been worked, though there are some in the mountains round the sources of the Perak River. The ore is almost always cassiterite in small abraded crystals. It is of a peculiar blackish-gray or brown aspect. Any person with a little experience would be able to distinguish between tin sand from Australia and that of Perak. The former is rather rich in gems, such as sapphires, rubies, hyacinths, garnets, topazes, and zircons. I have never seen any in Perak; but there is a good deal of fluor-spar, tourmaline, and less frequently wolfram.

The most of the workings are on the western slopes at the foot of the mountains. I cannot recall any instances of mines on the eastern slopes, but the wash or drift seems to have been greater on that side.

The matrix of the tin seems to be in the upper part of the granite at its junction with the Palæozoic clays. In the lower part of the clay there is also a small quantity of tin.

In the drift the tin is always found in nearly the lowest levels, lying in one or two strata from one foot to five feet thick. It is mingled with fine drift sand and gravel. Its position is, I think, due to the repeated sifting and washing it has been subject to in the stream bed. But as it is generally covered by from ten to thirty feet of material destitute of tin, the inference is that only one part of the granite was very rich in the metal.

The stream tin deposits lie upon (1) kaolin clay, or partly decomposed granite; (2) granite; (3) Palæozoic sandstones and clays. In the latter case the stream has come from the denudation of a portion of the same strata on the upper slopes of the hills.

On the highest granite ridges, or those above 5000 feet, there is found a distinct vegetation. Three or four of the genera are Australian (*Melaleuca*, *Leptospermum*, *Podocarpus*, *Leucopogon*), and two of the species (*Leptospermum* and *Leucopogon*) are common Australian forms. Similar facts have been observed in Borneo, but I have

not heard that they had been observed in the Malay peninsula. Nothing of the kind is seen on the lower slopes of these mountains even 100 feet below the summit. This Australian flora may be the relics of an ancient flora, which once included the Eastern Archipelago. But it does not appear why the species should be confined to the tops of the mountains. They grow in a much warmer climate in Australia.

There are no table-lands in Perak; the mountains are all sharp ridges. There is not the slightest sign of any recent upheaval of the coast-line, while the evidence of subsidence is equally absent. But the land is rapidly encroaching on the sea owing to the immense alluvial wash brought daily from the mountains in this land of heavy rains. Thus the shores are fringed with large mangrove swamps which yearly extend, and the Straits of Malacca form a shallow sea full of mud banks and shoals. The seas are consequently rather poor in certain forms of marine life to which muddy sediment is unfavourable.

Though the tin has been worked for centuries, only a comparatively small portion of the country has been worked out or worked at all. I consider that the deposits in Perak are practically inexhaustible. The mining industry is almost exclusively in the hands of the Chinese, who are almost the perfection of colonists for a country like this. Malays are not good miners. Gold is found associated with tin, but small, scaly, in sparing quantity, and only in one or two places.

There are only two instances known to me of the occurrence of recent volcanic rocks: one is in the Kinta River valley, the other on the western face of a small group of mountains not far to the east-south-east of the island of Penang, and near the Karau River. The rocks appear to be basaltic dykes, but the thick jungle and surface weathering prevented a proper examination.

The mountain system of this native State consists of detached groups of mountains which cover the west side of this part of the peninsula, an almost continuous range close to the sea in the Straits of Malacca. These groups of mountains form parallel chains about thirty miles long, with a direction a little oblique to the true meridional line. Sometimes they are wholly detached groups, so as to allow rivers from the eastward to pass between them. Such an instance is seen in the ranges between the Kinta and Perak rivers. This group terminates to the north so as to allow the River Plus to pass to the westward and to the south so as to give an outlet to the Kinta. Both rivers join the Perak River, which flows round another group (Gunong Bubu), and then flows into the sea in the Straits of Malacca.

The islands of the coast, such as the Dindings and those off the State of Keddah (Pulo Leddas, Pulo Lankawi, and Pulo Buton, known as the Buntings), are probably portions of similar groups, and so are Pulo Penang and the attendant islands. These groups and those on the mainland usually run in sharp parallel ridges, variously modified by oblique spurs, which at times connect the main chains forming watersheds which throw off small streams north-east and south-west.

The following are the principal groups of mountains known to me, beginning at the south:—

Dindings Islands.—Off the coast in front of the Dindings River (*Dinding*, Malay for boundary or partition), lat. 4° 12′ N., there is a series of islands of moderate elevation not exceeding 1000 feet in their highest peaks. They are granite, rich in tin, with a little fine scaly gold. They are densely clothed with jungle, and have fringing reefs of coral. I have visited three or four of these islands, and they are all of the same character.

On the mainland there is a cluster of hills called the False Dindings, from the fact that at a short distance they look like islands. These are also granitic, and tin occurs in the alluvial beds derived from them. They give rise to small rivers, such as the Dindings and its tributaries.

Gunong Bubu.—North-east of this group, but quite detached from it, is a series of parallel mountain ridges with a uniform trend of north-north-east. These ridges are eight or nine in number. The central one is the highest, culminating in Mount Bubu, a fine peak of about 5600 feet elevation. All the ridges are granitic, with occasional patches of metamorphic schists, all more or less rich in tin. A remarkable character in this range is that all the ridges are extremely steep, and frequently interrupted by granite precipices of 1000 feet and more. Gunong Bubu is only accessible in one or two places, the summit being surrounded by escarpments of rock of great height.

Many small streams join the Perak River and the sea from this range. The Kaugsa and Kenas both flow into the Perak to the eastward. In an ascent made by me to the summit of Mount Bubu I was able to explore some of the sources of both these rivers, which afford a home to many a rhinoceros, but few other animals except monkeys (*Hylobates*, *Semnopithecus*, and *Macacus*). The rivers descend many hundred feet in a series of cascades, giving rise to some of the finest scenery in the Malay peninsula.

North of Mount Bubu this group of ridges falls away abruptly, leaving a narrow pass (Gapis Pass) between them and the next group. This pass is about 400 feet above the level of the sea, and therefore too elevated to permit of any river outlet.

Mount Poudok.—In Gapis Pass, or rather at the eastern end of it, there is an isolated hill of highly crystalline limestone. It is an outlier of the great Palæozoic limestone formation already referred to. It is about 400 feet high, and quite precipitous. Its junction with the granite or Palæozoic clays is not visible. Its bright blue and red precipices crowned with dark-green jungle make it a singular and beautiful object, but there are many similar in the State.

Mount Ijau.—North of Gapis another group of ranges succeeds, culminating in Mount Ijau (Malay for green) at about 4400 feet above the sea. This cluster of ridges appears to me to be of nearly the same dimensions as the Mount Bubu group, but not so high by 1000 feet or so. I estimate that each group is from twenty to twenty-five miles long, and fourteen to sixteen broad, covering an area of about 400 square miles. This, however, is only a rough estimate formed from views I have been able to obtain from the summits of other mountains. I have not been able to examine personally the termination of the Mount Ijau group on the north. From the sea one is able to perceive a distinct pass like that of Gapis. It is probably about the same height, and does not form the outlet of any river from the eastern side.

Kurau Group.—North of Gunong Ijau is another group, which I do not know how to distinguish except that it forms the watershed of the Kurau River. Its highest point is a mountain which is also called Ijau by the Malays. I have not ascended the peak, but it seemed to me less elevated than Mount Ijau to the south.

Mount Inas.—What the Malays of Keddah call Mount Inas is the highest point of another detached group north of the Krian and Selama Rivers. I have been within a few miles of the foot of this mountain, and it seemed to me to be somewhat over 4000 feet high, and the highest point of an isolated group of ridges.

Keddah Peak.—North of Mount Inas, in the State of Keddah, there is, close to the sea, a detached group of mountains, at the foot of which the Keddah River flows. Keddah Peak is the highest summit,—probably over 4000 feet high. This is in what is called Lower Siam, in which I have only travelled to a very trifling extent north of the Krian River, the boundary of Perak State. In the north of Perak, near Patani, we have other groups of mountains. An Italian explorer named Bozzolo, who

has lived many years in Siam, assures me that he has travelled round the Gunong Kendrong group at the head of the Perak, and that it is quite detached from any other hills.

Perak River.—The whole of these groups are sufficiently connected to prevent any drainage from the central range flowing directly to the west coast of the peninsula. Thus the Perak River, which has its sources in the Keddah and Patani Mountains flows to the southward for over 180 miles. In its course it is joined by two important rivers from the eastward, namely, the Plus and Kinta.

Plus River.—The Plus River has its sources in the high mountain groups east of Mount Inas, and in the main range. It flows round the southern end of a group called by some the Bukit Panjang Range, and then joins the Perak.

Kinta Ranges.—South of this junction is a group of mountains called by some the Kinta Ranges. This group is about twenty-five miles long. It is perfectly detached from all the others, having a generally north and south direction, but sending off spurs from its west side a little to the west of south. The group is entirely granitic, but on its lower slopes has thick deposits of limestone belonging to the formation already referred to, above and below which tin is worked. For about twenty-five miles this range separates the valley of the Perak River from that of the Kinta, which flows on its eastern side. The highest peaks rise to about 3750 feet above the sea, and give rise to small streams which all flow into the Perak. There is a remarkable uniformity in three or four of the highest summits, which are about the centre of the chain, Mounts Merah (red), Prungin, &c. They are all within a few feet of the same height. From these mountains the range falls away gradually to the south, and sends off two considerable spurs to the south-west. Where it ceases the River Kinta joins the Perak.

Kinta Valley.—The valley of the Kinta River is about as wide as that of the Perak. The river flows, like the Perak, on the eastern side of the valley. The eastern tributaries are many and important. On the sides limestone granite and schistose slates crop out. To the eastward there are many detached hills of limestone fronting the main central chain. They form very characteristic features in the landscape, from their precipitous outline, and the brilliantly coloured faces of blue, green, and bright red rock. They are also distinguished by a different vegetation.

Perak Valley.—The valley of the Perak River is bounded by the groups of mountains already described on the west: on the east by the Kinta Range, and north of the Plus by the Bukit Panjang Range. The river flows on the eastern side of the valley; this is owing to the many spurs and outliers on the eastern sides of Mounts Bubu and the Ijau Ranges. It seems as if there had been much less denudation on the eastern than on the western sides of the range. This may be owing to the prevailing rains falling more abundantly on the western than on the eastern sides of the mountains.

As a consequence of this the tin workings appear to be, with little exception, on the western sides of the ranges, where the waste and wash has probably been greater.

Batu Kurau.—Between Mount Bubu Range and Mount Ijau Range and the sea there are no hills except small outliers, mostly of Palæozoic clay, which have evidently belonged to the ranges. But north of the Larut River there is an isolated limestone mountain near the Kurau River. This is called Batu (stone or rock in Malay) Kurau. It is very similar to Mount Poudok in the Gapis Pass. It is quite unconnected with the main range, and rises out of the plain between the spurs which form the valley of the Kurau River. There is also a small detached range dividing the valley of the Krian River from that of the Kurau.

Main Range.—Of the main range I know but very little from personal observation, having only visited it at Goping, and at the limestone hills, where the tin is worked on the Diepang River. But I have travelled along the most of the Kinta Valley skirting the base of the range either on foot or in boats. I have also traced the valley of the Kampar River. The geology is like the rest of the country, mainly granite, slates, and limestone, with traces of basaltic rocks. The general structure of the range can best be judged from some of the mountains to the westward. It forms a most imposing boundary to the whole of the western horizon. In the north, about the sources of the Plus River, there is a mountain of rounded outline, probably over 6000 feet high. The range there declines a little, with a somewhat serrated outline, but generally over 3000 feet. At a point corresponding with the latitude of about the centre of the Kinta Range, or opposite the Gapis Pass, the chain increases in elevation to perhaps over 5000 feet, and in the distance is seen a peak which must be over 8000 feet high. I know no name for this hill, but it is the most distant mountain usually seen. South and west of this the chain rises into a grand cluster of peaks, the highest of which is over 7000 feet. This is Gunong Robinson. It looks higher than the Sugar-Loaf Hill as seen from Gunong Bubu, but then it is much nearer. From Gunong Robinson the range declines to the southward, but is still a bold series of picturesque peaks, many of which must be over 6000 feet. It has been asserted by more than one observer that to the south of the point where the range is lost sight of from Arung Pura, there is a high mountain occasionally visible higher than any other in the main range, and probably over 12,000 feet. This I have not seen, but I am convinced that there are many things yet to be learned about the most elevated portions of this mountain chain. Seen from any point of view, it forms a magnificent mountain prospect. Its mysterious unexplored recesses are rendered more gloomy than any scene in the world from the dense forest and the masses of vapour and cloud with which they are always clothed. A few savage Sakies are the only inhabitants. I may add that perhaps in no country in the world is exploration rendered so difficult from the extraordinary thickness of the jungle and the steepness of the mountain ridges which unceasingly cross the traveller's path.

Penang, September 8 J. E. TENISON-WOODS

A NEW APPLICATION OF SCIENCE

DR. FERRIER'S researches on the brain, to which we have often drawn attention in these columns, have lately received an application of the most startling character. What this application is cannot be better stated now than in the accompanying letter, signed "F.R.S.," which appeared in Tuesday's *Times*. We shall return to this subject next week.

"While the Bishop of Oxford and Prof. Ruskin were, on somewhat intangible grounds, denouncing vivisection at Oxford last Tuesday afternoon, there sat at one of the windows of the Hospital for Epilepsy and Paralysis, in Regent's Park, in an invalid chair, propped up with pillows, pale and careworn, but with a hopeful smile on his face, a man who could have spoken a really pertinent word upon the subject, and told the right rev. prelate and the great art critic that he owed his life, and his wife and children their rescue from bereavement and penury, to some of these experiments on living animals which they so roundly condemned. The case of this man has been watched with intense interest by the medical profession, for it is of an unique description, and inaugurates a new era in cerebral surgery; and now that it has been brought to a successful issue, it seems desirable that a brief outline of it should be placed before the general public, because it illustrates vividly the benefits that physiological explorations may confer on mankind, shows how speedily useful fruit may be gathered from researches undertaken in the pursuit of knowledge and with no immediate practical aim, and reveals

Nature

A WEEKLY

ILLUSTRATED JOURNAL OF SCIENCE

VOLUME XXX

MAY 1884 to OCTOBER 1884

"To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH

London and New York
MACMILLAN AND CO.
1884

LONDON :
R. CLAY, SONS, AND TAYLOR, PRINTERS
BREAD STREET HILL, E.C.

INDEX

Abbadie (Antoine d'), the Earthquake of April 22, 1884, 101; Animal Intelligence, 125
Abbott (Dr. C. C.), the Ancestor of the Dipper (Cinclus), 30
Abercromby (Hon. R.), on the Origin and Course of the Squall that Capsised H.M.S. *Eurydice*, 22
Abrus Poison, the non-Bacillar Nature of, Warden and Waddell, 263
Absorption of Water by Plants, Francis Darwin, F.R.S., 7
Acheenese, Work on, by Brau de Saint-Pol Lias, 643
Acta Mathematica (Scandinavian Journal) and its Reputation in France, 153
Actinolite, Scottish Localities for, Paper Read before Mineralogical Society, 181
Acupuncture by Chinese Doctors, Use of, 324
Adams (Prof. J. C.), Delegate to International Prime Meridian Conference, 129
Adelaide University, 276
Afghan Frontier Commission, Zoology and the, 324
Africa: Proposed Circumnavigation of, 275; Return of Mr. Joseph Thomson from East, 298; Brief Account of Maurizio Buonfanti's Expedition across North, 131; African Exploration, 172; African Volcanoes, Dr. H. J. Johnston-Lavis, 62; Tropical African Mountain Flora, Sir J. D. Hooker, F.R.S., 635
After-Glow, Major Robert D. Gibney, 634
Agram, Earthquake at, 300
Agricultural Institute of Beauvais, 367
Agriculture in the United States, 77
Aitken (John, J.P.), Geologist, Death of, 371
Alabama, Geological Survey of, Ed. Smith, 77
Alabaster (Henry), Obituary Notice of, 546; Scientific Services of, in Siam, 546
Albania, Ethnography and Statistics of, 644
Albatross, Curious Behaviour of a Booby during the Cruise of the, 130
Albert Medal of the Society of Arts Awarded to Capt. James Buchanan Eads, 152
Albertite Beds of Strathpeffer, Ross-shire, W. Morrison on, 181
Alchemy, Mercury in Chinese, 299
Alcock (Nathaniel), Why Tropical Man is Black, 401
Alert, H.M.S., Sailing of the, 63; Report on the Zoological Collections made in the Indo-Pacific Ocean during the Voyage of the, 485
Alexandra House, Laying the Foundation-Stone of, 222
Algæ, upon the Occurrence of Bacteria and, on the Surface of Paper Money, Jules Schaarschmidt, 360; on Old Coins, 478; Algic Flora of the Arctic Seas, Veit Brecher Wittrock, 638
Algebraic Geometry, Conic Sections and, an Elementary Treatise on, G. Hale Puckle, 631
Algol, Minima of, 253
Allen (Grant), Flowers and their Pedigrees, 167
Alps, the Building of the, Prof. T. G. Bonney, F.R.S., 44, 65
Alternation of Generations, 67; Is Salpa an Example of, W. K. Brookes, 367
America: Fossil Mollusca of North, by C. A. White, Dr. J. G. Jeffreys, F.R.S., 99; American Law Decisions on Details of Education, Digest of, 108; American Journal of Science, 118, 232, 378, 459; American Association for the Advancement of Science, 152, 566, 596; American Jurassic Dinosaurs, 201; Proposed American Exhibition, 275; Native American Literature and Ethnology, Prof. A. H. Keane, 341; American Initiative in Methods of Deep-Sea Dredging, R. Rathbun, 399; American Vines near Nimes, 429; American Ornithologists' Union, 616
Ammonia, Action of, upon some Lepidopterous Pigments, Geo. Coverdale, 571
Amour, Exploration of, 615
Analysis, Chemical, as applied to the Examination of Pharmaceutical Chemicals, Hoffmann and Power, 51
Analysis, Chemical, for Schools, A. H. Scott White, 51
Analysis, Qualitative, for Beginners, Stoddard's, 51
Anatomy, Pathological, Ziegler's Text-Book of, 263
Anatomy, Work on, by Dr. Dudgeon, from Tung Wen College at Pekin, 458
Andalusite Schists of Aberdeenshire, Origin of, Paper by John Horne, F.R.S.E., read before Mineralogical Society, 181
"Andes, Across the Pampas and among the," Robert Crawford, 36
Angara, Rapids of the, 132
Animals, Intelligence in, Duncan Stewart, Dr. John Rae, F.R.S., 6; E. A. Lonergan, 77; Col. J. Herschel, 125; Antoine d'Abbadie, 126; T. W. Kirk, Dr. H. McCormac, 240; T. H. Potts, 265; Dr. G. J. Romanes, F.R.S., 267; R. J. Harvey Gibson, Thomas Harrison, 538; Dr. Hyde Clarke, 561
Annalen der Physik und Chemie, 160, 556, 579
Annam, Fish in Hué River, Tirant, 21
Annuaire du Bureau des Longitudes, 222
Antananarivo Magazine, the, 275

Antarctic and Arctic Seas, Voyages of Discovery in, R. McCormick, 239
Antedon roseaceus, the Pentacrinoid Stage of, Prof. W. A. Herdman, 634
Anthropological Banquet to Gabriel de Mortillet, 40
Anthropological Institute, 47, 162, 187, 235
Anthropological Picture, an, 41
Anthropology of Brazil, Early, 395
Aquarius, Variable Star in, 346
Ararat, Ascents of, 396
Archæological Collections in the Indian Museum, Catalogue and Handbook of, John Anderson, 511
Archibald (E. Douglas), Science and Military Examinations, 239; Solar (Dust?) Halo, 559
Archives Italiennes de Biologie, 330
Archives des Sciences Physiques et Naturelles (de Genève), 508
Arcimis' Observations of Sunset Phenomena in Spain, 324
Argyll (Duke of), Diffusion of Species, 462
Arithmetical Chemistry, C. J. Woodward, 4
Arlberg Tunnel, 615
Arnesen (Capt. M. E.) of Tromsö, Particulars of his Voyages in Spitzbergen Seas, 132
Arctic and Antarctic Seas, Voyages of Discovery in, R. McCormick, 239
Arctic Seas, Algic Flora of the, Veit Brecher Wittrock, 638
Ascent of Water in Plants, 561
Aseismatic Tables for Mitigating Earthquake Shocks, Chas. A. Stevenson, 193
Asia (Central), Regel's Explorations in, 275
Asia Minor, Earthquake in, 83
Asiatic Turkey, Natural History Collections of, 615
Association of German Naturalists and Physicians, 625
Astronomy: Astronomical Column, 21, 41, 64, 83, 131, 154, 181, 200, 253, 300, 325, 346, 374, 397, 431, 458, 479, 496, 519, 547, 594, 615, 643; Recent Improvements in Astronomical Instruments, 181; a New Astronomical Journal, 173; Astronomical Photography, 496; Pending Problems of Astronomy, Prof. C. A. Young, 501; Handy Book of Celestial Motion, W. T. Lynn, 606
Athens, Report of the School of Classical Studies at, 108
Atkinson (A. S.), Pons' Comet, 55, 463; Pink Glow, 463
Atlantic Ice and Mild Winters, Dr. John Rae, F.R.S., 76
Atlantic Sea-Surface, Temperature of, 545
Atmospheric Appearances at Berlin, 199
Atmospheric Dust, R. Brough Smyth, 170; Alexander McAdie, 194
Atmospheric Glow at Berlin, 546
Atti della R. Accademia dei Lincei, 161, 379, 403
Aumoitte (M.), Journey in Tonquin, 276
Aurora Borealis, the Artificial, 252
Auroræ in Northern Europe, Dr. S. Tromholt, 592]
Auroral Researches in Iceland, Dr. Sophus Tromholt, 80
Australasia, Early Discoveries in, E. A. Petherick, 109
Australian Museum, 642
Australian Orchids, 437
Austrian Geological Institute, 202
Ave-Lallemant (Dr. Robert), Obituary Notice of, 615
Axis of Rotation, Earth's, Prof. C. Piazzi Smyth, 29
Axis, Shifting of the Earth's, W. M. Flinders Petrie, 512, 561; W. H. M. Christie, F.R.S., 536; Prof. C. Piazzi Smyth, 582
Ayrton (Prof. W. E., F.R.S.), New Form of Spring for Electric and other Measuring Instruments, 205

Bachmetieff (M.), Magnetic Heat, 223
Bacillus, Comma-Shaped, Alleged to be the Cause of Cholera, Timothy Richards Lewis, 513
Backhouse (T. W.), the Supposed Volcanic Dust Phenomena, 54, 359, 633; Sky-Glows, 511
Bacteria and Minute Algæ on the Surface of Paper Money, upon the Occurrence of, Jules Schaarschmidt, 360
Bacteria, Fungi and, A. de Bary, 433
Bacteria on Old Coins, 478
Baden-Powell (Lieut.), Balloon Ascent, 20
Baginski (Dr. A.), Xanthines, 236
Baker (Henry B.), Cholera Germ, 407
Baker (J. G., F.R.S.), "Manual of the Mosses of North America," Leo Lesquereux and Thos. James, 461; Synopsis of the British Mosses, C. P. Hobkirk, 582
Baker (T. W.), Sextants, 464
Baku Naphtha and Specific Weights, 374
Balding (A.), Voracity of the Drosera, 241
Balearic Isles, Natural History Collections of, 615
Ball Lightning, M. Planté on its Cause and Explanation, 569
Ball (Prof. R. S.), Comets, 454
Ball (Prof. V., F.R.S.), the Distribution of Scientific Works Published by the British Government, 634
Balloons: Ascent by Lieut. Baden-Powell, 20; Ascent of Three from Finsbury Armoury, 494; Directing of, 373, 457, 494, 641
Baltic, Migrations of *Salmo salar* (L.) in the, Prof. And. Joh. Malmgren, 521
Baltimore, Peabody Institute of, 299
Barnard's Comet, A. A. Common, 511
Barometer of January 26, 1884, the Low, 58
Barral (J. A.), Obituary Notice of, 517
Bary (A. de), Fungi and Bacteria, 433
Bashworth (Rev. Fras.), on the Motion of Projectiles, 5
Bates (E. F.), Carnivorous Wasps, 408
Batteries, Storage, 585
Battery with Two Carbon Electrodes, 518
Batuta's (Ibn) Travels to Ceylon and the Maldive Islands, Translation into English of, 132
Bauerman (Hilary), "Text-Book of Descriptive Mineralogy," 461
Beauvais, Agricultural Institute of, 367
Beddard (F. E.), a Gigantic Earthworm, 570
Beetz, Standard Cell, 568
Belgian Erratics, 154
Belgium, Geological Survey of, 201
Bell (Dr. F. Jeffrey), a Rare British Holothurian, 146; the Cotton-Spinner, 193, 335
Bell (J. Lowthian, F.R.S.), Address to Mechanical Engineering Institute at Cardiff, 343
Bell (Dr. Robert), Geology and Mineralogy of Northern Canada, 228
Bellio (Prof.), Account of MS. by Castelli, 569
Bells, Water, 408
Ben Nevis: Observatory, 179, 613, 640; Plants from, 429; Meteorology of, Alexander Buchan, 336
Bentham (George, F.R.S.), Death of, 476; Obituary Notice of, 539; Memorial of, at Royal Herbarium, 591
Bergsman (Dr. M.), Difference between Sea and Continental Climate with Regard to Vegetation, 392
Berlin: Geographical Society, 570; Thüringo-Saxon, 592; Meteorological Society, 652; Physical Society, 24, 188, 308, 356; Physiological Society, 48, 96, 140, 212, 236, 260, 308, 380, 531
Bernard (Mrs. K. M.), the Earthquake, 145
Bertrand and the Académie Française, 613
Beryllium Chloride, Preparation of Pure, Nilson and Petterson, 84
Bevan (G. Phillips), London Water-Supply, 165; Kansas, 295
Bibliography, New Guinea, E. C. Rye, 275
Bidwell (Shelford), on a Relation between the Thomson Effect and other Physical Properties of Metals, 94
Binaries, Southern, 594
Binary-Star β Delphini, 301
Biological Association, Marine, 123, 350
Biological Coast Survey, Proposed, Prof. E. R. Lankester, F.R.S., 76
Biology at St. Andrew's, 107
Biology *v.* Botany, Rev. Geo. Henslow, 537
Birds: Meyer's Skeletons of, 78; Instinct in, 102; W. Brown, 56; Yarrell's History of British, 287; British Birds at the Natural History Museum, 491; Birds'-Nest Soup, 271; Bird's Nests, Henry Seebohm, 276; on the Preservation of Birds (Wild) in India, R. H. Elliott, 276
Bishop (S. E.), Red Glow, 194; September Stream of Krakatoa Smoke at Strong's Island, 537
Bismuth, Electrical Resistance of, 569
Black, Why Tropical Man is, N. Alcock, 401
Blanford (H. F., F.R.S.), Connection of the Himalayan Snowfall with Dry Winds and Drought in India, 46; Theory of the Winter Rains of Northern India, 304
Blavier (E. E.), "Étude des Courants Telluriques," 106

Blood Corpuscles, Photography of, 547
Blood, Experiment on Nature of, Dr. Cohnstein, 48
Blumentritt (Prof.), on Geography and Ethnology of Philippine Islands, 643
Body, Electrical Resistance of the Human, Dr. W. H. Stone, 269
Boeddicker (Otto), the Recent Eclipse of the Moon, 589
Boguslawski (Dr. von G.), Death of, 180
Bois (Dr. Du), on Earthquakes, 614
Bolide at Elizabethpol, 478
Boma, Meteorological Observatory at, 223
Bonney (Prof. T. G., F.R.S.), the Building of the Alps, 44, 65; Rhyolitic Rock from Lake Tanganyika, 193
Bontemps (M.), Death of, 107
Booby, Story of a, Alighting on the *Albatross*, 130
Botany: some Botanical Queries, 194; Botanische Practicum, Dr. Strasburger, 214; Butterflies as Botanists, 269; Younger School of Botanists, W. T. Thiselton Dyer, F.R.S., 559; Biology *v.* Botany, Rev. George Henslow, 537; Handbook of Botany, Dr. A. Schenk, 581; Tropical African Mountain Flora, Sir J. D. Hooker, F.R.S., 635
Bottomley (J. T.), Curious Phenomenon, 634
Boulder-Glaciation, Hugh Miller, 23
Bourdon, Death of, 568
Bournonite, Crystallography of, Paper read before the Mineralogical Society, 181
Boyle-Marriott Law, 458
Bozward (J. Ll.), *Peronospora infestans*, 216; the Remarkable Sunsets, 32
Brachiopoda in Kendal Museum, 154
Brachiopodenfauna, Beiträge zur Kenntniss der Liasischen, von Südtyrol und Venetien, Hyppolyt Haas, 192
Brain, Physiology of the, Prof. Christiani, 260
"Brasilische Sangethiere," Natterer's, 74
Brazil, Early Anthropology of, 395
BRITISH ASSOCIATION: Meeting at Montreal, 63, 217, 275, 410; Reception, Addresses of Welcome, Excursions, &c., 410, 439, 468; Inaugural Address by the President, the Right Hon. Lord Rayleigh, D.C.L., F.R.S., 410; Conferring Degree of LL.D. of McGill University on Prominent Members of Association, 439, 468; Movement to Establish a Public Library in Montreal as Commemoration of Visit of Association, 468; Gold Medal in Applied Science provided by Association for Benefit of McGill University, 439, 468; Proposed Formation of Science Scholarships in McGill University, 439; Grants, 468; Next Meeting of Association at Aberdeen, 469; Proposed International Scientific Congress, 469
Reports of Committees:—Continuing Inquiries relating to Teaching of Science in Elementary Schools, 496; Exploring Kilimanjaro and the adjoining Mountains of Eastern Equatorial Africa, 497; Reducing and Tabulating Tidal Observations in English Channel made with Dover Tide-Gauge, and connecting them with Observations made on French Coast, 498; on Best Methods of Recording Direct Intensity of Solar Radiation, 498; Investigating Natural History of Timor Laut, 498; on Migrations of Birds observed at Lighthouses and Light-vessels, 499: Investigating Circulation of Underground Waters in Permeable Formations of England and Wales, and Quantity and Character of Water supplied to various Towns and Districts from those Formations, 500; on Rate of Erosion of Sea-Coasts of England and Wales, 522
Section A (*Mathematical and Physical Science*).—Opening Address by the President, Sir William Thomson, 417; J. T. Bottomley, on Loss of Heat by Radiation and Convection as affected by Dimensions of Cooling Body, 523; W. J. Millar, on Phenomena connected with Iron and other Metals in Solid and Molten States, 524; Prof. Sir W. Thomson, on a Gyrostatic Working-Model of the Magnetic Compass, 524
Section B (*Chemical Science*).—Opening Address by Prof. Sir H. E. Roscoe, F.R.S., 421
Section C (*Geology*).—Opening Address by the President, W. T. Blanford, F.R.S., 440; Rev. E. Hill, on Ice-Age Theories, 526; C. Le Neve Foster, on What is a Mineral Vein or Lode?, 526; L. W. Bailey, on Acadian Basin in American Geology, 526; W. F. Stanley, on Improbability that Former Glacial Periods in Northern Hemisphere were due to Eccentricity of Earth's Orbit, &c., 526; F. D. Adams, on Norwegian "Apatitbringer" in Canada, and Microscopic Characters of some Laurentian Amphibolites 526; G. F. Matthew, on Geological Age of Acadia, Fauna, 527; Principal Dawson, F.R.S., on More Ancient Land Floras of Old and New Worlds, 527; E. Wethered, F.G.S., on Structure of English and American Carboniferous Coals, 527; Ralph Richardson, on Dissimilarity and Resemblance between Acadian and Scottish Glacial Beds, 528; V. Ball, F.R.S., on Occurrence of Precious Stones and Metals in India, 528; J. S. Gardner, F.G.S., on Relative Ages of American and English Cretaceous and Eocene Series, 528; Prof. E. W. Claypole, on Remains of Fish from Upper Silurian Rocks of Pennsylvania, 529; Hugh Miller, F.G.S., on Fluxion Structure in Till, 530; Dr. J. D. Dana, on Southward Ending of a Great Synclinal in Taconic Range, 530; G. F. Matthew, on Primitive Conocoryphean, 530; W. Whitaker, F.G.S., on Value of Detailed Geological Maps in Relation to Water-Supply, &c., 530; Prof. E. W. Claypole, on Pennsylvania before and after Elevation of Appalachian Mountains, 531
Section D (*Biology*).—Opening Address by the President, Prof. H. N. Moseley, F.R.S., 425
Department of Zoology and Botany.—Prof. Asa Gray, on Characteristic Features of North American Vegetation, 573; Prof. Moseley, on Trapping of Young Fish by *Utricularia vulgaris*, 574; Albert S. Bickmore, on the Jessop Collection in New York Natural History Museum, 574; W. J. Sollas, on the Origin of Freshwater Fauna, 574; Dr. Gwyn Jeffreys, on the Concordance of the Mollusca inhabiting both Sides of the North Atlantic, 574; Prof. J. Struthers, on the Rudimentary Hind Limb of the Humpbacked Whale, *Megaptera longimana*, 574: Prof. D. J. Cunningham, on the Value of Nerve-Supply in Determination of Muscular Anomalies, 574; Prof. A. M. Marshall, on Mutual Relation of Recent Groups of Echinoderms, 575; A. H. Caldwell, on Fœtal Membranes of Marsupials, 575; G. F. Dobson, F.R.S., on some Peculiarities in Geographical Distribution and Habits of Mammals inhabiting Continents and Oceanic Isles, 575; Howard Saunders on Geographical Distribution of Laridæ, 575; W. B. Hemsley, on Investigations of Insular Floras, 575; G. P. Hughes, on Direct Descendants of *Bos primigenius* in Great Britain, 575; Dr. W. Fraser, on Natural Co-ordination in Organic Evolution, 575
Department of Anatomy and Physiology:—Prof. H. N. Moseley, F.R.S., on Eyes and other Sense-Organs in Shells of Chitonidæ, 575; Rev. Dr. Dallinger, F.R.S., on Germs of Septic Organisms, 576; A. W. Bennett, on a Vegetable Organism which separates Sulphur, 576; Prof. H. N. Martin and W. H. Howell, on Coagulation of Blood, 576; Francis Gotch and J. P. Laws, on Blood of *Limulus polyphemus*, 576; Prof. H. P. Bowditch, on Vaso-Motor Nerves, 576; Prof. T. W. Mills, Demonstrating Co-ordinating Centres of Kronecker, 576; Profs. Kronecker and Mills on Cardiac Nerves of Turtle, 576; V. Horsley and Prof. Schäfer, on Functions of Marginal Convolution, 576; Prof. R. Ramsay Wright, on Sensory Nerve-Sacs in Skin of Amiurus and Function of Air-Bladder in Amiurus, 577; Announcement that Mr. Caldwell, Balfour Student, had discovered that Monotremes were Oviparous, 577
Section E (*Geography*).—Opening Address by Gen. Sir J. H. Lefroy, F.R.S., 469; Lieut. Greely, on his Recent Arctic Expedition, 438
Section G (*Mechanical Science*).—Opening Address by the President, Sir F. G. Bramwell, F.R.S., 472
Section H (*Anthropology*).—Opening Address by the President, E. B. Tylor, F.R.S., 448; Horatio Hale on the Origin of Wampum, 577; Major J. W. Powell on the Marriage Laws of North American Tribes, 577; C. A. Hirschfelper on Prehistoric Remains in Canada, 577; Major J. W. Powell on the Classification of North American Languages, 578; Mrs. E. A. Smith on the Customs and Language of the Iroquois, 578; F. H. Cushing on Art among the Zunis, 578; Dr. Daniel Wilson on the Huron-Iroquois, 579; Prof. G. Lawson on Food-Plants used by Indians, 579; Lieut. P. H. Ray on the Habits of the Inu, 579; R. Law on Flint Implements, 579
British Association Catalogue of Stars, 496

British Birds at the Natural History Museum, 491
British Fungi, Flora of, Rev. J. Stevenson, 181
British Government, the Distribution of Scientific Works Published by the, Prof. V. Ball, F.R.S., 634
British Isles, Temperature of Sea Round, 545
"British Mining," Robert Hunt, 358
British Mites, "The British Oribatidæ," A. D. Michael, Sir J. Lubbock, F.R.S., 141
British Mosses, Synopsis of the, C. P. Hobkirk, J. G. Baker, F.R.S., 582
Broca (Paul), Proposed Monument to, 82
Brook (Geo.), *Trachinus vipera*, 71
Brookes (W. K.), Is Salpa an Example of Alternation of Generations?, 367
Brorsen's Comet of Short Period, 300, 397, 459
Brown (E.), the Sky-Glows, 607
Brown (J. Croumbie), Forestry, 309; Forests and Forestry of Northern Russia and Lands Beyond, 535
Brown (W.), Instinct in Birds, 46
Browne (Miss T. M.), the Sky-Glows, 537
Browne (W. R.), Pyrometers, 366; Death of, 478
Bruel (M.), Death of, 21
Brussels Museum and its Work, 201
Buchan (Alexander), Meteorology of Ben Nevis, 336
Bulletin de l'Academie Royale de Belgique, 94, 209, 459, 508, 650
Bulletin de l'Académie des Sciences de St. Pétersbourg, 305
Bulletin de la Société d'Anthropologie de Paris, 160, 233, 650
Bulletin de la Société des Naturalistes de Moscou, 1883, 161, 627
Bulletin of the United States National Museum, 287
Bunge (Dr.), Revisiting the Place where the Adams Mammoth was found, 130, 430
Buonfanti's (Maurizio) Expedition across North Africa, Brief Account of, 131
Burder (Geo. F.), the Recent Eclipse of the Moon, 589
Burmah: Education in British, 545; Progress of English in, 644
Butterflies as Botanists, Dr. F. Müller, 240, 269

Calabar, Rogozinski's Travels between Cameroon and, 109
Calculus, Integral, Elementary Treatise on, B. Williamson, F.R.S., 143
Calcutta Botanic Garden, 196
California, Stormy Winter in, 41
Callovian Rocks, Position of the, 154
Calvert (James Snowdon), Death of, 547
Cambridge, Palæolithic Implements from, M. C. Hughes, 632
Cambridge Philosophical Society, 162, 187
Cameroon and Calabar, Rogozinski's Travels between, 109
Canada, Northern, Geology and Mineralogy of, Dr. R. Bell, 228
Canada Pacific Railway, Geology of the Country Traversed by the, Principal Dawson, F.R.S., 95
Canadian Coals and Lignites, 154
Canadian Meteorological Service, 641
Canadian North-West, Notes on the, Gerrard A. Kinahan, 340
Cane (Frank E.), Rainbow on Spray, 490
Cannibal Snake, a, John Fotheringham, 269; Dr. C. F. Crehore, 408
Cape Heliometer, the, 459
Capillary Constants of Liquids at their Boiling-Points, 618
Carnivorous Plant, a, Preying on Vertebrata, Prof. H. N. Moseley, F.R.S., 81
Carnivorous Plant, a, Commander A. Carpenter, 289
Carnivorous Wasp, 385; Rev. Geo. Henslow, 407; Rev. W. Clement Ley, 407; H. N. Dixon, 408; William White, 408; Thomas Edward, 408; E. F. Bates, 408
Carpenter (Commander A.), a Carnivorous Plant, 289
Carpenter (Dr. Herbert), Anatomy of Crinoids, 82
Carpenter (L. G.), the Remarkable Sunsets, 32
Carpenter (William Lant), Report on Comparison between Apparent Inequalities of Short Period in Sunspot Areas and in Diurnal Temperature Ranges at Toronto and at Kew, 118; Primary Education at the Health Exhibition, 218; Technical School Education at the Health Exhibition, 244
Casey (John, F.R.S.), the First Six Books of the Elements of Euclid, 606
Castelli (Fra Teramo), Curious MS. of, 569
Caucasian Geographical Society, 396
Cauterisation in China, 324
Cayley (Prof., F.R.S.), awarded the First De Morgan Gold Medal, 179; the De Morgan Memorial Medal, 640
Cecil (Henry), Fireball, 289
Celestial Motion, a Handy Book of Astronomy, W. T. Lynn, 606
Centaurus, Ptolemy's 30th of, 346
Central Asia and Tertiary Botany, 430
Central Institution for Technical Education, Contributions to, 129, 198; Programme, 476
Ceylon: Ibn Batuta's Travels to, 132; Insect Pests in, 615; W. L. Distant, 634; Public Instruction in, 641
Chadwick (H. C.), *Podalirius minutus*, 385
Chalk and the "Origin and Distribution of Deep-Sea Deposits," J. Starkie Gardner, 192, 264; Dr. J. Gwyn Jeffreys, F.R.S., 215
Challenger Reports, 533
Chambers's Vestiges of Creation, Dr. G. J. Romanes, F.R.S., 73
Chemistry: a Manual of, H. Watts, 357; Arithmetical Chemistry, C. J. Woodward, 4; Experimental, J. E. Reynolds, 4; Facts around us, C. L. Morgan, 51; Chemical Analysis as Applied to the Examination of Pharmaceutical Chemicals, Hoffmann and Power, 51; Chemical Analysis for Schools, A. H. Scott White, 51; the Discovery of the Periodic Law, by John A. R. Newlands, 51; Recent Chemistry, 51; Prof. Ramsay's Experimental Proofs of Chemical Theory for Beginners, 51; Chemical Society, 71, 119, 187; Roscoe and Schorlemmer's Chemistry, Dr. H. Watts, 75; Chemical Notes, 84, 616; Numerical Exercises in Chemistry, T. Hands, 239; Chimie Elementara, Prof. Licherdopol, 239; Chemical Research in England, Dr. Perkin, 246; Raoul Jagnaux's "Traité Pratique d'Analyses Chimiques et d'Essais Industriels," 311; Relations between Composition and Structure of Chemical Compounds, 616
Chester Society of Natural Science, 547
Chierchia (G.) and Dr. Albert Günther, F.R.S., Voyage of the *Vittor Pisani*, 365
China: Early Culture in, 276; Mercury in Chinese Alchemy, 299; Cauterisation and Acupuncture in China, 324; Mining in, 430; Chinese Diet, Dress, and Dwellings, 458; Chinese and Japanese Plants in Normandy, 431; Stone Hatchets in, Rev. Dr. Joseph Edkins, 515; the Connection between Chinese Music, Weights, and Measures, 565; Chinese Geographical Orthography, 592; Chinese Notions of Immortality, 642
Chlorophyll, Dr. Hansen, C. A. MacMunn, 224
Cholera: Award to Dr. Koch, 63; Cholera at Toulon, 213; the Cholera Germ, 237, 263; Henry B. Baker, 407; Commission to Inquire into Cholera in India, 323; "Comma-shaped Bacillus" alleged to be the Cause of Cholera, Timothy Richards Lewis, 513; Cholera Poison, 557; Report of Five French Physicians on, 545; in India and China, 546, 566; the Epidemic of 1884, 629
Christiani (Prof.), Physiology of the Brain, 260
Christie (W. H. M., F.R.S.), Shifting of the Earth's Axis, 536
Cinclus (Dipper) Ancestor of, Dr. C. C. Abbott, 30
Circular Rainbow seen from Hill top, E. L. Layard, 361; W. L. Goodwin, 465; W. P. Marshall, 584; W. Symons, 607
City Companies Commission, 222
City and Guilds of London Institute, 377
Clark (Edwin), Rotating Thermometers, 32
Clark (J. Edmund), the Earthquake of April 22, 1884, 19; Sky-Glows, 488, 607
Clark's (Latimer) Mercurous Sulphate Cell, 568
Clarke (Dr. Hyde), Animal Intelligence, 561
Classical Studies at Athens, Report of the School of, 108
Clay, Pipe-, A. Hale, 489
Clymenias, on Asiatic Slope of Ural, 495
Coals, Canadian, and Lignites, 154
Cobalt Chloride, Hydration of, Potilitzin on, 84
Coburg, Germany, and Russia, Forests in, 515
Cochin China, Excursions et Reconnaissances, 299

Cockchafer, European, 546
Cocking (Annie E.), Fireball, 269, 289
Coefficients of Capillarity of Liquid Carbon Compounds, 616
Coffee-Leaf Disease, the, 252, 546
Cohnstein (Dr.), Experiments on Nature of Blood, 48
Coleopterology of North America, 495
Cole's Pits, Rev. A. Irving, 560; Joseph Stevens, 607
Colini (Dr. G. A.), on Indians of Upper Amazon Regions, 344
Colliery Explosions, on the Influence of Coal-Dust in, Paper Read before the Royal Society, 262
Collimator, New, for Reflecting Telescopes, G. J. Stoney, F.R.S., 22
Collins (J. H.), Mineralogy, 143
Colombo, Proposed University in, 641
Colonial and Foreign Reports, 370
Colorado, the Silver Districts of, Henry Gunn, 71
Colorado and European Russia, Geological Parallel between, 614
Colour of Flowers, 519
Colours, Complementary, Dr. König, 308
Comets: Prof. R. S. Ball, 454; New, 83, 326, 346, 397; of 1729, 519; of 1858 III., the, 253; of 1882, the Great, 42, 154; of 1884 *b* (Barnard, July 16), 431, 458, 479, 496, 547; A. A. Common, 511; Comet 1884 *c*, 548; Periodical Comets in 1885, 346; Brorsen's Comet of Short Period, 42, 300, 459; Approaching Appearance of Encke's Comet, 594; Approaching Return of Olbers' of 1815, 64, 519; Pons' Comet, A. S. Atkinson, 55, 463; the Southern, Ross, January 7, 21; Wolf's Comet, 615, 643
"Comma-Shaped Bacillus," Alleged to be the Cause of Cholera, Timothy Richard Lewis, 513
Commercial Geographical Society of Paris, 644; of Oporto, 644
Common (A. Ainslie), Rings of Saturn, 144; Lœwy's New Telescope System, 434; Barnard's Comet, 611
Conference, International, on Education, 363
Congo, Exploration on the, 570
Conic Sections, G. Hale Puckle, 631
Continental Climate, Difference between Sea and, with regard to Vegetation, Dr. M. Bergsman, 392
Continents, Permanency of, Rev. Geo. Henslow, 407
Copper Sulphate, on the Density and Thermal Expansion of Aqueous Solutions of, Prof. J. G. MacGregor, 227
Corals, Deep-Sea, Prof. Martin Duncan, F.R.S., 464
Corea, Memoirs of the Interpreter, Otano Kigoro, on, Translated from the Japanese into Russian, 132
Cory (F. W.), How to Foretell the Weather with the Pocket Spectroscope, 606
Cotterill (James H., F.R.S.), "Applied Mechanics," Dr. J. F. Main, 382
Cotton Exhibition in America, 180
"Cotton-Spinner," Dr. F. Jeffrey Bell, 193, 335
Coudé, Equatorial, of the Paris Observatory, Howard Grubb, F.R.S., 123
"Courants Telluriques, Étude des," E. E. Blavier, 106
Coverdale (Geo.), Action of Ammonia upon some Lepidopterous Pigments, 571
Crayfishes, Habits of Burrowing, in the United States, Ralph S. Tarr, 127
"Creation, Vestiges of," Robert Chambers's, Dr. G. J. Romanes, F.R.S., 73
Crehore (Dr. C. F.), Cannibal Snake, 408
Crepuscular Lights, Theories of the Late Remarkable, A. G. Mocenigo, 82
Cresswell Caves in Derbyshire, 153
Cretaceous Flora of North America, Sir J. W. Dawson, 631
Crinoids, Anatomy of, Dr. Herbert Carpenter, 82
Crompton (R. F. B.), Artificial Lighting, 281
Crops, Field and Garden, Diseases of, Geo. Murray, 605
Crosskey (Henry W., LL.D.), Peripatetic Method of Instruction in Science and its Development, 622
Crystalline Rocks, the Origin of, T. Sterry Hunt, F.R.S., 227
Crystalline Schists, Origin of the, Dr. Johannes Lehmann, Arch. Geikie, F.R.S., 121
Cube, to Find the, of any Number by Construction, R. Tucker, 539, 561, 584
Curare, the Gaseous Inhalation and Exhalation in the Case of Animals affected with, Prof. Zuntz, 96
Currents, Earth, 106
Currents, Terrestrial, Dr. Wild, 223

Dairoku (Kikuchi), at Meridian Congress, 567
Dallinger (Rev. W., F.R.S.), Researches on the Origin and Life-Histories of the Least and Lowest Living Things, 619, 645
Dalton (John), Reminiscence of, 431
Daniel (Alfred), Text-Book of the Principles of Physics, 49
Darkness at Midday, Extraordinary, Rev. S. J. Perry, F.R.S., 6
Darwin (Charles), Five Bursaries at St. Petersburg University in his Name, 344
Darwin (Francis, F.R.S.), Absorption of Water by Plants, 7
Darwin (W. E.), Worm-Eating Larva, 146
Dawson (Principal Sir J. W., F.R.S.), Geology of the Country Traversed by the Canada Pacific Railway, 95; Prehistoric Man in Egypt and Syria, 95; Knighted, 494; Cretaceous Flora of North America, 631
Day (Francis), Salmon-Breeding, 488
Decharme, Experiments of, 568
Deep-Sea Deposits, on the Nomenclature, Origin, and Distribution of, John Murray and Rev. A. Renard, 84, 114, 132; J. Starkie Gardner, 192, 264; Dr. J. G. Jeffreys, F.R.S., 215
Deep-Sea Dredging, American Initiative in Methods of, R. Rathbun, 399
Deme and the Horde, the, Howitt and Fison, 235
Denning (W. F.), the Rotation Period of Mars, 55; Jupiter 125
Diatomaceous Deposits in Scotland, Prof. W. J. Macadam, 181
Diderot Centenary, 346
Diffusion of Species, Duke of Argyll, 462; Dr. G. C. Wallich, 512; R. Scot Skirving, 512
Dijmphna Expedition, Proposed New, 64
Dilatation of Liquids, 396
Diller (J. S.), Atmospheric Sand-Dust from Unalaska, Report on, 91
Dinosaurs, American Jurassic, 201
Dipper (Cinclus), the Ancestor of the, Dr. C. C. Abbott, 30
Discomycetes, a Manual of the British, 130
Distant (W. L.), Insect Pests in Ceylon, 634
Dittmar (Prof., F.R.S.), on the Composition of Ocean Water, 292
Dixon (H. N.), Carnivorous Wasps, 408
Dobbie (J. J.) and T. and A. Gray, on the Relation between the Electrical Qualities and Chemical Composition of Glass, 70
Dog-Poison, the Dilution of, 97
Dogs, Plague of, in Australasian Colonies, 345
Dolbear (Prof.), the Electrical Resistance of the Human Body, 56
Double-Star 99 Herculis, 375
Double-Stars, New Southern, 616
Double-Storied Houses in the Himalayas, B. D. Oldham, 30
Dragon-Flies at Moscow, Clouds of, 223
Drosera, Voracity of the, A. Balding, 241
Dublin Royal Society, 22, 72, 162, 331
Dublin, Sanitary Institute at, 557
Dublin University Experimental Science Association, 187
Dumas (J. B.), the Late *Éloges* on, 15
Dumas (Mathieu), Proposed Statue of, Dr. W. H. Perkin, 263
Duncan (Prof. Martin, F.R.S.), Deep-Sea Corals, 464
Dust: Atmospheric, R. Brough Smyth, 170; Alexander McAdie, 194; Solar, Prof. E. Douglas Archibald, 559; T. W. Backhouse, 633
Dust-Free Spaces, E. W. Serrell, jun., 53; Prof. O. Lodge, 54
Duter (M.), Experiments on Magnetic Shells, 568
Dyer (W. T. Thiselton, F.R.S.), Younger School of Botanists, 559
Dynamic Electricity, J. Hopkinson, J. N. Shoolbred, and R. E. Day, 144
"Dynamo-Electric Machinery," Prof. Silvanus P. Thompson, 144, 630

Earth Currents, 106
Earth, the Movements of the, by J. Norman Lockyer, F.R.S., 110, 254, 480

Earth Tremors, 614
Earth's Axis of Rotation, Prof. C. Piazzi-Smyth, 29
Earth's Axis, Shifting of the, W. M. Flinders Petrie, 512, 561; W. H. M. Christie, F.R.S., 536; Prof. C. Piazzi-Smyth, 582
Earthquake: the, of April 22, 1884, W. Topley, 17, 60; Surgeon-Major Eatwell, 18; Dr. J. E. Taylor, 18, 31; A. H. Waters, 19; Rev. O. Fisher, 19, 125; G. M. Whipple, 19; J. Edmund Clark, 19; C. E. De Rance, 31, 57; Edward Newton, 32; Rev. F. W. Ragg, 32; C. L. Prince, 57; M. I. Parr, 77; H. C. Sorby, F.R.S., 101; Antoine d'Abbadie, 101; A. Shaw Page, 102; J. Henry Kinahan, 125; W. F. Stanley, 125; R. Meldola, 145; Col. H. H. Godwin-Austen, F.R.S., 145; Mrs. K. M. Bernard, 145; R. McLachlan, F.R.S., 170, 344, 372; Earthquake at Timor, 300; at Agram, 300; in the Alban Hills, Rome, 372; in Asia Minor, 83; in Lower Austria, 478; in Bosnia, 344; in Ischia, 324, 614; in Italy, 64; Northern Japan, 614; in Japan, F. Warrington Eastlake, 435; at Kishm, 130; at Massowah, 324, 372; in New York, 372; in Philadelphia, 372; at Réunion, 458; in Ontario, 518; at Windsor, 518; off Reykjanes, 614; in Tokio, 614; Dr. H. J. Johnston-Lavis on, 608; Aseismatic Tables for Mitigating Earthquake Shocks, Chas. A. Stevenson, 193; W. Topley, 216; Measuring Earthquakes, Prof. J. A. Ewing, 149, 174
Earthworms: Notes on, Prof. T. McKenny Hughes, F.R.S., 57; E. A. Swan, 77; Fatal Effects of Sea on, 83; a Gigantic, F. E. Beddard, 570
Eastern Counties, Hydrodictyon in the, Rev. J. C. Saunders, 488
Eastlake (F. Warrington), Earthquake in Japan, 435
Eatwell (Surgeon-Major), the Earthquake of April 22, 1884, 18
Eclipses: Total Solar of 1816, November 19, 616; Solar, of March 16, 1885, 643; Total Solar, of 1889, January 1, 131; Lunar, on October 4, 519, 548; Otto Boeddicker on, 589; E. J. Lowe, F.R.S., 590; Geo. F. Burder, 590; H. Dennis Taylor, 632
Edinburgh: Mathematical Society, 71, 187; Mineralogical Society, 330; Royal Society, 120, 162, 235, 403; Royal Physical Society, 23, 71; Geology at Edinburgh University, 107
Edkins (Dr. Joseph), Early Culture in China, 276; Stone Hatchets in China, 515
Education: What is a Liberal,? Prof. S. Newcomb, 9; Inspector of Geographical Education for the Royal Geographical Society, 20; Digest of American Law Decisions on Details of Education, 108; the Peabody Institute and Education in America, 299; Education in the United States, 396; Recommendations of the Royal Commission on Technical Education, 113; International Conference on, 251, 363; Conference on, in Connection with Education Division of International Health Exhibition, 152, 198, 218, 244, 343; Education in Germany and England, by Oscar Browning, 517; Science in Schools, 517; Educational Statistics of Japan, 276, 490; in British Burmah, 545; Science and Art Education, 349
Edward (Thomas), Carnivorous Wasps, 408
Elasticity, Moduli of, Herbert Tomlinson, 234
Electric Lift on French Northern Railway Company, 300
Electric Lighting: Principles and Practice of, Alan Campbell Swinton, 144; Practical Treatise on Electric Lighting, J. E. H. Gordon, 333; Electric Light in Roman Catholic Church in Ayrshire, 394, 430; Electric Light for Lighthouses, J. Munro, 406; Oil and Electricity as Illuminants for, 518
Electric Resistance, Modifications of Wheatstone's Bridge applied to Measurement of, Dr. Frölich, 24
Electric Resistance of Bismuth, 569
Electrical Conference at Philadelphia, 566
Electrical Congress, Paris, 1884, 26
Electrical Exhibition at Rouen, 181, 252; at Turin, 130; at Philadelphia, 152, 543; Commission in Philadelphia, 431, 475, 494; Proposed Exhibition at Boston, 518
Electrical Induction in Metallic Conductors, F. N. Gisborne, 227
Electrical Rainbow, R. S. Newall, F.R.S., 464
Electrical Resistance of the Human Body, Dr. W. H. Stone, Prof. Dolbear, 56; Dr. W. H. Stone, 269
Electrical Rules and Tables, Munro and Jamieson's Pocket-Book of, A. Gray, 262, 290
Electricity: On the Relation between the Electrical Qualities and Chemical Composition of Glass, T. and A. Gray and J. J. Dobbie, 70; the Relation between the B.A. Unit and the Legal Ohm of the Paris Congress, R. T. Glazebrook, 311; Electricity and Health, W. H. Stone, 253
Electro-Dynamometer with extremely Light Suspended Coil, Dr. W. H. Stone, 635
Electrolysing Glass, 568
Electromotive Forces in the Voltaic Cell, on the Seat of, 594
Elgar (Prof.), Training in Naval Architecture, 483
Elliott (R. H.), on the Preservation of Wild Birds in India, 276
Encke's Comet, Approaching Appearance of, 594
"Encyclopædia Britannica," 405
Encyclopædia of Natural Science, Trewendt's, 21
Engineering, Modern Steam Practice and, John G. Winton and W. J. Millar, 509
England, Chemical Research in, Dr. Perkin, 246
"English Flower Garden," W. Robinson, 534
Equatorial *Coudé* of Paris Observatory, Reply to Grubb on, M. Loewy, 4, 53; Howard Grubb, F.R.S., 100, 123
Ericsson (Capt. J.), Temperature of the Solar Surface, 465
Eruption, the Krakatoa, R. D. M. Verbeek, 10; Prof. C. Piazzi-Smyth, 511
Essex Earthquake, 344, 372
Essex Field Club, 343, 374, 518, 615
Ethics, Physiology of, 180
Ethnographical Collections, 547
Ethnology: Native American Literature and, A. H. Keane, 341; and Geography, 569; of Philippine Races, 643; of Mindanao, 643
"Euclid," J. S. Mackay's, 311
"Euclid, the First Six Books of the Elements of," John Casey, F.R.S., 606
Europe, Forests of Northern, 397
Eurydice, H.M.S., on the Origin and Course of the Squall that Capsized, Hon. R. Abercromby, 22
Evans (Capt. Sir Fred. J. O.), Delegate to International Prime Meridian Conference, 129
Evans (Edwin H.), a Cannibal Snake, 216
Ewart (Prof. Cossar), Mission in Connection with Fishery Board, 567
Ewing (Prof. J. A.), Measuring Earthquakes, 149, 174
Exhibitions: General Italian, 130; of India and the Colonies, 343; of Inventions, International, 373

Family Faculties, Prize Records of, F. Galton, 82
Fauvel (M. A.), on Liquidambar, the Wood used in Chinese Tea Chests, 299
Fellow-Feeling in House-Flies and Swallows, 490
Ferraris, Prof., Director of International Department of Electrical Exhibition in Italy, 130
Field and Garden Crops, Diseases of, Geo. Murray, 605
Figure of Uranus, 519
Finmark, Geology of, 201
Fire, Risk of, 346
Fireball: Annie E. Cocking, 269, 289; in Norway, 300; W. J. Millar on, 312; W. M. Flinders Petrie, 360; W. G. Smith, 408; W. White, 464
Firth College, Sheffield, 153
First Meridian Congress at Washington, 517
Fish (C. F.), Handbook of Natural History, 547
Fish in Hué River, Catalogue of, Tirant, 21
Fish, the Weaver, Geo. Brook, 71
Fisher (Rev. O.), the Earthquake of April 22, 1884, 19, 125
Fishery Board, Prof. Ewart's Expedition to the United States, 567
Fishery Board for Scotland, 129, 387; Deputation to the Home Secretary for Further Funds, 198
Fison (Rev. Lorimer), the Deme and the Horde, 235
Fitzinger (Dr. Leopold), Death of, 567
Fixed Stars, David Gill, F.R.S., 135, 156
Flat-Fish, Artificial Culture of, Prof. McIntosh's Inquiries into the, 82
Flora, Algic, of the Arctic Seas, Veit Brecher Wittrock, 638
Flora of British Fungi, Rev. John Stevenson, 181
Flora, Cretaceous, of North America, Sir J. W. Dawson, 631
Flora of the Philippines, R. A. Rolfe, 71
Flora (Swedish), Enrichment by Railways of, 83
Flow of Streams, George Higgin, 560

Flower Garden, English, W. Robinson, 534
Flowers and their Pedigrees, Grant Allen, 167
Fly Killers, Wasps as, Geo. Lawson, 539
Fonvielle (W. De), on Directing Balloons, 641
Food, the Science of, 51
Foot (Capt.), Exploration of Nyassa Region, 546
Forestry: John R. Jackson, 194; John Croumbie Brown, 309; Forestry Exhibition, 222, 243, 337; Forests of Northern Europe, 397; Forests in Coburg, Germany, and Russia, 515; Forests and Forestry of Northern Russia and Lands beyond, J. Croumbie Brown, 535
Forked Lightning, Rev. Dr. C. Michie Smith, 463
Formaldehyde, Sugar-like Substance obtained by Action of Alkalies on, Tollens, 84
Forster (Westgarth), "Strata of the North of England," 3
Fossil Mollusca of North America, C. A. White, Dr. J. G. Jeffreys, F.R.S., 99
Fossil Reptiles, a History of British, Announced Publication by Sir Richard Owen, K.C.B., 517
Fotheringham (John), a Cannibal Snake, 269
Foussereau (M.), Specific Resistance of Distilled Water, 568
Franklin Institute, 545, 579
French Association for Advancement of Science, 343, 483, 517
Freshwater Faunæ, on the Origin of, Prof. W. J. Sollas, 163
Fries (Prof. Elis), on *Tricholoma colossum*, 547
Frogs, Intelligence in, 385, 465
Frölich (Dr.), Modifications of Wheatstone's Bridge Applied to Measurement of Electric Resistance of Galvanic Elements, 24
"Fuel and Water," Schwackhöfer's, Prof. Fleeming Jenkin, F.R.S., 311
Fungi and Bacteria, A. De Bary, 433

Galton (F., F.R.S.), Prize Record of Family Faculties, 82; on the "Measurement of Human Faculty," 129; "Identiscope," 637
Garbe (M.), on Lipmann's Capillary Electrometer, 568
Gardner (J. Starkie), Chalk and the Origin and Distribution of Deep-Sea Deposits, 192, 264
Gas: Application of, to Heating and Cooking, 641
Gas-Burners, Old and New, Owen Merriman, 270, 335
Gas Escapes, Means of Searching for, 615
Gasteropoda in Kendal Museum, 154
Gay (M.), the Rains and the Recent Volcanic Eruptions, 229
Geerts (Dr. A. J. C.), Death and Obituary Notice of, 20
Gegenbauer (Dr. Leopold), Elected Corresponding Member of Vienna Academy of Sciences, 129
Geikie (Arch., F.R.S.), Origin of the Crystalline Schists, Dr. Johannes Lehmann, 121
Generations, Alternation of, 67
Generations in Salpa, Alternation of, R. N. Goodman, 463
Geodetic Association, International, 371
Geodetical Operations, Norwegian, 105
Geography: Inspector of Geographical Education Appointed by the Royal Geographical Society, 20; the Orient Line Guide, 102; Geographical Notes, 109, 131, 478, 569, 643; the Russian Geographical Society, 109; Geographical Society in Edinburgh, 570; Teaching of Geography in Schools, 130; in Russian and German Universities, 457; Geographical Publications by Edward Stanford, 593
Geology: "Strata of the North of England," Westgarth Forster, 3; the Silver Districts of Colorado, Henry Gunn, 71; Geology of the Malayan Peninsula, Rev. J. E. Tenison-Woods, 76; Geological Survey of Alabama, E. A. Smith, 77; Geological Survey of Belgium, 201; Geological Survey of New Zealand, 202; Geology in Russia, 94; Geology of the Country Traversed by the Canada Pacific Railway, Principal Dawson, F.R.S., 95; Geological Society, 95, 139, 211, 235, 306; German Geological Society, 592; Geological Notes, 154, 201; Geology of Finmark, 201; Geology at the British Association, 217; the Origin of Crystalline Rocks, T. Sterry Hunt, F.R.S., 227; Geological Position of the Weka-Pass Stone, Capt. F. W. Hutton, 306; Thoroddsen's Geological Explorations, 317; International Geological Congress, Prof. John McKenny Hughes, F.R.S., 359; the New Geological Map of Russia, 608; Geology and Mineralogy of Northern Canada, Dr. Robert Bell, 228; Geology and Mineralogy of Madagascar, Dr. G. W. Parker, 307
Geometers, Two Greek, 315
Geometry, Solid, Elementary Treatise on, Chas. Smith, 143
Geometry, Some Propositions in, John Harris, 334
Georgia and Mingrelia, described in MS. of Castelli (1597-1659), 569
Germ, Cholera, Henry B. Baker, 407
German Naturalists and Physicians, Association of, 625
Germany, Coburg, and Russia, Forests in, 515
Gibney (Major Robert D.), Light-Phenomenon, 194; After-Glow, 634
Gibson R. J. Harvey), Animal Intelligence, 538
Gill (David, F.R.S.), Fixed Stars, 135, 156
Gisborne (F. N.), Electrical Induction in Metallic Conductors, 227
Glacial Age, Northern Norway under the, Karl Pettersen, 202
Glacial Boundary in Ohio, 155
Glaciation, Boulder, Hugh Miller, 23
Glaciers in the Main Strait of Magellan, Notes on a few of the, Capt. J. L. Wharton, 177
Glaciers of Terek, in Caucasus, 395
Glaciers, Measurement of, in Sweden, 494
Gladstone (Dr. J. H., F.R.S.), School Museums, 384
Glasenap (Dr.), Russian Private Observatories, 252
Glasgow: the Mitchell Library at, 82; Philosophical Society of, 327
Glass, on the Relation between the Electrical Qualities and Chemical Composition of, Thos. and Andrew Gray and J. J. Dobbie, 70
Glazebrook (R. T.), the Relation between the B.A. Unit and the Legal Ohm of the Paris Congress, 311; Prof. Tait on Light, 261
Gledhill (J.), Sky-Glows, 489
Glow, Red, S. E. Bishop, 194; Prof. W. N. Hartley, 384; A. S. Atkinson, 463; Robert Leslie, 463, 583; J. J. Murphy, 583
Godwin-Austen (Col. H. H., F.R.S.), Earthquake, 145; Ocean Swells, 487
Gonnermann (Dr. Wilhelm), Death of, 615
Goodman (R. N.), Alternation of Generations in Salpa, 463
Goodwin (W. L.), Circular Rainbow seen from a Hill-top, 465
Gordon (J. E. H.), Practical Treatise on Electric Lighting, 333
Gordon (Lieut. W. R.), Scientific Expedition to Hudson's Bay, 641
Gorilla, the Young, of the Jardin des Plantes, 128
Graham (R. H.), Graphic and Analytic Statics in Theory and Comparison, 383
Graphic and Analytic Statics in Theory and Comparison, R. H. Graham, 383
Graves (James), Rainbow after Sunset, 635
Gray (A.), Munro and Jamieson's Pocket-Book of Electrical Rules and Tables, 262, 290
Gray (T. and A.), and J. J. Dobbie, on the Relation between the Electrical Qualities and Chemical Composition of Glass, 70
"Great B," M. Thollon's Views of in the Solar Spectrum, Prof. C. Piazzi-Smyth, 535
Great Basin, Extinct Lakes of the, 197
Greeff (Prof.), the Island of St. Thomas, 109
Greek Geometers, Two, 315
Greely Relief Expedition, 64, 290, 395
Green Sun, Observations on a, and Associated Phenomena, Prof. C. Michie Smith, 347
Greenland: Map by Prof. Nordenskjöld, 64; Scientific Exploration of, 153; Lieut. Holm and the Greenlanders, 109
Griffen (H. H.), Tricycles of the Year 1884, 192
Grinnell Land, 438
"Grotto, Blue," on a Dalmatian Island, 200
Grub, Ravages of Coffee Plantations, Report by Mr. McLachlan on, 546
Grubb (Howard, F.R.S.), Equatorial *Coudé* of the Paris Observatory, 100, 123
Grye (M. Bouquet de la), Inventor of a Multiplying Seismograph, 569
Guldberg (Prof. G. A.), North Cape Whale, 148
Gulf Stream, Temperature of, 545
Gulland (G. Lovell), Lepidoptera, 560
Günther (Dr. Albert, F.R.S.), and G. Chierchia, Voyage of the *Vettor Pisani*, 365
Guthrie (Prof.), Action of Water on Triethylamine, 119
Gutta-producing Trees, 346

Haas (Hyppolyt), "Beiträge zur Kenntniss der Liasischen Brachiopodenfauna von Südtyrol und Venetien," J. Gwyn Jeffreys, 192
Haast (Prof. von), Snow and Ice Flora, 55
Hail, 513
Hailstones, Resilience from the Earth of, 519
Hainan, Henry's Journey Through, 41
Hale (A.), Pipe-Clay, 489
Hallett (Holt), Siamese Expedition, 324
Halo: Solar, W. W. Taylor, 241; (Dust?), Prof. E. Douglas Archibald, 559; Iridescent Lunar Halos, T. H. Potts, 464
Hampshire, Geological Survey of, 130, 494
Hands (T.), Numerical Exercises in Chemistry, 239
Hansen (Dr.) on Chlorophyll, C. A. MacMunn, 224
Harcourt (Sir William), on Science, 591
Harris (John), some Propositions in Geometry, 334
Harrison (Thos.), Singular Instance of Instinct, 436; Animal Intelligence, 538
Hartley (Prof. W. N.), Red Glows, 384
Hartz, Upper Germany, the Metallic Veins of, Paper read before the Mineralogical Society, 181
Hatchets, Stone, in China, Rev. Dr. Joseph Edkins, 515
Hatton (Frank) Annual Prize, 641
Haycraft (John B.), a Model Lens for Use in Class Demonstrations, 543
Hazen (Prof. H. A.), the Dry and Wet Bulb Thermometers "Froude," 6
Health, Electricity and, W. H. Stone, 253
Health Exhibition, the, 39, 274, 394, 430, 567, 641
Health Exhibition, International, Conference on Education, 152
Health Exhibition, Primary Education at the, 218, 244
Health Journal, the, 41
Health, National Work and, 183
Healthy Schools, 388
Heat, Measuring, Prof. J. Joly, 361
Heat, a New Principle of Measuring, Otto Pettersson, 320
"Heat," Prof. P. G. Tait, Prof. Balfour Stewart, F.R.S., 191
Heat, Specific, the Law of, L. E. Phillips, 288
Heath (D. D.), Repulsion, 490
Heliometer, the Cape, 459
Heliostat, the Local, G. J. Stoney, F.R.S., 72
Heluan, Sulphur Baths of, near Cairo, 518
Hemileia vastatrix in Natal, 252
Henry (MM.), Photography for Double-Stars, 21
Henry's Journey through Hainan, 41
Henslow (Rev. Geo.), Simple Methods of Measuring the Transpiration of Plants, 146; Permanency of Continents, 407: Carnivorous Wasps, 407; Biology *v.* Botany, 537
Herculis 99, Double-Star, 375
Herdman (Prof. W. A.), the Pentacrinoid Stage of *Antedon rosaceus*, 634
Hermite (Charles), Elected Foreign Honorary Member of Vienna Academy of Sciences, 129
Heron (Mark), Cultivation of Salmon Rivers, 146
Herrick (Sophie B.), Wonders of Plant-Life, 168
Herring-Eggs in Course of Development, 129
Herschel (Col. J.), Animal Intelligence, 125; the Yard, the Metre, and the Old French Foot, 312
Herschel (Prof. A. S.), the Sky-Glows, 536
Hick (Thomas), Protoplastic Continuity in Plants, 216
Higgin (George), the Flow of Streams, 560
Hill-top, Circular Rainbow seen from a, W. L. Goodwin, 465
Hill-tops, Pile-Dwellings on, S. E. Peal, 168
Himalayas, Double-Storied Houses and Concave Roofs in the, B. D. Oldham, 30
Histological Notes for the Use of Medical Students, W. Horscraft Waters, 168
Hoang-ho, Sources of the, 570
Hobkirk (C. P.), Synopsis of the British Mosses, J. G. Baker, 582
Hochstetter (Dr. Ferd. von), Reports from *Novara* Expedition, 547
Hoffmann (Dr.) and Dr. Egon Ihne, "Beiträge zur Phänologie," 588
Hoffmann and Power, Chemical Analysis as applied to the Examination of Pharmaceutical Chemicals, 51
Holm (Lieut.) and the Greenlanders, 109
Holothurian, Rare British, Dr. F. Jeffrey Bell, 146
Hooker (Sir J. D., F.R.S.), Letter from, on Opening of Kew Gardens and Museums on Sundays, 180; Tropical African Mountain Flora, 635
Hopkins (B. J.), Sky-Glow, 268
Horde, the Deme and the, Howitt and Fison, 235
Horse, Przevalsky's Wild, 301; W. W. Watts, 436
Horticultural Exhibition, St. Petersburg, 64, 179
Hoskyns-Abrahall (Rev. John), a Remarkably Brilliant Meteor, 102; Meteor, 385
"Hotel des Neuchâtelois," Discovery of Relics of, 477
House-Flies and Swallows, Fellow-Feeling in, 490
Howitt (A. W.), the Deme and the Horde, 235
Huber (M. Charles), Murder of, in Arabia, 547
Hué River, Catalogue of Fish in, Tirant, 21
Hughes (M. C.), Palæolithic Implements from Cambridge, 632
Hughes (Prof. T. McK., F.R.S.), Notes on Earthworms, 57; International Geological Congress, 359
Hull (Prof. E., F.R.S.), Remarkable Raised Sea-Bed near Lattakia, Syria, 384
Hunt (Robert, F.R.S.), the *Mining Journal* and, 298; British Mining, 358
Hunt (T. Sterry, F.R.S.), the Origin of Crystalline Rocks, 227
Hutton (Capt. F. W.), on the Geological Position of the Weka Pass, 306
Huxley (Prof., P.R.S.), Science in Schools, 63; on Parasites in Mackerel, 199; his Continental Tour, 591
Hydrate of Sulphuric Acid, Specific Gravity of, 374
Hydration of Cobalt Chloride, Potilitzin on, 84
Hydrodictyon in the Eastern Counties, Rev. J. C. Saunders, 488
Hydrophobia, Pasteur's Experiments on, 252, 371
Hydroxylamine and the Assimilation of Nitrogen by Plants, 548
Hygiene, International Congress of, at the Hague, 394, 429, 457
Hypersthene-Andesite and Triclinic Pyroxene in Augitic Rocks, 155

Ice, Atlantic, and Mild Winters, Dr. John Rae, F.R.S., 76
Iceland, Auroral Researches in, Dr. Sophus Tromholt, 80; Explorations in, Th. Thoroddsen, 563, 584
"Identiscope," Francis Galton, F.R.S., 637
Ihne (Dr. Egon) and Dr. Hoffmann, "Beiträge zur Phänologie," 558
Ike-Aral, in Transbaikalia, 430
Illuminants, Lighthouse, Trinity House Experiments on, 362
Immortality, Chinese Notions of, 642
India: Connection of the Himalaya Snowfall with Dry Wind and Drought in, H. F. Blanford, F.R.S., 46; Representation of, at International Prime Meridian Conference, 129; on the Preservation of Indian Wild Birds, R. H. Elliott, 276; Theory of the Winter Rains of Northern, H. F. Blanford, F.R.S., 304; Cholera Inquiry Commission, 323; Rivett-Carnac's Indian Stone Implements, 324, 593; Indians of the Upper Amazon Regions, 344; Catalogue and Handbook of the Archæological Collections in the Indian Museum, John Anderson, 511; Natural History of the Mammalia of India and Ceylon, R. A. Sterndale, 98
India-rubber, a New Application of, 544
Industrial and Cotton Exhibition in America, 180
Insect Allies, our, Theo. Wood, 582
Insect Pests in the United States, 241; in Ceylon, 615; W. L. Distant, 634
Insects, Injurious, E. A. Ormerod, 142
Insects in New Zealand, 478
Instinct, Singular Instance of, Thos. Harrison, 436; in Birds, 102; W. Brown, 56
Institution of Civil Engineers, 71, 187
Institution of Mechanical Engineers, 41, 343
Instruction, Technical, Report on, 357, 381
Instruments, New Form of Spring for Electric and other Measuring, Profs. W. E. Ayrton, F.R.S., and John Perry, 205
Integral Calculus, Elementary Treatise on, B. Williamson, F.R.S., 143
Intelligence in Animals, 170; Duncan Stewart, Dr. John Rae, F.R.S., 6; E. A. Lonergan, 77; R. J. Harvey Gibson, 538; Thomas Harrison, 538; Dr. Hyde Clarke 561; in Frogs, 465
International Conference on Education, 363

International Weights and Measures, 612
Inventions, International Exhibition of, 373
Iridescent Lunar Halos, T. H. Potts, 464
Iron and Steel Institute, 42; Meeting at Chester, 476, 517
Irving (Rev. A.), Cole's Pit, 560
Ischia, Earthquake at, 324, 614
Italian Geographical Congress, the, 323
Italy, Earthquakes in, 64

Jackson (John R.), Forestry, 194
Jacob (Ernest), "The Ores of Leadville," 437
Jacobsen (Capt. Adrian), Collecting Ethnographical Objects in Asia, 547
Jacobsthal (Prof.), on the Evolution of Ornament, 248, 272
Jagnaux (Raoul), "Traité Pratique d'Analyses Chimiques et d'Essais Industriels," 311
James (Thos.) and Leo Lesquereux, Manual of the Mosses of North America, J. G. Baker, F.R.S., 461
Jamieson and Munro's Pocket-Book of Electrical Rules and Tables, A. Gray, 262, 290
Jamin (M.), Elected Perpetual Secretary in the Section of Physical Sciences in Paris Academy, 179
Japan: Educational Statistics of, 276, 490, Department in Health Exhibition, 567, 592, 641; Meteorological System of Japan, 299, 478, 642; Medical Progress in, 345; Introduction of Vaccination into, &c., 345; Earthquake in, F. Warrington Eastlake, 435; Japanese Divination, 495; Japanese Nomenclature of Plants, 495; Pharmaceutical Factory, 519; Léon de Rosny on the Japanese, 570
Jardin des Plantes, the Young Gorilla of the, 128
Jeffreys (Dr. J. Gwyn, F.R.S.): White's Fossil Mollusca of North America, 99; Beiträge zur Kenntniss der Liasischen Brachiopodenfauna von Südtyrol und Venetien, Haas Hyppolyt, 192; Chalk and the Origin of Deep-Sea Deposits, 215
Jelly-fish, Phosphorescence of the, R. Meldola, 289
Jenkin (Prof. Fleeming), Schwackhöfer's "Fuel and Water," 311
Johns Hopkins University, 640
Johnston-Lavis (Dr. H. J.), Volcanoes on the Shore of Lake Nyassa, 62; Earthquakes, 608
Joly (Prof. J.): Note on Microscopical Examination of the Volcanic Ash from Krakatoa, 23; Measuring Heat, 361
Jouffroy Statue, 394; Jouffroy Claimed to be the Inventor of Steam Navigation, 394
Joule's (Dr.) Scientific Papers, 27
Journal of Anatomy and Physiology, 330
Journal of Botany, 209
Journal of the Chemical and Physical Society, 378
Journal of the Franklin Institute, 160, 508, 579, 627
Journal of Physiology, 330
Journal de Physique, 209
Journal de Physique théorique et appliquée, 556, 580
Journal of the Russian Chemical and Physical Society, 94, 118, 209, 555
Journal of the Straits Branch of the Royal Asiatic Society, 20
Jupiter, W. F. Denning, 125
Jupiter's First Satellite, Dark Transit of, W. F. Denning, 77
Jurassic Dinosaurs, American, 201

Kadiak Island, Advices from, 275
Kamchatka, Peninsula of, its Geography and History, 569
Kannonikow's Experiments in Measuring the Refraction-Equivalents of Metals, 84
Kansas, G. Phillips Bevan, 295
Kara Sea, 345; Trade between Europe and Siberia through the, 132
Kasai, Exploration of, 546
Keane (A. H.), Native American Literature and Ethnology, 341
Kendal Museum, 154
Kephir, 216
Kepler's Nova of 1604, 431
Kerosene Emulsion, New Remedy against Phylloxera, 429
Kerry Nicholls (J.), "King Country; or, Explorations in New Zealand," 535
Kew Gardens, 316; Opening on Sundays, 180
Kew, Royal Herbarium, 591
Kief, University of, 567
Kigoro Otano, Interpreter of the Corean Language into Chinese, 132
Kilimanjaro, Mount, Letter of H. H. Johnstone from, 457
Kinahan (Gerrard A.), Notes on the Canadian North-West, 340
Kinahan (J. Henry), Earthquake, 125
"King Country; or, Explorations in New Zealand," J. Kerry Nicholls, 535
Kirk (T. W.), Animal Intelligence, 240
Kishm, Earthquake at, 130
Koch (Dr.), Award to, 63
Kohlrausch's Meter-Bridge, Dr. W. H. Stone, 145
Kola Peninsula, Proposed Explorations of, 324
König (Dr.), Complementary Colours, 308
Krakatoa Eruption, the, 279; R. D. M. Verbeek, 10, 335; Prof. C. Piazzi-Smyth, 511; Atmospheric Effects produced by Volcanic Dust from, W. F. Stanley, 22; Notes on Microscopical Examination of the Volcanic Ash from, J. Joly, 23; Krakatoa and the Sun-Glows, 155; Dr. S. M. Rendall on, 287; Barometrical Indications in Rome of Aerial Disturbances Caused by, 324; Report of French Mission sent thither, 372; Krakatoa Smoke at Strong's Island, September Stream of, S. E. Bishop, 537
Krasheninnikoff, Exploring Expeditions in the Last Century of, 153
Kyanite and Staurolite Localities in the North, Paper Read before Mineralogical Society, 181

La Belgique Horticole, 233
La Nuova Scienza, 252
Laboratory at Paris, Municipal, 199
Lake Tanganyika, Rhyolitic Rock from, Prof. T. G. Bonney, F.R.S., 193
Lakes, Extinct, of the Great Basin, 197
Lankester (Prof. E. R., F.R.S.), the Marine Biological Association and a Coast Survey, 76, 123
Lapps, 52; Skeletons of, 518
Larden (W.), Sky-Glows, 489
Larva, Worm-Eating, W. E. Darwin, 146
Lattakia, Syria, Remarkable Raised Sea-Bed near, Prof. E. Hull, F.R.S., Rev. Dr. G. E. Post, 384
Lawes (Sir J. B.), Experimental Farm at Rothamstead, 642
Lawrence Smith Medal, Award to Scientific Merit in U.S., 373
Lawson (George), Wasps as Fly-Killers, 539
Layard (E. L.), Circular Rainbow seen from Hill-top, 361; Meteors, 538
Leadville, Ores of, Ernest Jacob, 437
Leaping and Running, Greek and English Records, 324
Least Squares, Text-Book on the Method of, Mansfield Merriman, 334
LeConte (Prof. Joseph), Right-sidedness, 76
Lehmann (Dr. Johannes), Origin of the Crystalline Schists, Arch. Geikie, F.R.S., 121
Lena, Survey of Two Branches of, 130
Lena Delta, Ravages of Small-Pox at, 567
Lens, a Model, for Use in Class Demonstrations, John B. Haycraft, 543
Lenses, Charles Pendlebury, 310
Lepidoptera, G. Lovell Gulland, 560
Lepidopterous Pigments, Action of Ammonia upon some, Geo. Coverdale, 571
Lepsius (Prof.), Death of, 274
Leslie (Robert), Sky-Glows, 463, 512, 583
Lesquereux (Leo) and Thos. James, Manual of the Mosses of North America, J. G. Baker, F.R.S., 461
Leuckart (Prof. L.), elected Foreign Corresponding Member of Vienna Academy of Sciences, 129
Lewis (Timothy Richards), "Comma-Shaped Bacillus" alleged to be the Cause of Cholera, 513
Ley (Rev. W. Clement), Carnivorous Wasps, 407
Leyden Museum, Notes from the, 389
Lias (Brau de Saint-Pol), 615, 643
Library Catalogues, W. Odell, jun., 636
Library, the Mitchell, at Glasgow, 82
Licherdopol (Prof.), Chimie Elementara, 239
Lick Observatory, 613

Life-Histories and Origin of the Least and Lowest Living Things, Researches on, Rev. W. Dallinger, F.R.S., 619, 645
Light at Great Depths in Sea, A. E. Verrill, 280
Light, by Prof. Tait, R. T. Glazebrook, 261
Light Phenomenon, Major R. D. Gibney, 194
Light, Wave-Theory of, 545
Lighthouse Illuminants, Trinity House Experiments on, 362
Lighthouses, Electric Light for, J. Munro, 406
Lighting, Artificial, R. E. B. Crompton, 281
Lightning, Forked, Rev. Dr. C. Michie Smith, 463
Lightning, Worthington G. Smith, 241
Lignites, Canadian Coals and, 154
Linnean Society, 70, 186
Linnean Society of New South Wales, 95, 259, 307
Linschoten, Corruption of Schichi-to, 643
Lipmann's Capillary Electrometer, 568
Liquidambar, the Wood used in Chinese Tea-Chests, Fauvel, 299
Liquids, Capillary Constants of, at their Boiling-Points, 618
Living Things, Researches on the Origin and Life-Histories of the Least and Lowest, Rev. W. Dallinger, F.R.S., 619, 645
Lockyer (J. Norman, F.R.S.), Movements of the Earth, 110, 254, 480
Locomotives, Consumption of Fuel in, M. Georges Marié, 41
Lodge (Prof. O. J.), Dust-Free Spaces, 54; Experiment in Thought-Transference, 145
Lœwy's New Telescope-System, A. Ainslie Common, 434; Reply to Grubb on Equatorial *Coudé* of Paris Observatory, 4, 53
London Institute, City and Guilds of, 377
London Water-Supply, G. Phillips Bevan, 165
Lonergan (E. A.), Animal Intelligence, 77
Longridge (J. A.), Wire in the Construction of Ordnance, 285
Loochoo Islands, their Geography, Müller-Beeck, 643
Lowe (E. J., F.R.S.), the Recent Eclipse of the Moon, 589
Lower Congo, Meteorology of the, 589
Lubbock (Sir J., F.R.S.), British Mites, A. D. Michael, 141
Luminous Phenomena at Morges, in Valley of Saas-Fée, at Sand-Alp, and at Madrid, 394
Lunar Eclipses: on October 4, 519, 548; Recent, H. Dennis Taylor, 632
Lunar Halos, Iridescent, T. H. Potts, 464
Lupton's Numerical Tables, 222
Luzon, History of, 643
Lynn (W. T.), "Celestial Motion," Handy Book of Astronomy, 606

McAdie (Alexander), Atmospheric Dust, 194
MacCormac (Dr. H.), Animal Intelligence, 240
McCormick (R.), Voyages of Discovery in Arctic and Antarctic Seas, 239
MacGregor (Prof. J. G.), on the Density and Thermal Expansion of Aqueous Solutions of Copper Sulphate, 227
McIntosh's (Prof.), Inquiries into the Artificial Culture of Flat-Fish, 82
McLachlan (R., F.R.S.), Earthquake, 170; Trichoptera of the European Fauna, 434
MacMunn (C. A.), Dr. Hansen on Chlorophyll, 224
Machinery, Dynamo-Electric, Prof. Silvanus P. Thompson, 630
Mackay (J. S.), "Euclid," 311; Simson's Line, 635
Mackerel, Prof. Huxley on Parasites in, 199
Madagascar, Geology and Mineralogy of, Dr. G. W. Parker, 307
Magellan, Notes on a Few of the Glaciers in the Main Strait of, Capt. J. L. Wharton, 177
Magnetic Heat, Bachmetieff, 223
Magnetic Observatory at Rome, Proposed, 199
Magnetic Rotatory Polarisation of Chemical Compounds, Perkin's Researches on, 616
Magnetic Shells, Experiments on, M. Duter, 568
Main (Dr. J. F.), "Applied Mechanics," James H. Cotterill, F.R.S., 382
Malacca, Natural History Collections of, 615
Malayan Geology, Rev. J. E. Tenison-Woods, 76
Malayan Ornithology, 346
Malayan Peninsula, the Mountain System of the, Rev. J. E. Tenison-Woods, 264
Maldives, Ibn Batuta's Travels to the, 132
Malmgren (Prof. And. Joh.), Migrations of *Salmo salar*, L., in the Baltic, 521
Malta and Sicily, Remarkable Sunsets in, 20
Mammalia of India and Ceylon, the, R. A. Sterndale, 98
Mammals, Brazilian, Natterer's, 74
Manby (Charles, F.R.S.), Obituary Notice, 343
Manchester Literary and Philosophical Society, 72
Manufactures, Science and, 1
Marié (M. Georges), Consumption of Fuel in Locomotives, 41
Marine Biological Association of United Kingdom, 40, 82, 275, 323, 350; Prof. E. Ray Lankester, F.R.S., 76, 123
Marine Station, Scottish, 566
Marine Zoological Survey, a Plea for a National, 25
Mars, the Rotation Period of, W. F. Denning, 55
Marshall (W. P.), Circular Rainbow, 584
Martin (H. Newell) and W. A. Moale, Handbook of Vertebrate Dissection, 143
Massowah, Earthquake at, 324
Mathematical Society, 71, 186, 355, 640
Maw (Geo.), the Flow of Streams, 486
Measuring Earthquakes, Prof. J. A. Ewing, 149, 174
Measuring Heat, Prof. J. Joly, 361
Mechanical Engineers, Meeting of, 614
"Mechanics, Applied," James H. Cotterill, F.R.S., Dr. J. F. Main, 382
Mechanics, Teaching of, 567
Medical Congress, International, at Copenhagen, 372, 394
Medicine in Japan, 345; in British Burmah, 545
Meldola (R.), the Earthquake, 145; Phosphorescence of the Jelly-fish, 289
Memoirs, Scientific, Diffusion of, Prof. John Milne, 267
Mendeléeff (Prof.), Increase of Densities of Solutions of Salts in Proportion to Increase of their Molecular Weights, 84; Researches into Specific Weights, 374
Mercury in Chinese Alchemy, 299
Merjelen Lake, Proposed Drainage of, 430
Merriman (Mansfield), Text-Book on the Method of Least Squares, 336
Merriman (Owen), "Gas-Burners," 270; Gas-Burners, Old and New, 335
Merv and Russo-Persian Frontier, 430
Messerschmidt, Exploring Expeditions of, 153
Metals, Refraction-Equivalents of, Kannonikow's Experiments in Measuring the, 84
Metals, on a Relation between the Co-efficient of the Thomson Effect and certain other Physical Properties of, Shelford Bidwell, 94
Meteorology: the Low Barometer of January 26, 1884, 58; Meteorological Observatories in the China Seas, 108; Meteorological Observatory at Boma, 223; Meteorological Observatory at Falmouth, Laying Foundation-Stone of, 429; Meteorology of Ben Nevis, Alexander Buchan, 336; Meteorology in Victoria, 126; Meteorological System of Japan, 299; Scottish Meteorological Society, 326; the Meteorological Conference, 351; Meteorological Office, 545, 567; of Japan, 478; in Hong Kong, &c., 567; in Hudson's Bay, 641; in Japan, 642; of the Lower Congo, 589; Committee of Meteorology, Magnetism, &c., at St. Petersburg, 430; Polar Station of, 430
Meteors: Rev. J. Hoskyns-Abrahall, 102, 385; at Stockholm, 300; E. L. Layard, 538; November, 615; in Norway, 200; Meteor-, Moon-, and Sun-shine, Prof. C. Piazzi-Smyth, 462
Meter-Bridge, Kohlrausch's, Dr. W. H. Stone, 145
Metrical System, Extent to which it is used and to which it is optional, 153
Metrics: the Yard, the Metre, and the Old French Foot, Lieut.-Col. Herschel, 312
Meyer's Bird-Skeletons, 78
Michael (A. D.), "The British Oribatidæ," Sir J. Lubbock, F.R.S., 141
Michela, in Italy, Author of New Development of Telegraphy, 546
Microbes, Dr. Klein and, 566
Microscopical Examination of Volcanic Ash from Krakatoa, Notes on, J. Joly, 23
Microseismology, 614
Midday, Extraordinary Darkness at, Rev. S. J. Perry, F.R.S., 6
Migration of Salmon, 361

Migrations of *Salmo salar*, L., in the Baltic, Prof. And. Joh. Malmgren, 521
Military Examinations, Science and, E. D. Archibald, 239
Millar (W. J.), Fireballs, 312
Millar (W. J.), John G. Winton, "Modern Steam Practice and Engineering," 509
Milleporidæ, the, John L. Quelch, 539
Miller (Hugh), Boulder Glaciation, 23
Milne (Prof. John), Diffusion of Scientific Memoirs, 267; Earth Tremors, 614
Mindanao, Geography and Ethnology of, 643
Mineralogical Society, 181, 650
Mineralogy, J. H. Collins, 143
Mineralogy and Geology of Northern Canada, Dr. Robert Bell, 228
Mineralogy and Geology of Madagascar, Dr. G. W. Parker, 307
Mineralogy, Text-Book of Descriptive, Hilary Bauerman, 461
Mingrelia and Georgia, Described in Italian Manuscript of Castelli (1597–1659), 569
Minimum of Mira Ceti, the next, 374
Mining, British, Robert Hunt, 358
Mining in China, 430; in Tonquin and Annam, 477
Mining Journal, and Mr. Robert Hunt, F.R.S., 298
Minusinsk, Journeys in the North-East Part of, 132
Mira Ceti, the Next Minimum of, 374
Missing Nebulæ, 201
Mitchell Library at Glasgow, the, 82
Moale (W. A.) and H. Newell Martin, Handbook of Vertebrate Dissection, 143
Mocenigo (A. G.), Theories of the Late Remarkable Crepuscular Lights, 82
Moduli of Elasticity, Herbert Tomlinson, 234
Moigno (Abbé), Death of, 275; Obituary Notice of, 291
Mollusca, Fossil, of North America, by C. A. White and Dr. J. G. Jeffreys, F.R.S., 99
Monster, a Sea, Alfred Morris, 513
Montigny (Ch.), on State of Atmosphere as Affecting Stellar Scintillations, 222, 344
Moon-, Meteor-, and Sun-shine, Prof. C. Piazzi-Smyth, 462
Moon, the Recent Eclipse of the, Otto Boeddicker, 589; E. J. Lowe, 590; Geo. F. Burder, 590
Morgan (C. L.), Facts around us, 51
Morphological Speculations, Recent, 67, 225, 328
Morphologisches Jahrbuch, 355
Morris (Alfred), a Sea Monster, 513
Morris (Chas.), the Red Sunsets, 312
Mortillet (Gabriel de), Banquet to, 40
Moscow, Cloud of Dragon-Flies at, 223
Moseley (Prof. H. N., F.R.S.), a Carnivorous Plant Preying on Vertebrata, 81
Mosquitoes in England, 372
Mosses, British, Synopsis of the, C. P. Hobkirk, J. G. Baker, 582
Mosses of North America, Manual of, Leo Lesquereux and Thos. James, J. G. Baker, F.R.S., 461
Mott (F. T.), Museums, 360
Mountain System of the Malayan Peninsula, the, Rev. J. E. Tenison-Woods, 264
Movements of the Earth, J. Norman Lockyer, F.R.S., 110, 254, 480
Mozambique and Lake Nyassa, Exploration of Country between, 546
Müller, Exploring Expeditions in last Century of, 153
Müller (Dr. F.), Butterflies as Botanists, 240; Christian Conrad Sprengel, 240
Munk (Prof.), on the Extirpation of the Cerebrum in Rabbits, 308
Munro (J.), Electric Light for Lighthouses, 406
Munro and Jamieson's Pocket-Book of Electrical Rules and Tables, A. Gray, 262, 290
Murphy (J. J.), Sky-Glows, 583
Murray (Geo.), "Diseases of Field and Garden Crops," 605
Murray (John), Deep-Sea Deposits, 84, 114; and Rev. A. Renard, on the Nomenclature, Origin, and Distribution of Deep-Sea Deposits, 132
Museum of the Nineteenth Century, Proposed, 567
Museums: Opening of, on Sundays, 180; Sir Joseph Hooker on the Opening of Kew Gardens on Sundays, 180; F. T. Mott, 360; School Museums, Dr. J. H. Gladstone, F.R.S., 384

Natal, Coffee-Leaf Disease in, 252
Natanson (Prof.), Obituary Notice of, 517
National Association of Science and Art Teachers, First Annual Conference of, 180
National Work and Health, 183
Natterer's Brazilian Mammals, 74
Natural History Collections, 615
Natural History, New Library and Museum of, at Newcastle, 430, 475
Natural History Museum, British Birds at the, 491
Natural History Societies, Midland Union of, 153
Natural Science, Establishment of a Chair of, in the Free Church Theological College of Glasgow, 130
Natural Science in Tasmania, 562
Natural Science, Teaching of, in Universities, 153; in Schools, 517
Naturalists, Manchester Field, 153
Naturalists and Physicians, German Association of, 517, 547
Naturalists' Societies, East of Scotland Union of, 130, 153
Naval Architecture, Training in, Prof. Elgar, 483
Naval Constructors, the Royal Corps of, W. H. White, 33
Nebulæ, Missing, 201
Neesen (Prof. F.), on Sebert's Registration of Velocity of Shot, 344
Negritos of the Philippines, Ethnology of, 643
New Guinea Bibliography, Rye's, 275
New South Wales, Rainfall of, 196
New Southern Double Stars, 616
New Zealand: Geological Survey of, 202; Insects in, 478; "King Country, or Explorations in," J. Kerry Nichols, 535
Newall (R. S., F.R.S.), Electrical Rainbow, 464
Newcomb (Prof. S.), What is a Liberal Education? 9; Appointed Professor of Mathematics in the Johns Hopkins University, 640
Newlands (J. A. R.), the Discovery of the Periodic Law, 51
Newton (Edward), the Earthquake of April 22, 1884, 32
Nicols (Arthur), Salmon-Breeding, 512
Niger: Exploration of, 570; Riebeck'sche Expedition, 592
Nilson and Petterson, Preparation of Pure Beryllium Chloride, 84
Nitrification, Notes on, 644
Nitrogen, Hydroxylamine and the Assimilation of, by Plants, 548
Nomenclature, Origin, and Distribution of Deep-Sea Deposits, John Murray and Rev. A. Renard, 132
Nomenclature, Zoological, 256, 277
Nordenskjöld (Prof.), Map of East Greenland, 64; "Popular Scientific Appendix to the Voyage of the *Vega*," Note on the Fifth Fascicule of, 131
North America: the Mosses of, Leo Lesquereux and Thos. James, J. G. Baker, F.R.S., 461; Cretaceous Flora of, Sir J. W. Dawson, 631
North Cape Whale, Prof. G. A. Guldberg, 148
Northern Europe, Forests of, 397
Northern Russia and Lands beyond, Forests and Forestry of, J. Croumbie Brown, 535
Northernmost Point of Europe, 518, 642
Norway: Northern, under the Glacial Age, Karl Pettersen, 202; Fireball in, 200, 300
Norwegian Geodetical Operations, 105
Novara Expedition, 1857–59, 547
November Meteors, 615
Numerical Tables and Constants in Elementary Science, Sidney Lupton, 222
Nyassa, Lake, and Mozambique, Exploration of Country between, 546

Observatories: Paris, 154; Reply to Grubb on Equatorial *Coudé* of, M. Lœwy, 4, 53; the Equatorial *Coudé* of the, Howard Grubb, 100, 123; Meteorological, in the China Seas, 108; Visitation of the Royal Observatory, 147; Oxford University, 200; Private Observatories in Russia, 181; Dr. Glasenap on, 252; Yale College, U.S., 432; in Hong Kong, 567; at

Stockholm, 592; at Ben Nevis, 613, 640; at Pulkowa, 615; at Dorpat, 615
Ocean Swells, Col. H. H. Godwin-Austen, 487
Ocean Water, on the Composition of, Prof. Dittmar, F.R.S., 292
Oceanography, Handbook of, 180
Odell (W.), Library Catalogues, 636
Œstridæ, Observations on, by Miss E. A. Ormerod, 641
Ohio, Glacial Boundary in, 155
Olbers' Comet of 1815, 64, 519
Oldham (B. D.), Double-Storied Houses and Concave Roofs in the Himalayas, 30
"Opah Fish," Fine Specimen of, 129
Oporto, Commercial Geographical Society of, 644
Orchids, Australian, 437
Ordnance, Wire in the Construction of, Mr. J. A. Longridge on, 285
O'Reilly (Prof. P.) "Red Glow" after Sunset, 170
"Ores of Leadville," Ernest Jacob, 437
Organisms under High Pressures, 494
Oribatidæ, the British, A. D. Michael, Sir J. Lubbock, F.R.S., 141
Orient Line Guide, the, 102
Origin and Life-Histories of the Least and Lowest Living Things, Researches on, Rev. W. Dallinger, F.R.S., 619, 645
Ormerod (E. A.), Injurious Insects, 142
Ornament, on the Evolution of, Prof. Jacobsthal, 248, 272
Ornithological Notes, 294
Ornithologists' Union, American, 616
Osten Sacken (Baron), Cannibal Snakes, 312
Ova, Hatching of Cod and Soles', in Norway, 181
Owen (Sir Richard, F.R.S.), Work on "A History of British Fossil Reptiles," 517
Oxford, Statute allowing Women to enter for Honour Examinations, 19
Oxford University Observatory, 200
Oysters, Attempts to Form Beds of, in Baltic, 458

Page (A. Shaw), Earthquake of April 22, 1884, 102
Palæolithic Implements from Cambridge, M. C. Hughes, 632
Pallas, Exploring Expeditions of, 153
"Pampas and among the Andes, Across the," Robt. Crawford, 36
Paper Money, upon the Occurrence of Bacteria and Minute Algæ on the Surface of, Jules Schaarschmidt, 360
Paris: Academy of Sciences, 23, 47, 67, 120, 163, 188, 211, 235, 259, 284, 307, 332, 355, 379, 404, 432, 460, 484, 508, 531, 556, 580, 604, 628, 651; Annual Meeting of, 40; Paris Electrical Congress, 1884, 26; the Observatory of Paris, 154; Reply to Grubb on Equatorial *Coudé* of, M. Loewy, 4, 53; the Equatorial *Coudé* of the, Howard Grubb, F.R.S., 100, 123
Parker (Dr. G. W.), Geology and Mineralogy of Madagascar, 307
Parsley Crop, Failure of the, 539
Pasco (Commander Crawford, R.N.), on Tidal Observations, 641
Pasteur (M.), Experiments on Rabies, 81; on the Attenuation of the Virus of Rabies, 97; Awarded a Gold Medal for his Work on Rabies, 179
Pathological Anatomy, Ziegler's Text-Book of, 263
Paulsen (Dr. Adam), Appointed Director of Danish Meteorological Institute, 179
Peal (S. E.), Pile-Dwellings on Hill-tops, 168
Pearson (Karl), Animal Intelligence, 289
Pen Pits, Somerset, 545
Pendlebury (Chas.), Lenses, 310
Pentacrinoid Stage of *Antedon rosaceus*, Prof. W. A. Herdman, 634
Periodic Law: the Discovery of the, J. A. R. Newlands, 51; Application of to Mineralogy, Prof. J. Carnelley, 181
Peripatetic Method of Instruction in Science and its Development, Henry W. Crosskey, LL.D., 622
Perkin (Dr. W. H.), Chemical Research in England, 246; Proposed Statue of M. Dumas, 263
Permanency of Continents, Rev. Geo. Henslow, 407
Peronospora infestans, J. D. Bozward, 216
Perrotin (M.), the Aspect of Uranus, 21
Perry (Prof. John), New Form of Spring for Electric and other Measuring Instruments, 205
Perry (Rev. S. J., F.R.S.), Extraordinary Darkness at Midday, 6; Black Rain, 32
Persia, Natural History Collections of, 615
Petermann's Mittheilungen, 644
Petherick (E. A.), Early Discoveries in Australasia, 109
Petrie (Capt. Frank), Sky-Glows, 268
Petrie (W. M. Flinders), Fireballs, 360; Shifting of the Earth's Axis, 512, 561
Pettersen (Karl), Northern Norway under the Glacial Age, 202
Pettersson (Otto), a New Principle of Measuring Heat, 320
Phänologie, Beiträge zur, Dr. Egon Ihne and Dr. Hoffmann, 558
Phenology, Contributions to, Dr. Egon Ihne and Dr. Hoffmann, 558
Phenomena, the Volcanic (Dust?), T. W. Backhouse, 633
Phenomenon, Curious, J. T. Bottomley, 634
Philadelphia, Electrical Exhibition at, 543
Philippine Islands, Systems of Writing by various Races in, 643
Philippines, Flora of the, R. A. Rolfe, 71
Phillips (S. E.), the Laws of Volume and Specific Heat, 288
Philosophical Society of Glasgow, 327
Phosphorescence of the Jelly-fish, R. Meldola, 289
Photographic Society, 546
Photographing Blood-Corpuscles, 495
Photography, Astronomical, 496
Photography for Double Stars, Henry, 21
Phylloxera, 429, 519; in Pomological Institute of Proskau, Silesia, 567; in Rhenish Provinces, 593; International Congress on Prevention of, 614
Physical Notes, 568
Physical Society, 47, 119, 139, 210, 283
Physics, Daniell's, 49
Physiology of the Brain, Prof. Christiani, 260
Physiology of Ethics, by Prof. Stricker, 180
Physiology, Work on, from Tung Wen College at Pekin, 458
Picture, an Anthropological, 41
Pile-Dwellings on Hill-tops, S. E. Peal, 168
Pinto (Major Serpa), 546
Pipe-Clay, A. Hale, 489
Pitch-Curves of Cogged Wheels, A. H. Curtis, LL.D., 162
Pits, Cole's, Rev. A. Irving, 560; Joseph Stevens, 607
Pitt-Rivers (General), his Excavations in Pen Pits, Somerset, 545
Plane Conics, Examples on the Analytic Geometry of, R. A. Roberts, 143
Plant, Carnivorous, Preying on Vertebrata, Prof. H. N. Moseley, F.R.S., 81; Commander Alfred Carpenter, 289
Plant-Life, Edward Step, 99; Wonders of, Sophie Bledsoe Herrick, 168
Planté, on Ball Lightning, 569
Plants: Absorption of Water by, Francis Darwin, F.R.S., 7; Simple Method of Measuring the Transpiration of, Rev. Geo. Henslow, 146; Protoplasmic Continuity in, Thomas Hick, 216; Hydroxylamine and the Assimilation of Nitrogen by, 548; Ascent of Water in, 561
Plarr (M. I.), the Earthquake of April 22, 1884, 77
Podalirius minutus, H. C. Chadwick, 385
Prison Congress at Rome, International, 108
Polar Conference, the, 93
Polar Expeditions: New Scheme of, 153; *viâ* Franz Josef Land, 457, 495; Russian, 199, 430
Polar Meteorological Station, 430
Polzunoff, Maker of the First Steam-Engine in Russia, in 1763, 344
Pons' Comet, A. S. Atkinson, 55, 463
Post (Dr. G. E.), Remarkable Raised Sea-Bed near Lattakia, Syria, 384
Potanin, sent by Russian Geographical Society, 570
Potétomètre, the, H. Marshall Ward, 79
Potilitzin on Hydration of Cobalt Chloride, 84
Potts (T. H.), Animal Intelligence, 265; Iridescent Lunar Halos, 464
Prehistoric Man in Egypt and Syria, V. C. Dawson, C.M.G., 95
Prehnite and other Zeolites in Samson's Ribs and Salisbury Crags, Andrew Taylor, 181
Primæval Man and Working-Men Students, 194

Prime Meridian, Universal, Conference on, 566, 567, 602, 613
Prince (C. L.), the Recent Earthquake, 57
Pritchard (Henry Baden), Death of, 83
Proceedings of the Linnean Society of New South Wales, 355
Projectiles, on the Motion of, Rev. Francis Bashforth, 5
Protoplasm, Continuity of the, through the Walls of Vegetable Cells, 182; Thomas Hick, 216
Przevalsky (Col.), News from, January 20 and March 22, 570; Przevalsky's Wild Horse, 391; W. W. Watts, 436
Psychology, Outlines of, James Sully, G. J. Romanes, F.R.S., 238
Ptolemy's 30th of Centaurus, 346
Public Service, Science and the, 32
Puckle (G. Hale), an Elementary Treatise on Conic Sections and Algebraic Geometry, 631
"Pyramids of Instruction" in Germany, 200
Pyrometers, W. R. Browne, 366
Pyroxene, Triclinic, in Augitic Rocks and Hypersthene-Andesite, 155, 201

Qualitative Analysis for Beginners, Stoddard's, 51
Quarantine, 546
Quelch (John L.), the Milleporidæ, 539
Quern Stones, 545

Rabbits, on the Extirpation of the Cerebrum in, Prof. Munk, 308
Rabies, M. Pasteur on the Attenuation of the Virus of, 81, 97
Rae (Dr. John, F.R.S.), Intelligence in Animals, 6; Atlantic Ice and Mild Winters, 76
Ragg (Rev. F. W.), the Earthquake of April 22, 1884, 32
Railway Carriages, Seats in, 320
Railways, Enrichment of Swedish Flora by, 83
Rain, Black, Rev. S. J. Perry, F.R.S., 32; Dr. Treutler, 216
Rainbow: Circular, E. L. Layard, 361; W. L. Goodwin, 465; W. P. Marshall, 584; W. Symons, 607; Electrical, R. S. Newall, F.R.S., 464; Rainbow on Spray, 464; Frank E. Cane, 490; Rainbow after Sunset, James Graves, 635
Rainfall of New South Wales, 196
Rains and the Recent Volcanic Eruptions, the, M. Gay, 229
Rains, Winter, of Northern India, Theory of the, H. F. Blanford, F.R.S., 304
Ramsay's (Prof.) Experimental Proofs of Chemical Theory for Beginners, 51
Rance (C. E. de), the Earthquake of April 22, 1884, 31, 57; Water Supply Conference, 375
Rathbun (R.), American Initiative in Methods of Deep-Sea Dredging, 399
Rawlinson (Sir Robert), Address to Sanitary Institute, 546
Rayleigh (Lord), on the Use of the Silver Voltameter, 283
"Red Glow" after Sunset, Prof. J. P. O'Reilly, 170; S. E. Bishop, 194; Prof. W. N. Hartley, 384
Red Light round the Sun—the Sun Blue or Green at Setting, 633
"Rede" Lecture, 129
Refraction-Equivalents of Metals, Kannonikow's Experiments in Measuring the, 84
Regel's Explorations in Central Asia, 275
Renard (Rev. A.), Deep-Sea Deposits, 84, 114; and John Murray, on the Nomenclature, Origin, and Distribution of Deep-Sea Deposits, 132
Rendall (Dr. S. M.), Krakatoa, 287
Rendiconti del R. Istituto Lombardo, 118, 161, 209, 306, 379, 403, 627
Repulsion, D. D. Heath, 490
Revue d'Anthropologie, 232, 403
Revue d'Ethnographie, 276
Reykjanes, Volcanic Island off, 614
Reynolds (J. E.), Experimental Chemistry, 4
Reynolds (Prof. Osborne, F.R.S.), the Two Manners of Motion of Water, 88
Rhode Island, its Geology, 495
Rhyolitic Rock from Lake Tanganyika, Prof. T. G. Bonney, F.R.S., 193
Riebeck'sche Niger Expedition, 592
Righi (A.), on Influence of Heat and Magnetism on Electrical Resistance of Bismuth, 569
Right-Sidedness, 102; Prof. Joseph LeConte, 76
Riley (Prof. C. V.), Entomologist and Curator of Insects in U.S. National Museum, Visit to Europe, 429
Rings of Saturn, A. Ainslie Common, 144
Ringwood (Alex.), Red Sunsets, 301
Rivers, Salmon, Cultivation of, Mark Heron, 146
Rivista Scientifico-Industriale, 118, 161, 508, 627
Roberts (R. A.), Examples on the Analytic Geometry of Plane Conics, 143
Robinson (W.), English Flower Garden, 534
Rocks, Callovian, Position of the, 154
Rogozinski's Travels between Cameroon and Calabar, 109
Rolfe (R. A.), Flora of the Philippines, 71
Romanes (Dr. G. J., F.R.S.), Chambers's "Vestiges of Creation," 73; Sully's "Outlines of Psychology," 238; Animal Intelligence, 267
Rome: International Prison Congress at, 108; Barometrical Indications in, of Aerial Disturbances caused by Krakatoa Explosion, 324
Roofs (Concave), in the Himalayas, B. D. Oldham, 30
Roscoe and Schorlemmer's Chemistry, Dr. H. Watts, 75
Rosny (Léon de), on the Japanese, 570
Rotation, Earth's Axis of, Prof. C. Piazzi-Smyth, 29
Rothamsted, Experimental Farm at, 642
Rouen, Electrical Exhibition, 252
Royal Corps of Naval Constructors, W. H. White, 33
Royal Meteorological Society, 22, 120, 211
Royal Microscopical Society, 47, 119, 284
Royal Society, 46, 70, 94, 109, 137, 161, 210, 234; *Conversazione*, 63
Royal Society of Canada, 227
Royal Society of New South Wales, 259
Running and Leaping, Greek and English Records, 324
Russia: Geology in, 94; Forests in, 515; the New Geological Map of, 608; Collection of Russian Folk-Lore, 130; Russian Geographical Society, the, 109, 130; Russian Private Observatories, Dr. Glasenap, 252
Rye (E. C.), and New Guinea Bibliography, 275
Rysselberghe's (Van) Telephone, 547

Sabine, Gen., on Connection between Temperature of Atlantic Waters and Weather of Europe, 545
Sabine (Robert, C.E.), Death of, 641
Sagastyr Meteorological Station, 130, 430, 567
Saigon to Tonquin and Bang-kok, Travels from, 644
St. Andrews, Biology at, 107
St. Clair, on Photographing Blood-Corpuscles, 547
St. Nicholas Agassiz Association in the U.S. for Teaching of Science, 396
St. Petersburg: Horticultural Exhibition, 64; Academy of Sciences, 153, 430; Five Charles Darwin Bursaries at University of, 344
St. Thomas, the Island of, Prof. Greeff, 109
Salmon: Migrations of *Salmo salar* in the Baltic, Prof. And. Joh. Malmgren, 521; Removal of Obstructions to Ascent of Salmon up Scotch Rivers, 129; Cultivation of Salmon Rivers, Mark Heron, 146; Migration of, 361; Salmon-Breeding, Francis Day, 488; Arthur Nicols, 512
Salpa, is it an Example of Alternation of Generations? W. K. Brooks, 367; R. N. Goodman, 463
"Salting-Mounds" or "Red Hills" of Colchester, 344, 374
Salts, Densities of Solutions of, Increase of, in Proportion to Increase of Molecular Weights, Prof. Mendeléeff, 84
Samarkand, Ruins of an Ancient City near, 593
Sand-Dust, Atmospheric, from Unalaska, Report on, J. S. Diller, 91
Sandhurst Examinations, Science and, 409
Sanitary Institute of Great Britain, 457, 546; at Dublin, 557
Sasaki (C.), *Udschimya sericaria*, Rond., a Fly Parasitic on the Silkworm, 435
Saturn, 105; Rings of, A. Ainslie Common, 144
Saunders (Rev. J. C.), Hydrodictyon in the Eastern Counties, 488
Scales, 385
Schaarschmidt (Jules), upon the Occurrence of Bacteria and Minute Algæ on the Surface of Paper Money, 360
Schellen (Dr. Heinrich), Obituary Notice of, 517
Schiödte (Prof. J. C.), Danish Entomologist, Death of, 153
Schmidt's Variable-Star in Virgo, 325, 397

School Museums, Dr. J. H. Gladstone, F.R.S., 384; Rev. G. Henslow, 407; W. Hewitt, 407
Schools, Healthy, 388
Schools, Science in, Prof. Huxley, 63
Schorlemmer and Roscoe's Chemistry, Dr. H. Watts, 75
Schrauf (Dr. Albrecht), Elected Corresponding Member of Vienna Academy of Sciences, 129
Schriften der Physikalisch-Oekonomischen Gesellschaft, 379
Schwackhofer's "Fuel and Water," Prof. Fleeming Jenkin, F.R.S., 311
Schweinfurth (Dr. Georg), Return to Africa, 343, 547
Science and Manufactures, 1
Science and the Public Service, 32
Science in Schools, Prof. Huxley on, 63
Science Lectures in Royal Victoria Coffee Hall, London, 180
Science and the Woolwich and Sandhurst Examinations, 189, 409
Science and Military Examinations, E. D. Archibald, 239
Science in Russia, 327
Science and Art Education, 349
Science: Government Endowment of, in Norway, 200; in Germany, 394; in the United States and England, 371, 394; Interdiction of, in Russia, 430
Science Teaching in America, 396; in Schools, 517
Science and its Development, Peripatetic Method of Instruction in, Henry W. Crosskey, LL.D., 622
Science, Natural, in Tasmania, 562
Scientific Association, International, 566
Scientific Associations, International Convention of, 371
Scientific Study, Specialisation in, 314
Scientific Works, the Distribution of, Published by the British Government, Prof. V. Ball, F.R.S., 634
Scotland, Fishery Board for, 387
Scottish Meteorological Society, 179, 326
Scott-White (A. H.), Chemical Analysis for Schools, 51
Scythic Disease among Aleutes and Kamchadales, 132
Sea, Light at Great Depths in, A. E. Verrill, 280
Sea, the Saltness and Temperature of the, H. R. Mill, 313
Sea and Continental Climate with regard to Vegetation, Difference between, Dr. M. Bergsman, 392
Sea-Bed, Remarkable Raised, near Lattakia, Syria, Prof. E. Hull, F.R.S., Rev. Dr. G. E. Post, 384
Sea Monster, Alfred Morris, 513
Sebert's Method of Registering the Velocity of Shot within the Tube of a Gun, 344
Seats in Railway Carriages, 320
Seebohm, Henry, on Birds' Nests, 276
Seismograph, a Multiplying, 569
Seismological Society, 614, 642
Seismology in Japan, 642
September Stream of Krakatoa Smoke at Strong's Island, S. E. Bishop, 537
Serrel Serigraph, 429
Serrell (E. W., jun.), Dust-Free Spaces, 53
Settari (Dr.), Death of, 517
Sextants, T. W. Baker, 464
Shamanism in Perak, 346
Shifting of the Earth's Axis, W. M. Flinders Petrie, 561; Prof. C. Piazzi-Smyth, 582
Shorthand, History of, 397
Siam, 546; Progress of English in, 644; Holt Hallett's Expedition, 324
Siberia, Steamers to, 344
Siberia, Arctic, Hydrography of, 345
Sicily, Malta and, Remarkable Sunsets in, 20
Siemens (Sir Wm.): Proposed Engineers' Memorial to, 221; Methods of Work, 477
Silica, Forms of, John Ruskin, D.C.L., 181
Silkworm, *Udschimya sericaria*, Rond., a Fly Parasitic on the, C. Sasaki, 435
Simms (G. E., jun.), *Utricularia vulgaris*, 295
Simplon, Piercing Alps at, 615
Simson's Line, 635
Singh (Chanda), an Intellectual Prodigy in India, 592
Sitzungsberichte der Naturforschenden Gesellschaft, 233
Skirving (R. Scot), Diffusion of Species, 512
Sky-Glows: B. J. Hopkins, Capt. Petrie, 268; J. Edmund Clark, 488, 607; J. Gledhill, 489; Clement L. Wragge, 489; W. Larden, 489; T. W. Backhouse, 511; Robt. Leslie, 512, 583; Prof. A. S. Herschel, 536; Miss T. M. Browne, 537; J. J. Murphy, 583; E. Brown, 607
Skye, Finds in a Peat Moss in, 181
Small-pox, 567
Smeaton Lighthouse, 567
Smith (Prof. C. Michie), Observations on a Green Sun and Associated Phenomena, 347; Forked Lightning, 463
Smith (Chas.), Elementary Treatise on Solid Geometry, 143
Smith (E. A.), Geological Survey of Alabama, 77
Smith (Rev. F. J.), Work-Measuring Machines, 220
Smith (J. P. G.), the Flow of Streams, 486
Smith (Dr. R. Angus, F.R.S.), Death of, 63; Obituary Notice, Prof. T. E. Thorpe, F.R.S., 104
Smith (Worthington G.), Lightning, 241
Smith (W. G.), Fireballs, 408
Smolensk, Uvaroff's Explorations in, 223
Smyth (Prof. C. Piazzi), Earth's Axis of Rotation, 29; Shifting of the Earth's Axis, 582; Meteor-, Moon-, and Sun-shine, 462; Krakatoa Eruption, 511; M. Thollon's Views of "Great B" in the Solar Spectrum, 535
Smyth (R. Brough), Atmospheric Dust, 170
Snake, a Cannibal, Edwin H. Evans, 216; Baron Osten-Sacken, 312; John Fotheringham, 269; Dr. C. F. Crehore, 408; Suicide of, Rev. W. R. Manley, 268; Snakes and Tortoises in Chinese Mythology, 180
Snow and Ice Flora, Prof. von Haast, 55
Snowfall, Himalaya, Connection with Dry Winds and Drought in India of the, H. F. Blanford, F.R.S., 46
Social Science Association, 180; Questions for Discussion at, 222; Meeting at Birmingham, 517; Inaugural Address by President O. Browning, 517; Paper by Dr. W. H. Crosskey, on Teaching of Science in Schools, 517
Società di Geografia ed Etnografia, 323
"Societies, Scientific and Learned, of Great Britain and Ireland, Year-Book of the," 108
Society of Arts, *Conversazione* by the Council at Health Exhibition, 199; Award of Silver Medals, 199
Solar (Dust?) Halo, Prof. E. Douglas Archibald, 559
Solar Eclipse, Total, of 1816, November 19, 616; of March 16, 1885, 643
Solar Halo, W. W. Taylor, 241
Solar Spectrum, Constitution and Origin of the Group B of the, M. L. Thollon, 520; M. Thollon's Views of "Great B" in the, Prof. C. Piazzi-Smyth, 535
Solar Surface, Temperature of the, Capt. J. Ericsson, 465
Songkoi or Red River, Survey of, 394
Sorby (H. C., F.R.S.), the Earthquake of April 22, 1884, 101
Soup, Birds'-Nest, 271
South America, German Expedition in, 570
Southern Binaries, 594
Sowerby (Rev. A.), the Remarkable Sunsets, 77
Spain, Arcimis' Observations of Sunset Phenomena in, 324
Specialisation in Scientific Study, 314
Species, Diffusion of, Duke of Argyll, 462; Dr. G. C. Wallich, 512; R. Scot Skirving, 512
Specific Resistance of Distilled Waters, M. Fousserau's Observations on, 568
Spectroscope, Pocket, How to Foretell the Weather with, F. W. Cory, 606
Spectrum Analysis: Constitution and Origin of the Group B of the Solar Spectrum, M. L. Thollon, 520; Prof. Piazzi-Smyth, 535
Spinach-Fly Attacking Beet-Root Plants, 494
Spirifer disjunctus (Devonian Brachiopod), its Chinese Equivalent and its Distribution over the Earth, 153
Spitzbergen, some Particulars of Capt. M. E. Arnesen's Voyages around, 132
Sprats, Specimen of Mature, 129
Spray, Rainbow on, 464; Frank E. Cane, 490
Sprengel (Christian Conrad), Dr. F. Müller, 240
Spring, New Form of, for Electric and other Measuring Instruments, Profs. W. E. Ayrton, F.R.S., and John Perry, 205
Stanley (H. M.), Return of, 324
Stanley (W. F.), Atmospheric Effect Produced by Volcanic Dust from Krakatoa Eruption, 22; Earthquake, 125
Stars: on the Atmospheric Influence on the Colours in the Scintillation of, Montigny, 222; British Association Catalogue of, 496; Double, Photography for, M. Henry, 21; 99 Herculis, 375; New Southern, 616; Fixed, David Gill,

F.R.S., 135, 156; Variable, 131, 200, 479, 594, 643; in Aquarius, 346; in Virgo, Schmidt's, 325, 397
Statics, Graphic and Analytic, in Theory and Comparison, R. H. Graham, 383
Steam-Engine, First Russian, in 1763, 344
Steam Practice, Modern, and Engineering, John G. Winton and W. J. Millar, 509
Stellar Scintillations and Atmosphere, 344
Stenberg (Prof.), Death of, 299
Step (Edward), Plant-Life, 99
Sterndale (R. A.), Natural History of the Mammalia of India and Ceylon, 98
Stevens (Joseph), Cole's Pits, 607
Stevenson (Chas. A.), Aseismatic Tables for Mitigating Earthquake Shocks, 193
Stewart (Prof. Balfour, F.R.S.), Report on Comparison between Apparent Inequalities of Short Period in Sunspot Areas and in Diurnal Temperature Ranges at Toronto and at Kew, 118; "Heat," Prof. P. G. Tait, 191
Stewart (Duncan), Intelligence in Animals, 6
Stockholm: Meteor at, 300; Society of Natural Sciences, 628
Stoddard (J. P.), Qualitative Analysis for Beginners, 51
Stone (Dr. W. H.), the Electrical Resistance of the Human Body, 56, 269; Kohlrausch's Meter-Bridge, 145; Health and Electricity, 253; Electro-Dynamometer with Extremely Light Suspended Coil, 635
Stone Hatchets in China, Rev. Dr. J. Edkins, 515
Stone Implements (Indian), Rivett-Carnac's, 324; in West Indian, 593
Stoney (G. J., F.R.S.), New Collimator for Reflecting Telescopes, 22; the Local Heliostat, 72
Storage Batteries, 585
Strachey (Lieut.-Gen. R.), Delegate to International Prime Meridian Conference, 129
Strasburg, New University Building, 615
Strasburger (Dr.), "Das Botanische Practicum," 215
"Strata of the North of England," Westgarth Forster, 3
Streams, the Flow of, Geo. Maw, 486; J. P. G. Smith, 486; George Higgin, 560
Stricker (Prof.), on the Physiology of Ethics, 180
Strong's Island, September Stream of Krakatoa Smoke at, S. E. Bishop, 537
Suicide of Snakes, Prof. W. R. Manley, 268
Sully's (James) "Outlines of Psychology," G. J. Romanes, F.R.S., 238
Sumatra, Natural History Collections of, 615
Sun: Observations on a Green, and Associated Phenomena, Prof. C. Michie Smith, 347; Red Light Round the—the Sun Blue or Green at Setting, 633; Sun-Glows, Robert Leslie, 463; Sunsets, the Remarkable, L. G. Carpenter, 32; J. Ll. Bozward, 32; Rev. A. Sowerby, 77; A. G. Mocenigo, 82; in Malta and Sicily, 20; Prof. J. P. O'Reilly, 170; Alex. Ringwood, 301; Chas. Morris, 312; Rainbow after Sunset, James Graves, 635; Sunset Phenomena in Spain, Arcimis' Observations of, 324; Meteor-, Moon-, and Sun-shine, Prof. Piazzi-Smyth, 462; Sunspots and Diurnal Temperature Ranges, Stewart and Carpenter, 109; the Theory of, Rev. T. W. Webb, 59
Sunday Society and Health Exhibition, 180
Swallows and House-Flies, Fellow-Feeling in, 490
Swan (E. A.), "Notes on Earthworms," 77
Sweden, a Remarkable Phenomenon in, 153
Swedish Flora, Enrichment by Railways of, 83
Swells, Ocean, Col. H. H. Godwin-Austen, 487
Swinton (Alan Campbell), Principles and Practice of Electric Lighting, 144
Sydney: Royal Society of New South Wales, 332, 459, 580; Linnean Society of New South Wales, 404, 603, 651
Symons (W.), Circular Rainbow, 607

Tailed Child, a Recent Case, 200
Tait (Prof. P. G.): "Heat," Prof. Balfour Stewart, F.R.S., 191; "Light," R. T. Glazebrook, 261
Tarr (Ralph S.), Habits of Burrowing Crayfishes in the United States, 127
Tasmania, Natural Science in, 562
Taxidermy, Practical, 338
Taylor (H. Dennis), Recent Lunar Eclipse, 632
Taylor (Dr. J. E.), the Earthquake of April 22, 1884, 18, 31
Taylor (W. W.), Solar Halo, 241
Tea-Trees in Transcaucasia, 397
Technical Education in America, 394
Technical Instruction, Recommendations of the Royal Commission on, 113, 357, 381
Technical Forms of European Science, their Translation into Japanese, 477, 495
Technical Teaching, Catalogue of Apparatus for, 567
Telegraph Engineers and Electricians, Society of, *Conversazione* and Conference, 179
Telegraphic and Telephonic Transmissions along the same Wire, 519
Telegraphy: Cheap, 394; New Development of, by Michela in Italy, 546
Telephone, Application of, to Measurement of Temperatures at a Distance, 345
Telephone and Telegraph, 547
Telephonic and Telegraphic Transmissions along the same Wire, 519
Telescope System, Lœwy's New, A. Ainslie Common, 434
Telescopes, Reflecting, New Collimator for, G. J. Stoney, F.R.S., 22
"Telluriques, Etude des Courants," E. E. Blavier, 106
Temperature of the Solar Surface, Capt. J. Ericsson, 465
Temperatures in America and Europe, Difference of, 457
Tenison-Woods (Rev. J. E.): Malayan Geology, 76; the Mountain System of the Malayan Peninsula, 264
Terrestrial Currents, on, Dr. Wild, 223
Tertiary Botany in Central Asia, 430
Thenard, Baron, Obituary Notice of, 430
Thermometers: "Froude," the Dry and Wet Bulb, Prof. H. A. Hazen, 6; Rotating, Edwin Clarke, 32
Thollon (L.), Constitution and Origin of the Group B of the Solar Spectrum, 520; Prof. C. Piazzi-Smyth, 535
Thompson (Joseph), Return of, 298
Thompson (Prof. Silvanus P.), Dynamo-Electric Machinery, 144, 630
Thompson (Mrs.), Contribution to International Scientific Association, 566
Thomson Effect and other Physical Properties of Metals, on a Relation between the, Shelford Bidwell, 94
Thomson (Prof. James), Whirlwinds and Waterspouts, 648
Thomson (Sir William, F.R.S.), Elected Foreign Honorary Member of Vienna Academy of Sciences, 129; on "Wave-Theory of Light," 545; Lectures in Johns Hopkins University, 640
Thoroddsen's Geological Explorations, 317
Thoroddsen (Th.), Explorations in Iceland, 563, 584
Thorpe (Prof. T. E., F.R.S.), Robert Angus Smith, 104
Thought-Transference, Experiment in, Prof. Oliver J. Lodge, 145
Tide, &c., in the Baltic, Measurement of, 200
Tides, the Regular, Record of, 641
Timor, Earthquake at, 20
Tollens, Sugar-like Substance obtained by Action of Alkalies on Formaldehyde, 84
Tomlinson (Herbert), Module of Elasticity, 234
Tonquin, M. Aumoitte's Journeys in, 276
Tonquin and Cambodia, Tribes on Frontiers of, 644
Topley (W.), the Earthquake of April 22, 1884, 17, 60; Aseismatic Tables for Mitigating Earthquake-Shocks, 216
Tortoises and Snakes in Chinese Mythology, 180; their Mutual Affection, 180
Total Solar Eclipse of 1816, November 19, 616; of 1889, January 1, 131
Toulon, Cholera at, 213
Tourmaline, Crystals of, a Peculiar Development of, Paper read before Mineralogical Society, 181
Trachinus vipera, Geo. Brook, 71
Training in Naval Architecture, Prof. Elgar, 483
Transpiration of Plants, Simple Method of Measuring the, Rev. Geo. Henslow, 146
Trautschold (Prof.), Geological Parallel between Colorado and European Russia, 614
Travel, Modern, the Orient Line Guide, 102
Treutler (Dr.), Black Rain, 216
Trewendt's Encyclopædia of Natural Science, 21
Tricholoma colossum, Specimen of, on Ask Island, 547

Trichoptera of the European Fauna, Robert McLachlan, F.R.S., 434
Triclinic Pyroxene, 201
Tricycles of the Year 1884, H. H. Griffin, 192
Triethylamine, Action of Water on, Prof. Guthrie, 110
Trimen (Dr.), on Insects in Ceylon, especially *Helopeltis antonii*, 615
Trinity House Experiments on Lighthouse Illuminants, 362
Trinomial Nomenclature in Zoology, 198
Tromholt (Dr. Sophus), Auroral Researches in Iceland, 80; Auroræ in Northern Europe, 592
Tropical African Mountain Flora, Sir J. D. Hooker, F.R.S., 635
Tropical Man, Why he is Black, Nathaniel Alcock, 401
Tucker (R.), to Find the Cube of any Number by Construction, 539, 561, 584
Turbot, Peculiar Specimen, 129
Turin Exhibition, Scientific Features of, 181
Tuttle's Comet, a New, 83
Typhoon, History of a, 388

Udschimya sericaria, Rond., a Fly Parasitic on the Silkworm, C. Sasaki, 435
Unalaska, Atmospheric Sand-Dust from, Report on, J. S. Diller, 91
United States: National Academy of Sciences, 40; Agriculture in the, 77; Habits of Burrowing Crayfishes in the, Ralph S. Tarr, 127; Insect Pests in the, 241
"Universal Column," Proposed, 567
Universities (Scotland) Bill, New, 153
University Intelligence, 22, 46, 94, 117, 137, 159, 186, 209, 232, 259, 531, 602, 649
Uranus: the Aspect of, Perrotin, 21; Figure of, 519
Utricularia vulgaris, G. E. Simms, jun., 295
Uvaroff's (Count) Explorations in Smolensk, 223
Uzboi (the), 223

"Vaccination, Facts Concerning," 300
Variable Stars: 131, 200, 479, 594, 643; in Aquarius, 346; in Virgo, Schmidt's, 325, 397
Vegetable Cells, Continuity of the Protoplasm through the Walls of, 182
Vegetation, Difference between Sea and Continental Climate with Regard to, Dr. M. Bergsman, 392
Venus, White Spots on, 41
Verbeek (R. D. M.,), the Krakatoa Eruption, 10, 335
Verhandlungen des Naturhistorischen Vereins der Preussischen Rheinlande und Westfalens, 305, 627
Vermin in our Colonies, 345
Verrill (A. E.), Evidence of Existence of Light at Great Depths in the Sea, 280
Vertebrate Dissection, Handbook of, H. Newell Martin and W. A. Moale, 143
Vertebrates, the Origin of, 225
"Vestiges of Creation," Robert Chambers's, Dr. G. J. Romanes, F.R.S., 73
Vettor Pisani, Voyage of the, G. Chierchia and Dr. Albert Günther, F.R.S., 365
Victoria Institute, 95
Victoria, Meteorology in, 126
Vienna: Imperial Academy of Sciences, 24, 72, 129, 164, 212, 332, 460, 532; New University Building, 615
Virgo, Schmidt's Variable Star in, 325
Vladivostok, Exploring Society at, 615
Volcanic Ash from Krakatoa: Notes on Microscopical Examination of, J. Joly, 23; Atmospheric Effects Produced by Eruption, W. F. Stanley, 22; the Supposed, F. W. Backhouse, 54, 359, 633; the Rains and, M. Gay, 229
Volcanoes on the Shores of Lake Nyassa, Africa, Dr. H. J. Johnston-Lavis, 62
Voltaic Cell, on the Seat of Electromotive Forces in the, 594
Voltameter, the Silver, on the Use of, Lord Rayleigh, 283
Volume, the Law of, S. E. Phillips, 288

Waddell and Warden's Non-Bacillar Nature of Abrus Poison, 263
Wakburg, Electrolysing Glass, 568
Wallich (Dr. G. C.), Diffusion of Species, 512
Ward (Prof. H. Marshall), the Potetomètre, 79
Warden and Waddell's Non-Bacillar Nature of Abrus Poison, 263
Wasp, Carnivorous, 385; Rev. Geo. Henslow, 407; Rev. W. Clement Ley, 407; H. N. Dixon, 408; William White, 408; Thomas Edward, 408; E. F. Bates, 408
Wasps as Fly-Killers, Geo. Lawson, 539
Water: Absorption by Plants of, Francis Darwin, F.R.S., 7; the Two Manners of Motion of, Prof. Osborne Reynolds, F.R.S., 88; on the Composition of Ocean, Prof. Dittmar, F.R.S., 292; Schwackhöfer's Fuel and, Prof. Fleeming Jenkin, F.R.S., 311; Bells, 408; Ascent of, in Plants, 561; London Water-Supply, G. Phillips Bevan, 165; Conference on Water-Supply, 298; C. E. de Rance, 375
Waters (A. H.), the Earthquake of April 22, 1884, 18
Waters (W. Horscraft), Histological Notes for the Use of Medical Students, 168
Waterspouts, Whirlwinds and, Prof. James Thomson, 648
Watts (Dr. H., F.R.S.), a Manual of Chemistry, 3; Watts's Inorganic Chemistry, 57; on "Roscoe and Schorlemmer's Chemistry," 75; Obituary Notice of, 217
Watts (W. W.), Przevalsky's Horse, 436
Wave-Refraction, Prof. Poynting, 119
Weather, How to Foretell, with the Pocket Spectroscope, F. W. Cory, 606
Webb (Rev. T. W.), the Theory of Sunspots, 59
Weights and Measures and Chinese Music, the Connection between, 565
Weights and Measures, International, 612
Weka-Pass Stone, on the Geological Position of the, Capt. F. W. Hutton, 306
Whale, North Cape, Prof. G. A. Guldberg, 148; Dr. Guldberg on, 252
Wharton (Capt. J. L.), Notes on a few of the Glaciers in the Main Strait of Magellan, 177
Whipple (G. M.), the Earthquake of April 22, 1884, 19
Whirlwinds and Waterspouts, Prof. James Thomson, 648
White (W. H.), the Royal Corps of Naval Constructors, 33
White (William), Carnivorous Wasps, 408; Fireballs, 464
White's Fossil Mollusca of North America, Dr. J. G. Jeffreys, F.R.S., 99
Wight, Isle of, Geological Survey, 130, 494
Wilczek (Count Hans), Elected Honorary Member of Vienna Academy of Sciences, 129
Wild (Dr.), on Terrestrial Currents, 223
Wild Horse, Przevalsky's, 391
Williamson (B., F.R.S.), Elementary Treatise on Integral Calculus, 143
Wilson (Sir Erasmus), Death of, 371
Winter, Stormy, in California, 41
Winter, Mild, Atlantic Ice and, Dr. John Rae, F.R.S., 76
Winton (John G.) and Dr. J. Millar, "Modern Steam Practice and Engineering, 509
Wire in the Construction of Ordnance, Mr. J. A. Longridge, 285
Wissmann (Lieut.), Exploration of the Kasai, 546
Wittrock (Veit Brecher), Algic Flora of the Arctic Seas, 638
Wolf's Comet, 615, 643
Women, Statute allowing, to Enter for Oxford Honour Examinations, 19
Women Students, College Hall of Residence for, 457
Women's College, Working, 568
Wood (Theodore), Our Insect Allies, 582
Woodward (C. J.), Arithmetical Chemistry, 4
Woodward (Dr. J. J.), Death of, 494
Woolwich and Sandhurst Examinations, Science and the, 189
Work, National, and Health, 183
Work-Measuring Machines, Rev. F. J. Smith, 220
World's Industrial and Cotton Centennial Exposition, 180
Worm-Eating Larva, W. E. Darwin, 146
Wragge (Clement L.), Sky-Glows, 489
Writing, Systems of, in Philippine Islands, 643
Wurtz (Karl Adolphe), Death of, 63, 103; and his Chemical Work, 170

Xanthines, Dr. A. Baginski, 236

Yakutsk and Verkoyansk, Geography of, 430
Yale College Observatory, U.S., 432

Yarrell's "History of British Birds," 287
Yellow Fever, Glaring Example of Ignorance of Physiology, 298
Yenisei, Antiquities in the Basin of, 132
Yorkshire College, Appointment of Mr. Archibald Barr to be Professor of Civil and Mechanical Engineering in, 130
Young (Prof. C. A.), Pending Problems of Astronomy, 501

Zeitschrift für Wissenschaftliche Zoologie, 355
Ziegler's Text-Book of Pathological Anatomy, 263
Zoisite, New Locality for, Mr. Hamilton Bell, 181
Zoological Collections, Report on the, made in the Indo-Pacific Ocean during the Voyage of H.M.S. *Alert*, 1881–82, 485
Zoological Gardens, Additions to, 21, 41, 64, 83, 109, 130, 154, 181, 200, 223, 252, 377, 300, 325, 346, 374, 397, 431, 458, 478, 495, 519, 547, 568, 594, 615, 642
Zoological Marine Survey, a Plea for a National, 25
Zoological Nomenclature, 256, 277
Zoologicus, Scudder's Nomenclator, 287
Zoological Society, 95, 139, 162, 235
Zoology and the Afghan Frontier Commission, 324
Zoology at Edinburgh University, 107
Zootomy, Course of Instruction in, T. Jeffrey Parker, 144
Zuntz (Prof.), the Gaseous Inhalation and Exhalation in the Case of Animals affected with Curare, 96

impressively the precision and veracity of modern medical science.

"This case, then—this impressive and illustrative case—is that of a man who, when admitted to the Hospital for Epilepsy and Paralysis, presented a group of symptoms which pointed to tumour of the brain—a distressing and hitherto necessarily fatal malady, for the diagnosis or recognition of which we are indebted to bed-side experience and post-mortem examination. But while clinical and pathological observations have supplied us with knowledge which enables us to detect the existence of tumours of the brain, they have not afforded us any clue to the situation of these morbid growths in the brain mass, and it was not until Prof. Ferrier had, by his experiments on animals, demonstrated the localisation of sensory and motor functions in the cerebral hemispheres that the position of any diseased process by which they might be invaded could be definitely determined. By the light of these experiments it is now possible in many instances to map out the seat of certain pathological changes in these hemispheres with as much nicety and certainty as if the skull and its coverings and linings had become transparent, so that the surface of the brain was exposed to direct inspection. And thus in the case to which I am referring, Dr. Hughes Bennett, under whose care the patient was, guided by Ferrier's experiments, skilfully interpreted the palsies and convulsive movements which the man exhibited, and deduced from them that a small tumour was lodged at one particular point in his "dome of thought," and was silently and relentlessly eating its way into surrounding textures. Not more surely do the fidgetings of the electric needle intimate their origin and convey a meaning to the telegraph clerk than did the twitchings of this man's muscles announce to Dr. Hughes Bennett that a tumour of limited dimensions was ensconced at a particular point of a particular fold or convolution of the brain—the ascending frontal convolution on the right side.

"Very brilliant diagnosis this, it may be remarked, and nothing more. A conclusion has been arrived at which, should it prove correct, will gratify professional pride; but as it cannot be confirmed or refuted until the poor patient is no longer interested in the matter, and cannot be made the basis of any active interference, no great advance has been made after all, and vivisection has yielded only some barren knowledge. Until quite recently, criticism of this kind would have been justifiable in a sense, but now it is happily no longer possible, for another series of experiments on living animals, undertaken by Profs. Ferrier and Yeo, have proved that through our power of localising brain lesions we may open a gateway for their removal or relief. The old notion that the brain is an inviolable organ with *noli me tangere* for its motto—a mysterious and secluded oracle of God that simply falls down and dies when its fane is desecrated by intrusion—has been dissipated by these experiments; and we now know that under punctilious antiseptic precautions the brain, in the lower animals at any rate, may be submitted to various operative procedures without risk to life or fear of permanent injury. Emboldened by this knowledge, Dr. Hughes Bennett devised a way of helping his patient whose disease he had diagnosed with such remarkable exactitude, and gave him one chance, if he had the courage to embrace it, of saving his life and recovering his health.

"The patient had the position in which he stood faithfully explained to him. He was told that he laboured under a malady which medicines were powerless to touch, and that if left unassisted he must die in a few months at latest, after prolonged sufferings similar to those which had already brought him to the verge of exhaustion, and which could be only partially alleviated by drugs; but that one outlet of escape, narrow and dangerous, but still an outlet, was open to him in an operation of a formidable nature and never before performed on a human being, under which he might, perhaps, sink and die, but from which he might, perhaps, obtain complete relief. The man, who had faith in his doctor, and no fine-spun scruples about availing himself of the results of vivisectional discoveries, eagerly chose the operation. On the 25th ult. accordingly, Mr. Godlee, surgeon to University College Hospital, in the midst of an earnest and anxious band of medical men, made an opening in the scalp, skull, and brain membranes of this man at the point where Dr. Hughes Bennett had placed his divining finger, the point corresponding with the convolution where he declared the peccant body to be, and where sure enough it was discovered. In the substance of the brain, exactly where Dr. Hughes Bennett had predicted, a tumour, the size of a walnut was found—a tumour which Mr. Godlee removed without difficulty. The man is now convalescent, having never had a bad symptom, and full of gratitude for the relief afforded him. He has been snatched from the grave and from much suffering, and there is a good prospect that he will be restored to a life of comfort and usefulness. In that case he will be a living monument of the value of vivisection. The medical profession will declare with one voice that he owes his life to Ferrier's experiments, without which it would have been impossible to localise his malady or attempt its removal, and that his case opens up new and far-reaching vistas of hopefulness in brain-surgery. Many men and women will henceforth, there is reason to anticipate, be saved from prolonged torture and death by a kind of treatment that has been made practicable by the sacrifice, under anæsthetics, of a few rabbits and monkeys."

NOTES

THE Council of the British Association for the Advancement of Science has requested the following to allow themselves to be nominated as Presidents of Sections for the meeting at Aberdeen, which begins on Wednesday, September 9, 1885:—Section A (Mathematics, &c.), Prof. J. C. Adams; Section B (Chemistry), Prof. Armstrong; Section C (Geology), Prof. Judd; Section D (Biology), Prof. McIntosh; Section E (Geography), General Walker; Section F (Economics), Prof. J. Bryce; Section G (Mechanics), Mr. B. Baker; Section H (Anthropology), Mr. F. Galton.

WE learn with pleasure that M. Mascart was on Monday last elected a Member of the Academie des Sciences, Paris.

THE Berkeley Research Fellowship has been given by Owens College, Manchester, to Mr. G. H. Fowler of Keble College, Oxford. An opportunity is thus given to Mr. Fowler of carrying on his work on the anatomy of the Zoantharian corals.

THE immense economical importance of Government botanic gardens, especially in young colonies, is well shown by the last report of the Curator of the Gardens in Brisbane. Omitting the distribution of ornamental trees, shrubs, &c., to the gardens of public institutions, as well as that of ornamental pot plants, we find that economic plants have been distributed on a very large scale. The demand for these has been unprecedentedly large, and no application is ever refused so far as it can be supplied. About 3000 economic plants were sent out during the year; these consisted chiefly of various kinds of coffee, tea, cocoa (*Theobroma cacao*), cinchona, and vanilla. Grafted Indian mangoes and plants of the Brazilian nut (*Bertholletia excelsa*) have been given to likely growers, and the demand for the latter is so great that application has been made to the universal feeder of these institutions, Kew, for more. Besides acting as a collecting and distributing agency, the Brisbane Gardens do what is perhaps of even more value, viz. ascertain by experiment the conditions under which certain foreign plants will grow best in the colony. The most important trials recently have been with regard to cinchona, which, Mr. Pink shows, may by care in its early stages, be successfully cultivated in Queensland. The hop plant has been tried, and appears a success, 10 cwt. being the produce per acre the first season, while in England under similar circumstances it is only 4 cwt. Sugar is at present the staple of the colony, but no efforts are spared to discover new kinds elsewhere which may be better adapted to the place. 100 tons of various kinds of cane, chiefly from Mauritius, were sent to planters during the year. Economic and valuable timbers also receive much attention, and the gardens have now ready for transplanting 20,000 trees of various kinds, including cedars, olives, silky oak, English oak, English ash, poplars, and chestnuts. The recent experiments have conclusively shown that Queensland can introduce among her staple produce-crops such valuable and remunerative products of the soil as coffee, hops,

and cinchona. As an example of the care and labour devoted to the work, it may be mentioned that every method of cultivating the cinchona in Ceylon and South America was tried in the gardens without much success; and finally Mr. Pink was compelled to devise a method of his own, which proved successful.

WE regret to announce the death of Dr. Heinrich Bodinus, for many years Director of the Berlin Zoological Gardens; he died at Berlin on November 23 last. Also of Dr. Karl von Vierordt, formerly Professor of Physiology at Tübingen University; he died at that place on November 22, aged sixty-seven.

La Nature records the death of M. Henri Lortigue, to whom is due the practical introduction of the telephone in most of the large towns in France, and who was in many other respects a man of scientific note. In 1855 he was employed by Leverrier, the Director of the Paris Observatory, who was then organising a series of meteorological observations, to superintend the instruments by which, by means of photography and electricity, the slightest variations of the barometer, thermometer, and compass were recorded. In 1859 M. Lortigue took charge of the telegraph service on the Chemin de Fer du Nord, and received a gold medal for his various inventions of semaphores, automatic whistles, &c. In 1880 he was Director of the Société des Téléphones. He was also a botanist and entomologist of note, and has left behind him some excellent collections in natural history.

THE part of Turkestan bordering on China and comprising the countries retroceded by Russia, is now entirely incorporated with the Chinese Empire, and will form henceforward the 19th Province.

WE have received from Messrs. Collins of Glasgow the new edition (twentieth thousand) of Prof. Guthrie's well-known "Text-Book of Magnetism and Electricity." Not only has the present edition been carefully revised, but it contains a supplementary chapter by Mr. C. V. Boys, referring chiefly to the practical applications which have been made of electricity during the last few years, such as the telephone and microphone, dynamo machines, electric light, secondary batteries, &c. Electric and magnetic units are also referred to at some length.

OUR readers will be glad to know that the Fine Art Society announces the publication of an etching of Prof. T. H. Huxley, after the picture painted by Mr. John Collier, which was exhibited at the Royal Academy in 1883. The etching is the work of the distinguished etcher, M. Léopold Flameng, and corresponds in size with the portrait of the late Mr. Charles Darwin, painted and etched by the same artists, and published by the same Society last year.

AN examination of a series of water-marks set in 1750 all round the Swedish coasts, from the mouth of the Tornea to the Naze, in order to settle a dispute between the Swedish astronomer Celsius and some Germans, as to whether the level of the Baltic has been rising or sinking, shows that both parties were right. The gauges were renewed in 1851, and again this year, and have been inspected regularly at short intervals, the observations being carefully recorded. It appears that the Swedish coast has been steadily rising, while that on the southern fringe of the Baltic has been as steadily falling. The dividing line, along which no change is perceptible, passes from Sweden to the Schleswig-Holstein coast, over Bornholm and Laland. The results have lately been published by the Swedish Academy of Sciences; and it appears from them that while during this period of 134 years the northern part of Sweden has risen about 7 feet, the rate of elevation gradually declines as we go southwards, being only about 1 foot at the Naze, and nothing at Bornholm, which remains at the same level as in the middle of the last century. The general average result would be that the Swedish coast has risen about 56 inches during the last 134 years.

THE Central Geodynamic Observatory at Rome recently received notice from Corleone, in the province of Palermo, of another violent shock of earthquake, making the fourth in Italy in less than a fortnight. The first occurred on November 23, at 7.30 p.m., on the eastern slope of the Western Alps, and coincided with the reawakening of Vesuvius. The second, at midnight on the 27th, extended from the same region to Switzerland and Lyms on the north, and to the Liguarian coast of Italy. The third, at midnight on the 29th, shook Cosenza and Paola in Calabria. The fourth touched Sicily at Corleone at four o'clock in the afternoon of the 5th inst. During this period an unusual agitation had been noted in the seismographic instruments at Rome and elsewhere in Italy. Prof. Di Rossi, Director of the Geodynamic Observatory, announces the early publication of very interesting observations taken at Rocca di Papa, comprising the alterations in level, and in the temperature of subterranean waters.

A NOTICE has just been received from M. Hepites, who has long been carrying on meteorological observations in Roumania, to the effect that the Roumanian Government has decided on the establishment of a meteorological organisation, and has voted the necessary funds. The Central Institute is being built at Bucharest. The organisation was started July 1. M. Hepites is the director.

IN a paper recently read before the Shanghai branch of the Royal Asiatic Society, Dr. Macgowan affirms the claims of the Chinese to be the originators of gunpowder and firearms. This claim was examined in an elaborate paper some years ago by the late Mr. Mayers, and decided by him in the negative. Dr. Macgowan admits that gunpowder as now used is a European discovery. Anterior to its granulation by Schwartz it was a crude compound, of little use in propelling missiles; this, says the writer, is the article first used in China. The incendiary materials stated by a Greek historian to have been employed by the Hindus against Alexander's army, are stated to have been merely the naphthous or petroleum mixtures of the ancient Coreans, and in early times used by the Chinese. The "stink-pots," so much used by Chinese pirates, is, it appears, a Cambodian invention. Dr. Macgowan states also that as early as the twelfth or thirteenth century the Chinese attempted submarine warfare, contriving rude torpedoes for that purpose. In the year 1000 an inventor exhibited to the then Emperor of China "a fire-gun and a fire-bomb." He says that while the Chinese discovered the explosive nature of nitre, sulphur, and charcoal in combination, they were laggards in its application, from inability to perfect its manufacture, so, in the use of fire-arms, failing to prosecute experiment, they are found behind in the matter of scientific gunnery.

IN *The Hull Quarterly and East Riding Portfolio*, edited by W. G. B. Page, Sub-Librarian of Subscription Library, Hull, will appear, during the year 1885, interesting articles by T. M. Evans, President of the Literary and Philosophical Society, Hull, on the ancient Britons and the lake-dwelling at Ulrome in Holderness; A. C. Hurtzig, C.E., on some tidal and engineering features of the River Humber; and William Lawton, on the meteorology of Hull.

THE Leicester "Literary and Philosophical," now entering upon its jubilee year, appears to be a flourishing society in a flourishing town. Over 300 members distribute themselves into five sections, containing many ladies as Associates, and both making outdoor excursions for practical observation, and holding evening meetings at which lectures are given, professional as well as amateur, followed at the latter by discussions. These lead to the collection and distribution of valuable knowledge of archæology, literature, and economics; of astronomy, physics,

and chemistry; of geology, where the exposures made by local railway cuttings are carefully studied and recorded; of biology (combining botany and zoology); and of zoology, specially directed to the study of the animals of the county, a list of which will be published as it approaches completeness. Some of these productions are not among the abstracts at the end of the Report, being reserved for publication in "another place." These papers are read in a new lecture-hall adjoining the Museum, another institution which, though not very extensive, is in a most active state of growth and improvement. A new curator has led to a thorough rearrangement of the zoological collection in such cases and surroundings as show the specimens in their natural habitats, with index sketches attached to each case, supplying names, &c., hanging near. So large an outlay has been made upon these cases, that only 4 per cent. of the expenditure has been devoted to fresh objects. A large increase in the number of visitors has followed these reforms, and nothing, we venture to say, would so increase the attendance at a museum as the introduction of variation instead of rigid order, and the contributions from South Kensington can best assist in this "movement." It seems hardly possible than an institution like this should be frequented by persons engaged in business when the hours of opening it are only the middle hours of the business day, viz. from ten till four, and the fact that on a holiday like Whitsun Monday 97 persons per hour were admitted during the daytime, and 353 persons per hour were admitted in the evening, shows that, here at any rate, the latter hours are the favourite hours also. Why, on the same ground, should a series of "popular" lecturettes be given at three o'clock in the afternoon?

Dr. A. Penck has recently studied the old glaciers of the Pyrenees in detail, and has found remarkable differences between them and the Alpine glaciers of the Ice period. Even at that remote period the Pyrenean glaciers were of far smaller extent than those of the Alps—in the western part of the Pyrenees indeed there existed not a single one. Wherever traces of glaciers could be found they were accompanied by lake beds; these have by now been filled up for the greatest part, at least in the lower altitudes, the only lakes still existing being situated in altitudes of between 1500 and 3000 metres.

We have received a pamphlet on the climatic conditions of Luxor and Egypt, with especial reference to invalids, by Dr. Maclean (H. K. Lewis). The author spent three years as an invalid and also in the practice of his profession in Egypt. There are several meteorological tables and diagrams, and very much information of all kinds for the traveller, although the traveller who wants to escape the English winter is the special object of the writer's solicitude.

Prof. Lindström, the keeper of the palæontological collections at the Stockholm Museum, has made an interesting discovery amongst a number of petrefacts obtained from the Island of Gothland. It is an air-breathing crustacean from the Silurian period, the first specimen of the kind yet found.

Prof. Gustav von Hayek, the author of the well-known "Atlas of Natural History" (published by Perles of Vienna), has received the gold medal for arts and sciences from the Emperor of Austria, in recognition of the excellence of the work referred to.

We learn from *Science* that Commander Bartlett's annual report on the operations of the U.S. Hydrographic Office makes a good showing for activity and enterprise. Lists of light-houses and "Notices to Mariners," in which bearings are given in degrees from true north, instead of magnetic bearings in points, as formerly, have been liberally published; the official correspondence with other hydrographic offices has been increased; and a complete set of the charts issued by all nations is kept on file, and is always at the service of the public for the determination of any questions relating to hydrography. The only vessel engaged in making surveys during the year was the *Ranger*, on the west coast of Mexico and Central America; but it is strongly recommended that new surveys be undertaken in several regions where they have long been wanted. The charts of the northern coast of South America are mostly based on old Spanish surveys dating back to 1794. "Watson's Rock," latitude 40° 17′ N., longitude 53° 22′ W., in the path of North Atlantic traders, has been reported so many times that its existence ought to be definitely settled or unsettled. The recommendation of previous hydrographers with regard to surveys of the Caroline and Marshall Islands, in the equatorial Pacific, should no longer be neglected; they lie in the belt of the trade-winds and westerly current, the natural highway of vessels crossing the ocean to Japan, China, and the East Indies, and require immediate examination. In the North Pacific alone there are over 3000 reported dangers that need decisive observation. In many cases the same island has half a dozen different positions, with as much as fifty miles between the extremes. It is urged that every naval vessel be provided with modern sounding-apparatus, by which even deep-sea measures can be quickly made, and required to sound wherever the charts show no depths reported within twenty miles on any side; and it is desired that a ship should be fitted out expressly to make investigations into ocean temperatures at all depths, and thus obtain data necessary to complete the determination of the actual oceanic circulation.

M. Guinet, a rich burgher of Lyons, having spent some years of his life and 200,000*l.* of his money in the erection and furnishing of a museum, recently opened in his native town, intended to illustrate the religions of the East, has further applied to have the establishment transferred to Paris, where it would be likely to interest and instruct a larger number of visitors. He has, in addition, offered to consign the whole into the hands of the Government under certain conditions, an offer which has been accepted. A number of priests belonging to the Buddhist and Brahmanic religions are to be brought to Paris, and at fixed salaries employed in translating historical and liturgical books connected with their respective faiths.

The French Government have bestowed fresh honours on the officers of the Meudon steering balloon, one of them having had his name put down on the list for the distinction of a "Chef de Bataillon," while another has been made a knight of the "Légion d'Honneur," and a third, who was wounded in preparing the hydrogen gas, has had the same distinction awarded him. At the same time that we observe the services of these gallant officers so well appreciated, we learn that the steering balloon has been dismantled without undergoing any new experiments, nor do we hear that the Commission appointed by the Academy of Sciences to report on the balloon has published any verdict respecting it.

The Municipal Council of Paris having been called on to vote on the question of a site for the Centennial Exhibition of 1889, have selected the Champ de Mars, the ground on which former exhibitions were held. This unexpected vote on a matter to which in the circumstances of the case great importance was attached has caused a considerable amount of sensation.

"Celsus and his Works" was the subject of the first of a course of lectures during the current session, delivered at the Faculty of Medicine in Paris, by M. Laboulbène. The course is to be devoted to a history of the principal discoveries in medicine and surgery, and the lectures are to appear in the *Revue Scientifique*.

many as 420 people are to be found crowded within the limits of one square kilometre. The total debt of the Government is reckoned at 266,000,000 francs, of which 214,000,000 francs have been contracted within the Empire itself, leaving only 52,000,000 francs of foreign debt. The army is composed of two large bodies: the Tartar army, including the Manchoos and the Mongols; and second, the Chinese army. The Tartar army, guarding Pekin, the frontiers, and the coast, comprises the army of Manchooria of 30,000 men, the Mongolian army of 20,000 men, the Turkestan army of 40,000, and lastly the army occupying the maritime provinces, numbering 100,000. The Chinese army proper is distributed throughout the eighteen provinces, and performs the functions of police in addition to its military duties. Its number ranges from 20,000 to 100,000 in each province, according to its population and its defensive requirements. The navy in 1879 was estimated to comprise fifty-six ships armed with 283 guns, and manned by 5860 marines. Since that date, however, the fleet has been largely developed.

L'Exploration states that the Geographical Society of Amsterdam is about to acquire the fac-simile of the most ancient map known, and which represents the Roman Empire as it was in the time of Augustus. It is formed of eleven folding maps, which make one large map 8½ metres in length. The original is in the Royal Library at Vienna, which purchased it in the sixteenth century from the estate of Conrad Peutinger of Augsburg, a circumstance which gave the map its name of *Tabula Peutingeriana*. Peutinger purchased it for 40 ducats. The original, which is dated 1265, was the work of a Dominican monk of Colmar.

THE deaths are announced of two Italian geographers and travellers, Eugenio Balbi and Carlo Guarmani. The former was the son of the celebrated Adrien Balbi, and was born at Florence in 1812. After several years' travel in Europe, he finally returned to Italy, where he devoted all his energy to the study of ethnography and geographical science. His principal works are: "Gea"; "I monumenti della geografia nell' evo medio e moderno"; "L'Italia nei suoi naturali confini." Guarmani had travelled widely, and in his last years was one of the correspondents of the geographical review of Milan, *L'Esploratore*.

THE Institute of Argentine Geography has decided to organise an expedition into the Andes of Patagonia. The explorers will leave Lake Nahuel-Huapi, and will then undertake a detailed investigation from a geographical point of view of the Argentine slope of the Andes, following it to the Straits of Magellan. The head of the expedition will be Capt. Moyano, who has been instructed to present a report to the Institute at the earliest possible date, indicating the plan of work, the instruments, and other objects necessary, as well as an approximate estimate of the expense. The Federal Government will be requested to grant the co-operation of the troops stationed on the frontiers of Limay, as well as to send a sloop-of-war to act where possible in concert with the expedition.

A TEACHING UNIVERSITY FOR LONDON

IN connection with our leading article this week we append the following Plan for Promoting a Teaching University for London, which was discussed at the meeting:—

A sub-committee was appointed on Monday, November 10, to draw up a plan, in accordance with the objects of the Association for promoting a Teaching University which are as follows:—(1) The organisation of University Teaching in and for London, in the form of a Teaching University, with Faculties of Arts, Science, Medicine, and Laws. (2) The association of University Examination with University Teaching, and direction of both by the same authorities. (3) The conferring of a substantive voice in the government of the University upon those engaged in the work of University Teaching and Examination. (4) Existing Institutions in London, of University rank, not to be abolished or ignored, but to be taken as the bases or component parts of the University, and either partially or completely incorporated, with the minimum of internal change. (5) An advice to be established between the University and the Professional Corporations, the Council of Legal Education as representing the Inns of Court, and the Royal Colleges of Physicians and of Surgeons of London.

The Sub-Committee, consisting of Lord Reay, Chairman, Mr. John Marshall, F.R.S., Ex-P.R.C.S., Dr. W. M. Ord, F.R.C.P., Mr. F. Pollock, Barrister-at-Law, Mr. R. S. Poole, British Museum, Dr. P. H. Pye Smith, F.R.C.P., Prof. G. C. W. Warr, King's College, Prof. A. W. Williamson, University College, and Sir George Young, met and considered the subject of reference, and submitted the following proposed plan of a Teaching University for London for the consideration of the Committee, on Monday, the 15th inst.:—

(*a*) THE CONSTITUTION OF THE TEACHING UNIVERSITY.—To be founded on (1) the *Faculties* or Constituent Bodies; (2) a *Board of Studies* for each Faculty; (3) a Governing Body or *Council*.

(1) *The Council.*—To consist of Members representative of—

(*a*) The several Faculties. The proportion of representatives of the Faculties to the whole number of the Council to be at least one-third.

(*b*) The Senate of the University of London.

(*c*) The Council of Legal Education.

(*d*) The Royal Colleges of Physicians and of Surgeons.

(*e*) It should be a point for future consideration whether other Public Bodies should be directly represented on the Council, *e.g.*, the Authorities of the British Museum, of the Royal Academy and Royal Society, of the Incorporated Law Society, and of the Institute of Civil Engineers.

(*f*) Colleges and other Educational Institutions associated with the University. The amount of representation and the qualification for direct representation on the Council to be determined, in each case, having regard both to the nature and the amount of the educational work performed by the Associated Institution.

(*g*) Endowing Bodies, *e.g.*, the Crown, if the Teaching University should receive State endowment; the Corporation and Companies of the City of London, if they contribute to endow the University.

Representatives of Associated Institutions and Endowing Bodies not to exceed one-third of the whole number of places on the Council.

(2) *The Boards of Studies.*—To be elected by each Faculty. Some additional Members might be appointed by the Council. The Board to advise in all matters relating to the Faculty, and to exercise authority in such matters as are delegated to it by the Council. Facilities to be provided for joint meetings and action of two or more Boards of Studies when necessary. The Board to appoint some or all of the representatives of the Faculty upon the Council. If any are appointed by the Faculty direct, they should also be *ex officio* Members of the Board.

(3) *The Faculties.*—To consist for electing purposes of—

(*a*) Teachers: being Professors, Lecturers, or persons of equivalent standing, in the Colleges or Educational Institutions associated with the University.

(*b*) Examiners for the time being in the Teaching University and in the existing University.

(*c*) Additional Members, to be appointed by the Council, on the recommendation of the Board of Studies.

There might also be Honorary Members of Faculties, including Graduates in that Faculty, of the Teaching University; Members of Convocation of the existing University according to their Degrees; recipients of degrees *honoris causâ*, and so forth; such Honorary Members having the right to attend and vote only at a General Meeting of the Faculty, to be summoned on requisition when necessary.

(*b*) RELATIONS OF THE TEACHING UNIVERSITY WITH OTHER BODIES.—(1) *The Existing University.*—There might be one Chancellor, with two Vice-Chancellors, the Teaching University and existing University constituting one University in two departments. The Degrees might, if necessary, be distinguished by their designation in some suitable manner. The Senate of the existing University would remain unaltered, would be appointed as at present, and would control the present Examinations and confer Degrees, without interference. Convocation might accept the Graduates of the Teaching University as full Members. The Teaching University might, so far as is practicable, find a place of meeting at Burlington House, together with the existing University.

(2) *The Professional Corporations.*—Degrees in Law, Medicine, and Surgery to be recognised as qualifying *pro tanto* for Call to the Bar or for Licence to practise, the power of Calling to the Bar or of conferring Licences to practise being reserved to the existing Authorities. The previous Examinations of the Teaching University to receive recognition by those Authorities, such as is now given to the Examinations of existing Universities.

(3) *Colleges, Educational Institutions, Special Schools, and Institutions for Purposes of Research.*—Each Associated Institution to remain unaffected in any way, save in so far as it might be willing to adopt the recommendations of the University Council.

The School of Law of the four Inns of Court to be an Associated Institution, and its Professors and Examiners to be Members of the Faculty of Law, but without further direct representation on the Council than that already given to the Council of Legal Education.

The recognised Hospital Schools of London to be Associated Institutions, and their Professors and Lecturers to be Members of the Faculty of Medicine.

The direct representation of the Hospital Schools on the Council being difficult, owing to their number, it might be provided that they should all have one representative, at least, on the Board of Studies of the Medical Faculty.

Schools of Fine Art and Technical Schools employing Teachers, some of whom are not engaged in what can be called, strictly speaking, University work, if composing part of an Associated Institution, to be admissible as Special Schools of the University, and their principal Teachers to be Members of the appropriate Faculties.

Junior Schools forming part of Associated Institutions to be admissible similarly as Special Normal Schools, for the purpose of training Teachers.

Institutions for purposes of Research to be admissible as Special Schools, and their Principals or principal Members to be eligible as additional Members of the appropriate Faculty.

Educational Institutions, of which the work is either in kind or quantity insufficient to entitle them to rank as Associated Institutions, while at the same time partaking of a University character, to be similarly admissible as Special Schools.

(*c*) WORK OF THE TEACHING UNIVERSITY.—The Teaching University to obtain power to confer the usual Degrees, either by way of supplemental Charter to the University of London or otherwise, after such course of study and examination as may be determined on.

As means and opportunity will allow, the Teaching University to appoint Professors in the more advanced studies, and for purposes of original research.

The Council to negotiate with Associated Institutions for the increase of facilities for common attendance at lectures, laboratory work, and admission to Libraries and Museums, and for the concentration of teaching within one or more of such Institutions, or within the University itself, in such studies as may appear desirable.

The extent to which it may be found possible to blend the examinations of the Teaching University with those of the existing University, of the Professional Corporations, or of other Examining Bodies, to be determined hereafter, full liberty of action being reserved to the respective Authorities.

Professors, Lecturers, &c., who are Members of the Faculty, to have the title of "——— Professor, Lecturer, &c., of (or on) ——— " in the proposed University; the first blank denoting the College or Institution with which they are connected, preceded by the title (if any) by which their Chair or other office is known.

Students in Associated Institutions and Special Schools to be at liberty to become Undergraduates in the Teaching University, or to obtain Degrees as at present from the existing University.

Signed on behalf of the Sub-Committee,

REAY, *Chairman*

NATURE-DRAWING [1]

BEFORE explaining the objects aimed at in the new drawing classes proposed to be formed in University College School, to be called Nature-Drawing Classes, let us look back and note briefly what we have achieved up to the present time, and gather if we can from it what kind of foundation we have for the work we are about to do, and what our necessities are in order to secure success. Of the past I am able to speak with some authority, having been connected with the drawing classes in this school for nearly forty years. That we have achieved a very considerable success is proved by the high position these classes are known to hold as compared with similar classes in other public schools; also by the fact that every boy who has taken the "Trevelyan Goodall Art Scholarship" in the school and has competed for the Slade Scholarships in the Slade Schools of Fine Art in University College has, without an exception, succeeded in securing the object of his ambition, and in the case where two of our boys were competitors at the same time, they succeeded in carrying off both scholarships, and all in competition with students older than themselves.

Now it is evident that such remarkable success must rest on some very sound foundation. Though there is no doubt that our method of teaching may account in part for this, and in no small part, yet by far the larger part of the foundation of this success has been laid by the zeal, energy, and intelligence in teaching displayed by the assistant drawing-masters, and I desire frankly, and without any reservation whatever, not only to acknowledge their signal ability and their right to the merit due from the results, but also to acknowledge my own indebtedness to their loyalty in giving effect and unity to the method of teaching, without which our success could never have been secured. The teaching has hitherto ranged from the drawing of simple geometrical forms to the drawing of the figure from the antique, together with mechanical drawing, model drawing, and perspective. And now I have a word for the younger boys, who, sometimes, may find the repeated drawing of curved and other lines a little wearisome, but they may rest assured that they are doing valuable work, and acquiring an invaluable power, for it is mainly in the combination of these curved lines, in the perception of their grace, and the power to render them accurately and freely, that the expression of the most beautiful form, and even the recognition of it, at length becomes possible.

That curriculum in our public schools is best which has the greatest elasticity, and is not bound so closely within the four walls of precedent that it is deprived of the power to expand in any direction to meet the necessities of the times. That the teaching of drawing in our public schools has not advanced adequately to meet these necessities will be, in most cases, frankly recognised by the teachers themselves. But the fault does not lie at their door. It is the "governing bodies" of our public schools, and the outside public, who are to blame. The past low estimate of both alike as to the utility of drawing as a serious study has proved the detriment to its advance. Both have recognised in drawing little more than a sort of harmless amusement to keep children out of mischief when not otherwise employed. Both have been blind to the influence which the imitation of beautiful forms must needs have on the minds of the young, and, yet more, to the influence it must have in after life. A love for beautiful form goes far towards making a beautiful life. While due effect is given to the utilitarian side of education, the æsthetic side cannot be ignored, but through literature and art the æsthetic phase of the student's mind should be developed as widely as possible, and, as a help to this, Prof. Huxley has publicly stated his conviction that it should be made *absolutely necessary* for everybody for a longer or a shorter period to learn to draw, and that there is nobody who cannot be made to draw more or less well.

It is proposed to arrange the new nature-drawing classes under two broad divisions, namely, landscape-art and science-art. Let us deal first with the proposed study of landscape-art, and, in order to make the direction these studies are to take the more clear, it were as well to state the direction they are not to take. They are not to take their direction on the old lines of making in a blind, ignorant way, copies from the flat to be "finished off" by the more or less facile pencil of the master, and sent home *as the work of the pupil* at the close of the term. The influence of such palpable dishonesty can only be bad, and the more bad because of the openness with which the fraud is committed. It may be asserted that no fraud is intended, but is not almost every child sensible that there is a very real fraud, to which he has been made a party without his consent, when he shows his drawings and is praised for work he is well aware is not his own? Moreover, do you think he does not recognise how frequently and *easily* the fraud succeeds? But enough of us dismiss it—it is bad. In the "nature-drawing" classes of University College School, landscape-drawing from the flat is to be used only to secure with the pencil and the brush that *technique* absolutely needful. Concurrently, lessons will be given in the shape of lectures on natural phenomena, towards inducing a close, intelligent observation of them, in the belief that a boy will not draw an object—a cloud or a tree from Nature—any the worse, or with any the less interest, because he knows something about it, some scientific facts concerning it. Drawing is a

[1] An address by W. H. Fisk, in part delivered at University College School, Gower Street, London.

f thought as well as of observation, and the measure of thought, s applied to form, is in exact ratio to the knowledge of the auses of it, and the knowledge of them the measure of intelli- nt delight in observing and recording their results. Accept s as a fact—*art cannot be divorced from science*, for it is science hich teaches us to see truly, and by art we render the truth we e. In representing the human figure, this has been a recognised ct for perhaps over two thousand years. They who have drawn e figure finely have been earnest students of anatomy. Yet e anatomy of landscape-forms has been persistently ignored by but a very few. The recognition of the anatomy of landscape an art-study is a very modern recognition indeed. Yet to see ly in order to render truly is of as paramount importance in e representation of landscape as in that of the figure. Indi- dual form is a correlation of scientific facts, a knowledge of which les us to understand its structure and to imitate its appear- ce with correctness. It is mainly with these that we have to if we would represent a mountain, a tree, a cloud. It is true at all forms are modified by their environment—by a ceaseless uggle with the varying conditions by which they are sur- unded—while the modifications are the result of scientific facts the forms themselves are. So, if we would represent objects *ully*, science alone can be our guide; for it is science which aches us to see truly, not through the medium of our fancy, t through the exercise of our intelligence. Thus, for example, these nature-drawing classes, the structural forms of mountains granite, downs of chalk, hills of limestone, will be presented d explained side by side with the forms as they at present ist, and which are the results of modifications produced by rsistent disintegration and denudation owing to the action of ins, frosts, winds, glaciers, streams, &c., during vast lapses of me. So with the structural forms of trees and their environ- ent—whether of Coniferæ on the limits of the snow line; or ees in a dense forest-growth or on the outskirts of a wood; ithin the Arctic Circle or in tropical regions; affected by imatic extremes, by drought or excessive moisture; the free cess of light or through its deficiency; by the repeated action winds mainly in one direction distorting the tree, or their luence in many giving a healthy stimulus to the circulation of e sap.[1] It is needless further to pursue the explanation of the an it is proposed to carry out in landscape-art; enough has een explained to make clear the object in view and the method be pursued. But the student must be prepared for many jections which will be raised: by painters careless of truth, d by some scientists who will insist on divorcing science from t because they feel their own minds chained by love of minute beautiful detail, not thinking it possible for other minds to ert their freedom; by painters too lazy to enter the field of ence, and who will assert that the mission of the artist is to present what he sees, or rather what he fancies he sees, no tter whether he sees truly or falsely; or by people who, mis- ing a certain deftness of handling for a true representation of ural phenomena, will exclaim, "Surely, if such landscape- as we have has been sufficient in the past to secure public plause, will it not suffice to retain that applause for the art of future? or are canvases to be crowded with illustrations of any, geology, meteorology, bryology, and a host of other logies," and then to be called landscape-art?" Such talk as is common enough, but it is sheer nonsense. To the true ist applause is a very small matter: he will not look to the rket for the measure of his success, but he will gauge the ality of his own work, whether it be true or whether it be se. The one question with him is whether his picture is to a painting of fancies which have no existence except in the le mind of the ignorant painter, or is it to give us a represent- ion of facts: in short, is it to be true or is it to be a sham? true artist will ignore scientific truth, for he knows that it is to impossible truly to generalise a multitude of like forms he is ignorant of the special characteristics of any one idual form of the group. He will not ignore scientific e, for that truth is the concrete foundation of all noble, all ical art. There is one sovereign antidote to that poison so ded by some timid minds, viz. the chance that rigid illus- on of scientific fact will dominate the work, and the anti- lies in the *individuality* of the artist. He will clothe all with the poetry of his own nature—with the force of his character. He will be humbly and faithfully dependent on science for his *knowledge* of all form, but it will be on himself that he will depend for that *expression* of it through the medium of a psychical truth which is extra-scientific, and transcends in beauty the visible form of all natural truth, of which it is at once the sublimation and the epitome.

That division of the nature-drawing classes which I purpose to call science-art, presents in its plan a fourfold object. (1) To induce youths while yet at school to take up, seriously, some branch of natural science, with a view, eventually, to original investigation, and to afford them a power, both with pencil and brush, of accurately recording the results of their observation. (2) To supply that demand which Mr. Norman Lockyer informs us is now being made by scientific men, that students in science shall be able to draw. (3) To supply intelligent and artistic draftsmen for scientific purposes and for the illustrating of scientific works. (4) Mainly and especially to engender in young men, before they leave school to enter on the business of life, a love for the pursuit of scientific truth as being amongst the keenest amusements and the truest and most enduring pleasures of life.

In the ultimate purpose of any instruction lies the test of its future usefulness to the student and to society at large. The teaching of children has in it as much the making of the history of a nation as fighting battles and making laws, and earnest teaching is amongst the grandest employments of life, provided it be noble and useful and good. The teaching which is an inducement to a proper use of time goes far to create an environment which will be beneficial to maintenance and pleasure of life mentally and morally alike, and I know of no better use of time than that of scientific inquiry, which should be encouraged in all our public schools. So with drawing. By uniting it with the pursuit of science it will cease to be subject to that derogation it at present suffers through those who regulate, both within and without, the curriculum of our schools. But here in University College School the governing body is, as is well known, liberal to a fault, and the head master takes considerable interest in this new departure in the teaching of drawing.

Time will not permit me to dwell long on the plan to be adopted in the classes for science-art. At the commencement one or more scientific subjects will be selected. In connection with these the collecting of objects will be encouraged for purposes of investigation and illustration, but collecting for the mere sake of collecting will not be countenanced. Let us take entomology as an example. The student will capture the larvæ of a *few* moths or butterflies. Of each of these larvæ he will make careful coloured illustrations from time to time, according to the results of the changes they may undergo. Faithful drawings of the plants they are fed on will be required, also of any evidences of mimicry, defensive or otherwise. Further drawings will be required of the cocoons of such of the larvæ as form them, also of the chrysalis and of the fully developed insect (together with its eggs) and of whatever mimetic peculiarities it may present. From time to time original papers will be required stating minutely the observations made while the insect is being reared. After a time the more advanced pupils will be required to pursue their investigations into its anatomical structure and functions, with the use of the microscope.

A lucid mind will guide the hand to lucid drawing—the last is, as it were, a photograph of the first. The habit of clearly defining the object in the mind will lead to clear and definite work with the pencil. To students in science the securing of this power while at school will enable such to meet the requirements of science-teachers, and will be a source of economy of time and toil. This will form a branch of the teaching in the science-art classes. Moreover it will be the foundation for realising the third object in view, viz. to supply intelligent and artistic draftsmen for scientific purposes, and for illustrating scientific works. In this branch something more—much more—will be required of the pupil than faithful and intelligent exactness of outline of form. For instance, if the boy is drawing some vegetable form, he will be required to observe, closely, not only the peculiarities of the structure, but the *habit* which is the exemplar of the mind of the plant. Further he will be shown wherein the physical beauty of the plant resides, and wherein lies that beauty which is suggestive of some psychical power which, for a purpose beyond that of mere physical form, has tinted the butterfly's wing and the corolla of flowers fertilised by humming-birds. With such instruction there is no reason why the illustrations in works on natural history should not as far transcend most modern illustrations as these transcend those in a nurseryman's catalogue.

[1] Until the student can go direct to Nature he will draw and paint, in the classes, from water-colour studies which have been executed entirely doors, and of which a large number have been kindly lent by different

But the chief aim of the science-art classes will be to encourage a pursuit of scientific truth for its own sake, not for the sake of displaying talent in making beautiful drawings to be praised for them, nor for the money to be got for them when drawn, but, *simply and only, for the sake of the* TRUTH, which will yield us pure and incessant pleasure all our lives, and engender a sincere reverence for the Creator who has clothed his truths in wrappages of beautiful blossoms, and pure crystals, and opalescent clouds; in wrappages, too, which appear mean and even ugly, but they are wrappages only; even sin—that, too, is a wrappage, and looks very ugly, and is very revolting, but it covers some good, some truth which lies hid in every human heart, if we will only seek to find it.

There is a vast amount of real art-power unutilised, and so wasted, in our public schools, through narrowness of purpose in the teaching. It has been so amongst ourselves, though what we have done we have done thoroughly. We have laid a sound foundation in close observation of beautiful form and acquisition of technical power in representing it. In adding to it these nature-drawing classes, we have nothing to unteach. The field of work is simply widened that the power may be the more effectually utilised with more pleasure and with greater profit to the student, not only while at school, but as a pursuit in after life, and possibly drawing many from pleasures which are ugly, coarse, bad, and fleeting. This is a view of nature-drawing which parents might think about not without profit to their children. The pursuit of scientific truth, whether in the shape of landscape-art or of science-art, is a very noble pursuit, a very lasting pleasure; besides which science and art cannot fail to be mutually benefited, mutually advanced, in the long run, by such a conjunction as this, for indeed art loses her right hand when divorced from science, and science loses her right hand when divorced from art.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—The following have been elected to the General Board of Studies:—Mr. H. M. Taylor, by the Special Board for Mathematics; Prof. Liveing, by the Special Board for Physics and Chemistry; Dr. Vines, by the Special Board for Biology and Geology.

The election to the Cavendish Professorship of Experimental Physics will take place on December 22. The endowment of the professorship is 850*l.* a year.

The provision of 100 additional microscopes for the Biology Schools has been sanctioned, and a small charge will be made to students for their use.

Mr. C. T. Heycock, of King's College, has been approved as a Teacher of Chemistry, under the regulations for medical study.

The Syndicate for obtaining plans for a Geological Museum and Chemical Laboratory has been re-appointed.

Clare College offers to give scholarships of from 40*l.* to 60*l.* for Natural Science by examination, beginning March 19 next. The subjects will be Chemistry and Chemical Physics, Botany and Geology. A fortnight's notice will be required. Candidates, who must be under nineteen on the day of examination, must also pass in Elementary Latin, Greek, and Mathematics.

It is announced that in the next Fellowship election at St. John's College (November 2, 1885) regard will be paid to candidates' original dissertations or other writings, the candidates to be prepared to be examined in the subject-matter of the same. Candidates may also be examined in special subjects chosen by themselves, provided they give full and precise information regarding such subjects not later than June 1. The performance of the candidates in the University and other examinations will be regarded.

SCIENTIFIC SERIALS

Journal de Physique, October 1884.—The constitution and origin of group B in the solar spectrum, by M. L. Thollon (one plate).—On the colour of water, by M. J. L. Soret.—The effect of the electrical state of the surface of a liquid on the maximum vapour-tension of the liquid in contact with the surface, by M. R. Blondlot (one figure).—On the measurement of the maxima and minima electromotive forces in cells with a single electrolyte, by M. Emile Reynier (two figures).—Standard cell for the measurement of electromotive forces, by M. Emile Reynier.—On the chemical theory of accumulators, by M. Emile Reynier.—On the electrolysis of solid glass, by E. Warburg.

Journal of the Russian Physico-Chemical Society (Physical Section), vol. xv., 1883.—On an air-calorimeter, by N. Heschus.—On a differential air-calorimeter, by W. Preobragenski.—On the critical temperature of isomerides and bodies belonging to the same homologous series, by A. Nadejdine.—New application of Carnot's theorem, by B. Sresnewsky.—On an algebraic transformation and its applications to mathematical physics, by N. Slouginoff.—On the focal properties of diffracted rays, by M. Mertching.—On the peculiar properties of caoutchouc, by N. Hesehus.—Method of determining the mean tint of a multi-coloured surface, by Th. Petronchewsky.—On the cause and the law of the change of electrical resistance of selenium by the action of light, by N. Heschus.—On the relation between the magnetic moment of a bundle of iron wire, its mass, and the diameter of the constituent wires, by P. Bakmetieff.—Note on organ-pipes, by P. Bakmetieff.—On some phenomena of permanent magnetism, by P. Bakmetieff.—On the luminous phenomena accompanying electrolysis, by N. Slouginoff.—On the theory of gratings traced on curved surfaces.

Royal Academy of Belgium, Nos. 9 and 10, 1884.—Among other communications is a paper by Dr. J. MacLeod describing some interesting particulars respecting the structure and homologies of the anterior intestine of the *Arachnides*. In the *Phalangides* he has found a gland of the same nature and function as the coxal glands recently described by Prof. E. Ray Lankester as belonging to the *Limules*, the *Scorpionides*, and the *Aranéides tetrapneumones*. In the *culs-de-sac*, moreover, of the male gland of the *Trombidium holosericeum*, he has found, in all the individuals examined by him, ovules situated between the mother-cellules of the spermatozoides, though there was no question there of a functional hermaphroditism.—A paper by Émile de Borchgrave gives a graphic sketch of the history of Etienne Douchan, Emperor of Servia, and the Balkan Peninsula in the fourteenth century, and of the events which led up to the battle of Kossovo, the grave of the liberty and greatness of Servia.

Cincinnati Society of Natural History.—In the October *Journal* are two papers by U. P. James: one describing four new species of fossils from the Cincinnati group, the other treating of Conodonts and fossil annelid jaws.

SOCIETIES AND ACADEMIES

LONDON

Mathematical Society, December 11.—J. W. L. Glaisher, F.R.S., President, in the chair.—The Rev. T. C. Simmons, Christ's College, Brecon, and Mr. W. J. Ibbetson, Clare College, were elected members.—Mr. Tucker read a paper on a group of circles connected with the nine-point circle considered as the locus of the intersections of orthogonal Simson lines. If PL, PM, PN are the perpendiculars from any point of the circum-circle on the sides BC, CA, AB of ABC, then LMN is a Simson line: if POP' be a diameter, then the Simson line $L'M'N'$, corresponding to P', intersects LMN at right angles in a point Q, on the nine-point circle, which is also the inscribed circle of the tricusp, enveloped by the Simson lines. These properties were stated in a paper by Steiner ("Crelle," Band liii.). In the present paper points l, m, n are taken on PL, PM, PN, such that $Ll = K.PL$, $Mm = K.PM$, $Nn = K.PN$. It was shown that the lines lmn, $l'm'n'$ intersect at right angles on a system of circles whose centres lie on the line connecting the circum-centre and ortho-centre (H) of ABC, that the sets of Q points (as above) lie on another straight line through H: that the circles are inscribed in tricusps, the points of contact lying on three straight lines symmetrically situated and passing through H. In the special case of no radius, *i.e.* when the (K) circle becomes the ortho-centre, it was seen that the images of any point on the circum-circle with regard to the three sides lie on a straight line through H.—Mr. Tucker then read parts of a paper by Mr. R. A. Roberts, entitled "Notes on the Plane Unicursal Quartic."—Two posthumous notes by the late Dr. Spottiswoode, F.R.S., were communicated, viz. on quadratic transformations, and to find whether a (certain) quadratic transformation be possible.—The Treasurer (A.